new business

City of Palmer
Information Memorandum No. 16-039
Resolution No. 16-024

Subject: Resolution No. 16-024: Adoption of the City of Palmer Wastewater Treatment Plant Facility Plan 2016 Update, Developed by HDR Alaska, Inc.

Agenda of: September 13, 2016

Council Action: ______________________________

Originator Information:			
Originator:	Chris Nall, Public Works Director		
Date:	August 25, 2016	**Requested agenda date:**	September 13, 2016

Department Information √:

Route to:	**Department Director:**	**Signature:**	**Date:**
	Community Development		
√	Finance	[signature]	8/25/16
	Fire Department		
	Police Department		
√	Public Works	[signature]	08/25/2016

Approved for presentation by:

	Signature:	**Remarks:**
City Manager	[signature]	
City Attorney	[signature]	
City Clerk	[signature]	

Certification of Funds:

Total amount of funds listed in this legislation: $ ______

This legislation (√):
- [X] Has no fiscal impact
- [ ] Creates a positive impact in the amount of: $ ______
- [ ] Creates a negative impact in the amount of: $ ______

Funds are (√):
- [ ] Budgeted — Line item(s): ______
- [ ] Not budgeted — Affected line item(s): ______

General fund unassigned balance (after requested budget modification): $ ______

Enterprise unrestricted net position (after requested budget modification): $ ______

Director of Finance Signature: [signature]

Attachment(s):
- Resolution No. 16-024
- City of Palmer Wastewater Treatment Facility Plan 2016 Update

Summary Statement: On January 27, 2015, the City Council authorized the City Manager to enter into and execute a professional services agreement with HDR Alaska, Inc. to update the Palmer Wastewater Treatment Facility Plan.

In coordination with the City Manager, HDR Alaska, Inc., has completed the facility plan update.

This update outlines a way ahead for the City of Palmer Wastewater Treatment Facility to come into compliance with current Environment Protection Agency's permitting requirements.

Administration recommendation: Adopt Resolution No. 16-024.

Introduced by: City Manager
Date: Sept 13, 2016
Action:
Vote:

Yes:	No:

CITY OF PALMER, ALASKA

Resolution No. 16-024

A Resolution of the Palmer City Council Adopting the City of Palmer Wastewater Treatment Plant Facility Plan 2016 Update

WHEREAS, the Palmer City Council voted to update the Wastewater Facility Plan in January 2015, to allowing the Palmer City Manager to enter into and execute a professional services agreement with HDR Alaska, Inc. to develop the City of Palmer Wastewater Treatment Plant Facility Plan 2016 Update; and

WHERAS, the Wastewater Treatment Plant Facility Plan will bring the City of Palmer Wastewater Treatment Plant Facility into compliance with Environmental Protection Agency's permitting requirements; and

WHEREAS, HDR Alaska, Inc. has completed the City of Palmer Wastewater Treatment Plant Facility Plan 2016 Update.

NOW, THEREFORE, BE IT RESOLVED the Palmer City Council hereby adopts the City of Palmer Wastewater Treatment Plant Facility Plan 2016 Update as developed by HDR Alaska, Inc.

Passed and approved by the City Council of the City of Palmer, Alaska this _____ day of September, 2016.

____
DeLena Johnson, Mayor

____
Norma I. Alley, MMC, City Clerk

City of Palmer

Wastewater Treatment Plant Master Plan
(Wastewater Facility Plan)

2016 Update

City of Palmer, Alaska
May 19, 2016; Revised September 1, 2016

City of Palmer Wastewater Facility Plan

Prepared by:
HDR
2525 C Street Suite 500,
Anchorage, AK 99503

Prepared for:
City of Palmer
231 W. Evergreen Avenue
Palmer, AK 99645

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviations

AACE	American Association of Cost Engineers
AD	Anaerobic Digester
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AER	Aerobic
ANX	Anoxic
APDES	Alaska Pollution Discharge Elimination System
ASP	Aerated Static Pile
Ave	Average
BFP	Belt Filter Press
BNR	Biological Nutrient Removal
BOD	Biological Oxygen Demand
City	City of Palmer
COD	Chemical Oxygen Demand
DAFT	Dissolved Air Flotation Thickener
DF	Digester Feed
DO	Dissolved Oxygen
DOE	Department of Ecology
DS	Digested Sludge
EDU	Equivalent Dwelling Unit
EFF	Effluent
EPA	Environmental Protection Agency
FBI	Federal Bureau of Investigation
GBT	Gravity Belt Thickener
GHG	Greenhouse Gases
HRT	Hydraulic Retention Time
IFAS	Integrated Fixed Film Activated Sludge
IN	Inch
INF	Influent
LAS	Lagoon Activated Sludge
MBBR	Moving Bed Bioreactor
MBR	Membrane Bioreactor
MD	Maximum Day
MGD	Million gallons per day
mg/L	Milligrams per Liter
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MM	Maximum Month
MPN	Most Probably Number

MW	Maximum Week
NPV	Net Present Value
O&M	Operations and Maintenance
PCL	Primary Clarifier
PE	Primary Effluent
PE	Population Equivalent
PFRP	Process of Further Reduction of Pathogens
Plan	Wastewater Facilities Plan Update
ppd	Pounds Per Day
PSA	Palmer Service Area
PSL	Primary Sludge
RAS	Return Activated Sludge
RD	Rural Development
RST	Rotating Screen Thickener
sBOD	soluble (filtered) BOD
SAGR	Submerged Attached Growth Reactor
SCL	Secondary Clarifier
SE	Secondary Effluent
SOTE	Standard Oxygen Transfer Efficiency
SRT	Solids Retention Time
SVI	Sludge Volume Index
TKN	Total Kjehldahl Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
TWAS	Thickened WAS
US	United States
USDA	U.S. Department of Agriculture
UV	Ultra Violet
VFA	Volatile Fatty Acids
VSS	Volatile Suspended Solids
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WWTP	Wastewater Treatment Plant

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Executive Summary- City of Palmer Wastewater Treatment Plant Facility Plan Update

ES1 Objective

The purpose of this document is to summarize the work completed in this Wastewater Facilities Plan Update (Plan). The Plan outlines the required upgrades and expansions for the Palmer Wastewater Treatment Plant (WWTP) in order to bring the facility into compliance with its Alaska Pollution Discharge Elimination System (APDES) permit and meet future flow demands for the next 20 years. Capital improvements are separated into near-term and long-term projects and the costs for these improvements have been estimated.

ES2 Introduction

The Palmer WWTP operates under an existing APDES permit No. AK-002249-7. The permit was last renewed in 2007 and has been administratively extended since its expiration in 2011. The current APDES permit limits the peak daily flow capacity of the plant to 0.95 million gallons per day (MGD) and limits the loading of total suspended solids (TSS), biochemical oxygen demand (BOD), ammonia nitrogen, and fecal coliforms to the Matanuska River outfall. The 2007 permit introduced the current ammonia effluent limits (average monthly limits of 1.7 milligrams per liter (mg/L; July-August) and 8.7 mg/L (rest of the year)) due to the presence of spawning salmon in the side channel where treated effluent discharges.

The existing facility provides screening, aerated lagoon treatment, and Ultra Violet (UV) disinfection and was originally designed as a facultative lagoon in the 1970s. The existing aerated lagoon system consistently provides BOD and TSS removal. When the ambient and wastewater temperatures are sufficiently high in the summer, the plant can achieve some level of nitrification but this is inconsistent and the plant is not capable of nitrifying (or meeting its current ammonia effluent limit) for most of the year in its current configuration. The recommended improvements in the Plan are based on bringing the WWTP into compliance with current and potential future permit limits.

ES3 Wastewater Flows and Loads

Current and projected wastewater flows and loads were calculated based on population projections developed in conjunction with the City's other planning efforts. Current economic and political drivers in the state suggest a general slowing of growth for the foreseeable future. In addition to a general slowing of growth, increases to the flows at the Palmer WWTP will be dependent on expansion of the sewer service in the Palmer Service Area (PSA). There have been no major sewer main extensions in the recent past nor are there any anticipated in the near future other than two known subdivisions (Springer Park Subdivision with 23 lots and Mountain Ranch 5 Subdivision with 13 lots).

Primarily due to the hilly topography west of the Palmer city limits, the tendency of new lots to use on-site sewer due to high percolation rates, and the expense of extending new sewer mains, it is anticipated that most of the development in the PSA outside the

Palmer city limits will continue to use on-site septic wastewater disposal. All of the factors discussed above underscore the need to evaluate multiple growth scenarios and develop flexible, phased improvement alternatives for the Palmer WWTP.

It is recommended that the City of Palmer (City) implement improvements at the WWTP for the current average maximum month flow at the plant (0.65 MGD) with plans for phased expansion to average maximum month1.2 MGD and 1.8 MGD, respectively.

ES4 Wastewater Facilities Recommendations

It is recommended that the City look at phasing out the existing lagoon treatment facility over the next 5 years.

The following project phasing plan is recommended:

Phase I: Near-Term modifications to the Palmer wastewater system:

- Initiate grant-funding requests for design and construction of an updated WWTP.
- Construct a new pipeline from the existing headworks to the new treatment facilities, bypassing the existing lagoon system. This will maintain wastewater temperatures and keep them from cooling in the lagoons.
- Construct two Moving Bed Bioreactor (MBBR) aeration basins with a maximum month treatment capacity of 1.2 MGD.
- Purchase and install sufficient MBBR media to treat the projected 2018 average maximum month wastewater flow of 0.65 MGD.
- Construct two secondary clarifiers to remove the solids from the MBBR effluent.
- Construct waste activated sludge (WAS) pumping facilities.
- Waste solids will be pumped to Lagoon 3 for aerobic digestion and storage.
- Annual solids removal with a dredge operation pumping to dewatering geotubes stored in the lined Lagoon 2 area. Sludge will continue to be limed for elevated pH and applied on-site.

The following are recommended Phase II and Phase III: Long-Term changes to the Palmer wastewater system:

Phase II:

- Additional media should be added to match Palmer's population growth and wastewater flow until the flows near an average maximum month flow of 1.2 MGD (1.0 MGD annual average).

Phase III:

- In the event that the wastewater flow rate reaches an average maximum month of 1.2 MGD, an additional MBBR train (concrete tanks, aeration grid, diffusers, retention screens, and media) shall be required. An additional MBBR cell system as proposed will provide up to an average maximum month flow of 1.8 MGD (1.5 MGD annual average)

- Grit removal facilities should be considered in the future to reduce maintenance and potential grit accumulation in the aeration basins.

ES5 Cost Estimates for WWTP Improvements

Costs for these facility improvements are estimated in Table ES-1 below. These are order-of-magnitude costs only for the purpose of comparison of alternatives. The costs are broken down into Phase I: Near-Term Improvements, Phase II: Media Addition, and Phase III: Long-Term Improvements.

Table ES1 Wastewater Treatment Recommended Improvements and Costs

Alternatives	Phase 1 (to 0.65 MGD)	Phase 2 (to 1.2 MGD)	Phase 3 (to 1.8 MGD)
Phase I			
MBBR	$ 5,000,000 - $7,400,000	-	-
Secondary Clarifier	$ 4,800,000 - $7,200,000	-	-
Phase II			
MBBR – Additional media	-	$ 500,000 - $700,000	-
Phase III			
MBBR – Additional cells and media	-	-	$ 2,300,000 - $3,500,000
Project Costs[a]	$ 9,800,000 - $14,600,000	$ 500,000 - $700,000	$ 2,300,000 - $3,500,000
O&M Costs	$ 170,000	$ 171,000	$ 218,000
Net Present Value (NPV) Costs	**$ 12,500,000 - $17,300,000**		

Note[a]: These are "Project Costs," which include construction costs, engineering, and city administration costs and are given as a range based on typical expected accuracy at this planning level.

Cost estimates prepared as part of the Facilities Plan are order-of-magnitude, Class 5 estimates, as defined by the American Association of Cost Engineers (AACE). According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

CLASS 5 ESTIMATE - Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20% to –50% on the low side and +30% to +100% on the high side.

MGD = million gallon(s) per day

MBBR equipment includes media, stainless steel aeration grid and diffusers and media retention screens.

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1.0 Introduction

The purpose of this Wastewater Facilities Plan Update (Plan) is to outline the required upgrades and expansions for the Palmer Wastewater Treatment Plant (WWTP) in order to bring the facility into compliance with its Alaska Pollution Discharge Elimination System (APDES) permit and meet future flow demands through 2035. The Plan is an update to the previous facility plans and thus does not include a full document per Environmental Protection Agency (EPA) Facility Plan Guidelines but focuses on identifying alternatives to bring the WWTP into compliance with current and potential future permit limits (particularly the effluent limit for ammonia).

The development of this Plan included the following items, which are discussed in this Plan update:

1. An estimate of existing and projected flows and loads.
2. Review of regulatory requirements.
3. Evaluating process alternatives for meeting current and future flow demands and effluent limits.
4. Developing potential site layouts to accommodate facility improvements and future expansion.
5. Developing planning-level cost estimates for recommended alternatives.

1.1 Background

The project planning area includes the City of Palmer (City) and surrounding area. Treatment of wastewater occurs at a single facility located south of the City on Brooks Road. Existing infrastructure will be utilized to the extent possible to reduce capital costs.

The existing Palmer WWTP, an aerated lagoon treatment system, discharges to an unnamed side channel in the Matanuska River floodplain. This small, clear-water side channel has been designated by the Alaska Department of Fish and Game (ADF&G) as an anadromous spawning stream where salmon spawning occurs.

For purposes of planning the wastewater treatment plant improvements, a 20-year planning period will be utilized. The plan is being developed and design of improvements is expected to begin in 2016. Therefore, wastewater flow projections were developed to 2035 utilizing the growth projections and development trends discussed in the following sections.

1.2 Plant History

The original Palmer WWTP was constructed in the 1950s and consisted of a single facultative lagoon, which is now Lagoon 3. The City added Lagoon 2 as it expanded to an aerated lagoon system in 1972. Lagoon 1 was added in 1985 to address continued expansion and growth in the City. The timeline below provides a summary of significant upgrades and improvements to the facility over its operating history:

- 1972: A chlorine contact chamber was built for wastewater disinfection. At this time a lab was established to comply with EPA regulations. There have been many improvements and upgrades to the plant since 1985.
- 1988: A new headworks building was constructed as well as manhole flow control structures.
- 1998: A new blower building, new blowers, and improved aeration system was installed to improve the dissolved oxygen levels in the ponds and to help to reduce odor complaints from neighbors of the lagoons.
- 2001: Baffle curtains were added to the existing ponds to reduce short circuiting in the ponds.
- 2002: A new headworks building was built which contains an Auger Monster grinder and screen which is able to screen, grind, wash, compact, and deposit solids into a stainless steel dumpster.
    - A new building was constructed to house the Ultra Violet (UV) equipment. This upgrade allowed the treatment plant to eliminate both sodium hypochlorite and sodium bisulfate, which eliminated all chemical treatment of the wastewater.
    - Backup power generators were also added at this time to the headworks building and the UV building to insure continued operation in case of a power outage.
- 2003: An equipment storage building was constructed to store the newly purchased dredge and portable generator (used for powering the dredge) and the various vactor trucks and other sewer related equipment.
- 2010: Lagoons 1 and 2 were covered with 4 inch insulated panels made by Lemna Corporation. The existing baffles in Lagoons 1 and 2 were replaced with new baffles at the same time. By insulating the pond, the intent was to maintain the temperature of the incoming wastewater further through the ponds to facilitate ammonia removal.
    - A second UV treatment system was purchased and installed in the UV building. At the time of construction a second channel was provided for future expansion. This gave the City redundancy and the ability to disinfect up to 2 MGD.
- 2012: New, more efficient, blowers were installed. These are high capacity blowers and are to be controlled by dissolved oxygen sensors installed in the ponds.
- 2014: A new Auger Monster was purchased and installed in the headworks building. This gave the city redundancy with the grinders and the ability to perform maintenance on the grinder units without bypassing the headworks building.

1.2.1 Previous Wastewater Treatment Plant Studies

The City has been working with the EPA and the Alaska Department of Environmental Conservation (ADEC) since ammonia limits were first established in the discharge permit in 2000. The 2000 permit included an average monthly ammonia (as N) limit of 34 milligrams per liter (mg/L). The 2007 permit renewal included more stringent ammonia effluent limits and established seasonal limits during salmon spawning months. Meeting the stringent discharge limits has proven difficult for the aerated lagoon treatment system during the winter months. Palmer has performed a number of studies over the years to improve ammonia treatment performance. The timeline below summarizes previous studies performed for the plant (since the introduction of ammonia effluent limits):

- 1999: Preliminary Engineering Report/Facility Plan (LCMF & G.V. Jones & Associates (GV Jones)) – This Preliminary Engineering Report (PER) identified alternatives to upgrade the facility to meet the then upcoming ammonia limits at the facility and provide capacity for expected growth in the area.
- 2007: Current Permit Issued (low ammonia limits) – This permit has been administratively extended since expiration in 2011.
- 2008: Preliminary Engineering Report/Facility Plan (Hattenburg, Dilley, & Linnell, LLC (HDL) and GV Jones) – PER to address the required plant upgrades and expansions to address the more stringent 2007 ammonia limits as well as expected growth in the Palmer Service Area (PSA).
- 2009-2010: Regional Wastewater and Septage Treatment Study (HDL, HDR, and GV Jones) – This study evaluated regional treatment plant options for the communities of Palmer, Wasilla, and the Matanuska Susitna Borough. This study also included further analysis of the Palmer WWTP to address short and long term facility planning.
- 2009-2010: Subsurface discharge option (HDL) – A separate study was conducted around the time of the regional wastewater study to assess the viability of subsurface discharge on the property immediately adjacent to the west of the Palmer WWTP.
- 2009-2010: Preliminary Evaluation Report (Ecological Engineering Group, Inc.) - A separate Preliminary Evaluation Report, prepared to address compliance with ammonia limits, recommended covering the aerated lagoons and installing a Solar Aquatic System® (greenhouse) for nutrient removal.
- 2011- 2014: The City, with consultation from AlaskChem Engineering, evaluated several attached growth treatment alternatives and awaited a compliance order by consent from ADEC.

1.3 Implementation and Timing Issues

Planned improvements to the City's wastewater treatment facilities are discussed in Chapter's 5.0 and 7.0 of this facility plan update. The City has developed a schedule for the implementation of improvements over the next several years based upon the ability to meet the current and proposed APDES permit limits, the estimated growth in sewer services, the City's treatment plant capacity requirements, and available funding sources. The implementation schedule generally includes the following:

1. June 2016: Agency Review of the Facility Plan Update
2. Summer 2016: Preliminary Design of Plant Improvements and Permit Applications
3. Fall-Winter 2016: Final Design of Plant Improvements
4. Spring 2017: Bid Period and Construction Contractor Selection
5. Summer 2017- Fall 2018: Construction of Wastewater Treatment Improvements

2.0 Basis of Planning

The following section discusses factors affecting the design criteria for the WWTP evaluation and basis of planning for this Plan including; water quality, current and future regulatory requirements, and basis for project cost evaluation.

2.1 Water Quality and Regulatory Requirements

The City currently operates their WWTP under ADEC APDES Permit No. AK-002249-7. The permit was last renewed in 2007 and has been administratively extended since its expiration in 2011. The 2007 permit introduced the current ammonia effluent limits due to the discovery of spawning salmon in the side channel where treated effluent discharges. Current APDES permit limits are summarized in Table 1 below.

Table 1: Current APDES Permit Limits

Parameter	Units	Effluent and Influent Limits			Monitoring Requirements		
		Average Monthly Limit	Average Weekly Limit	Maximum Daily Limit	Monitoring Location	Monitoring Frequency	Sample Type
Ammonia (as N)	mg/L	8.7	-	18.5	effluent	1/week	grab
	lbs/day	68.9	-	146.6			
Ammonia (as N) (July & August)	mg/L	1.7	-	3.6	effluent	1/week	grab
	lbs/day	13.5	-	28.5			
BOD	mg/L	30	45	60	Effluent and influent	1/week	24-hour timed composite
	lbs/day	258	357	475			
	% Removal	See I.B.3.					
DO	mg/L	≥2 at all times			effluent	1/month	grab
Fecal Coliform Bacteria	FC/100 mL	100	-	200	effluent	1/week	grab
Fecal Coliform Bacteria (July & August)	FC/100 mL	20	-	40	effluent	1/week	grab
Flow	mgd	-	-	0.95	effluent or influent	continuous	recording
pH	s.u.	6.5-8.5 at all times			effluent	5/week	grab
TSS	mg/L	30	45	60	effluent and influent	1/week	24-hour timed composite
	lbs/day	258	357	475			
	% Removal	See Part I.B.3.					
Residue	-	See Part I.B.2.			effluent	1/week	visual
Petroleum Hydrocarbons	-	See Part I.B.2.			effluent	1/week	visual
Total Residual Chlorine	µg/L	1.7	-	3.4	effluent	2/week	grab
	lbs/day	0.013	-	0.027			
Temperature	C°	-	-	-	effluent	5/week	grab
Whole Effluent Toxicity	TU_c	-	-	-	effluent	3x/5 years	grab

The recommendations contained in this plan are based on meeting the current effluent discharge permit conditions. However, based on discussions with ADEC it is likely that a renewed permit, with new effluent criteria, will be issued in the near future. The City is currently working with the ADF&G and ADEC to determine likely permit limits in the upcoming permit renewal. Issues currently being discussed include:

- Seasonal limits – The City is awaiting input from ADF&G on the length of the salmon spawning season in the side channel where treated effluent discharges (July-August in the current permit). The City is also waiting on input from the Alaska Department of Law on the applicability and continued use of seasonal discharge limits in a new permit for the facility.
- Utilizing ADEC's recently developed *Reasonable Potential Analysis and Effluent Limits Development Guide and Tool* to calculate potential future Water Quality Based Effluent Limits. The reasonable potential calculations are being developed based on available monitoring data of the effluent and receiving water from 2010 through 2014 with both seasonal mixing zone and no mixing zone scenarios.

The alternatives analyses performed for this Plan have been developed based on meeting the current effluent discharge permit conditions as well as a scenario involving no allowance for a seasonal mixing zone and year-round limits of 1.7 mg/L ammonia (average monthly limit).

2.2 Basis for Cost Estimates

Estimates of the project and operations and maintenance (O&M) costs associated with the preferred treatment alternatives were prepared and used during the evaluation process. All cost estimates prepared as part of the Plan are order-of-magnitude estimates, as defined by the American Association of Cost Engineers (AACE). An order of magnitude estimate is one that is made without detailed engineering design data, and uses techniques such as cost curves and scaling factors from similar projects. Cost estimates for each alternative are presented in the following sections and detailed cost estimates are included in Appendix A.

The estimates have been prepared in accordance with the guidelines of the AACE International. According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

CLASS 5 ESTIMATE - Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20 percent (%) to –50% on the low side and +30% to +100% on the high side.

2.2.1 Project Costs

The project costs presented in the Plan include estimated construction dollars, contingencies, permitting, administration, and engineering fees. Construction costs are based on preliminary layouts for treatment alternatives, and suggested unit process sizes. The costs have been estimated based on information from cost estimating guides, budgetary estimates provided by equipment manufacturers, and experience gained while designing similar facilities.

While the estimated construction costs prepared at the planning level are intended to represent average bidding conditions for projects that are similar in nature, variations in the bidding environment at the time of project implementation will likely affect actual construction costs. The alternatives presented herein will also likely be refined during the preliminary and final design phases, affecting overall project costs.

Preliminary cost estimates prepared during the planning effort include the costs to construct the improvements as well as a number of additional factors, including an allowance for the contractor’s overhead and profit and mobilization/demobilization costs. Other factors used, based on a percentage of construction costs, are:

- Contingency: 25%
- Electrical, instrumentation, and control: 25%
- Mechanical: 15%
- Engineering and Construction Management: 25%
- City administration and legal: 5%

2.2.2 Operation and Maintenance Costs

O&M costs are based on estimated manpower needs, resource requirements (power and chemicals), and equipment replacement and maintenance costs. For certain analyses, the O&M costs were considered to be equivalent for the alternatives, so they were left out of the calculations. Where they were included, O&M costs were estimated by projecting existing costs into the future and modifying those costs to reflect process changes.

2.2.3 Net Present Worth Methodology

Economic evaluations of the alternatives presented in this plan are based on comparison of their estimated net present worth (NPW). An alternative's NPW is an estimate of the dollar value that would need to be invested in year zero, given an appropriate interest rate, in order to finance all capital and O&M costs that will be incurred over the planning period. Although all of the alternatives are assumed to have the same useful life over the planning period, each will have different capital and O&M cost requirements. Determination of the NPW is a way to compare alternatives on an equivalent basis.

Given estimates of project and O&M costs, the associated NPW is calculated by the equation:

NPW = PWp +PWO&M

Where: PWp = present worth of capital costs, including all initial and phased construction

PWO&M = present worth of O&M costs incurred over the planning period

The factors used are:

- Planning period: 20 years (2015 to 2035)
- Interest rate (assumes rate similar to the ADEC State Revolving Fund loan): 2.0%
- General inflation: 2.0%

Other factors that can affect NPW economic analyses include equipment depreciation and replacement costs. These factors were not considered in the planning-level economic analyses.

3.0 Wastewater Treatment Facilities

3.1 Service Area Description and Land Use

The City was established as a farming colony in 1935. The City is located approximately 42 miles northeast of Anchorage, Alaska on the Glenn Highway in the Matanuska Valley. The City began operating the WWTP in its current location in the 1950s as a single facultative lagoon system. The WWTP has expanded over the years as the community has grown and the sewer service area has expanded.

The current Palmer WWTP service area includes commercial and residential properties within and adjacent to the City limits. The Palmer Service Area (PSA), as approved by the Regulatory Commission of Alaska (RCA), was expanded in 2004 to its current size (31.1 square miles) and is approximately bounded by Palmer Fishhook Road (north), the Matanuska River (east), the Glenn Highway (south), and Trunk Road (west). See Figure 1 for a map of the current PSA boundaries.

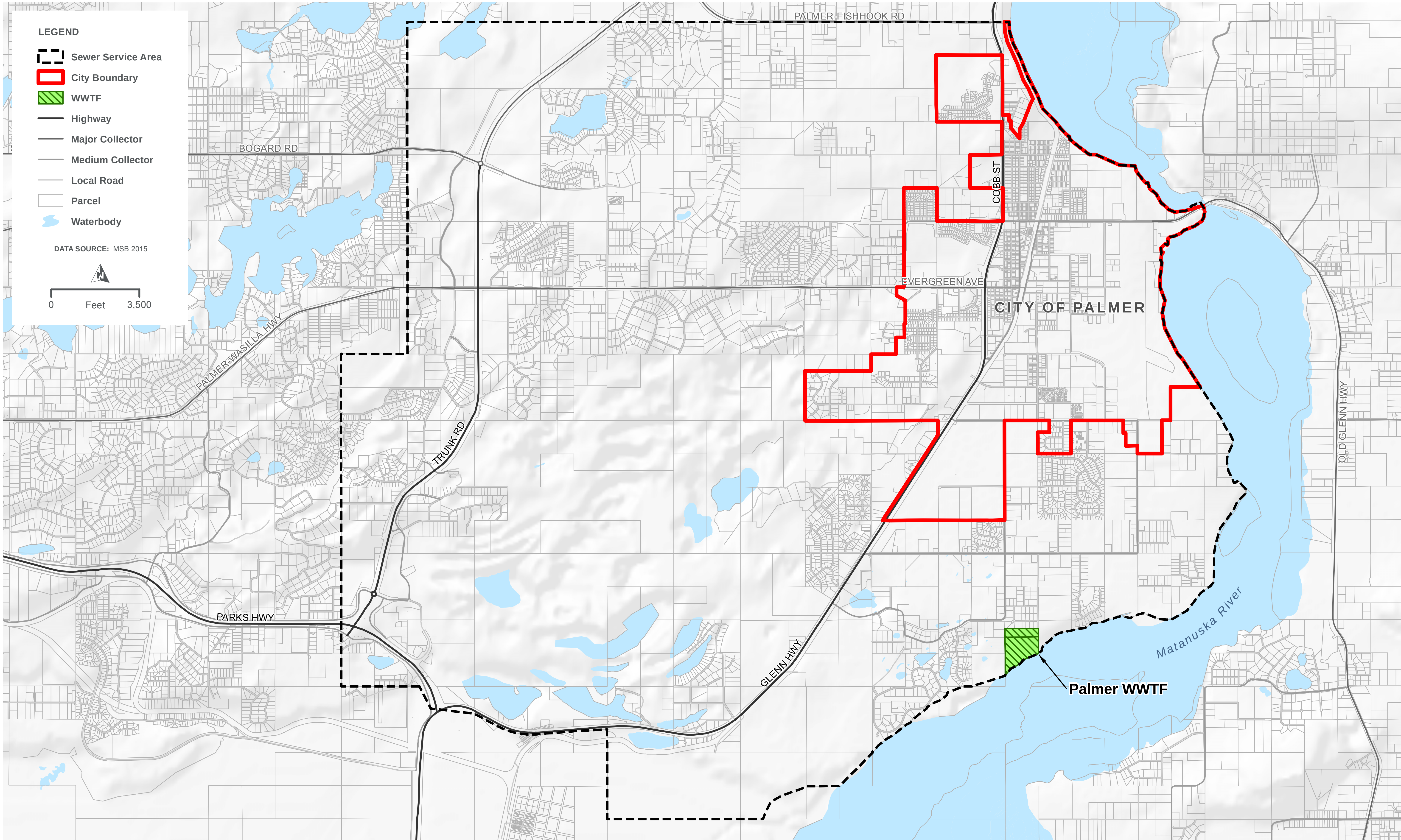
3.1.1 Existing Sewer Collection System

Most of the properties within the City limits are served by the Palmer wastewater collection and treatment system. The existing sanitary sewer collection system has 1,907 connections, which represents approximately 90% of the current City population and several parcels outside of the City but within the PSA. The parcels connected to the sewer collection system are shown in Figure 2.

Some portion of the future development and population growth within the City limits will be in areas outside the PSA. For planning purposes, it is assumed that 95% of population growth in the City will be in areas currently serviced by sewer. The remaining 5% of the City's growth in the planning period will use private on-site septic systems.

There are currently approximately 12 residential sewer services outside the City, but within the PSA. These services are located in the Mountain Ranch Subdivision immediately south of the City limits. There are three commercial sewer services outside the City but within the PSA located at or near the Matanuska-Susitna Regional Medical Center complex approximately three miles southwest of the City at the intersection of Trunk Road and the Parks Highway. Figure 2 provides a map of existing residential and commercial sewer services within the City and the PSA.

Large portions of PSA are not served by the Palmer sewer utility. All development in the PSA not served by Palmer's sewer system uses on-site septic waste disposal approved by the ADEC.



HDR

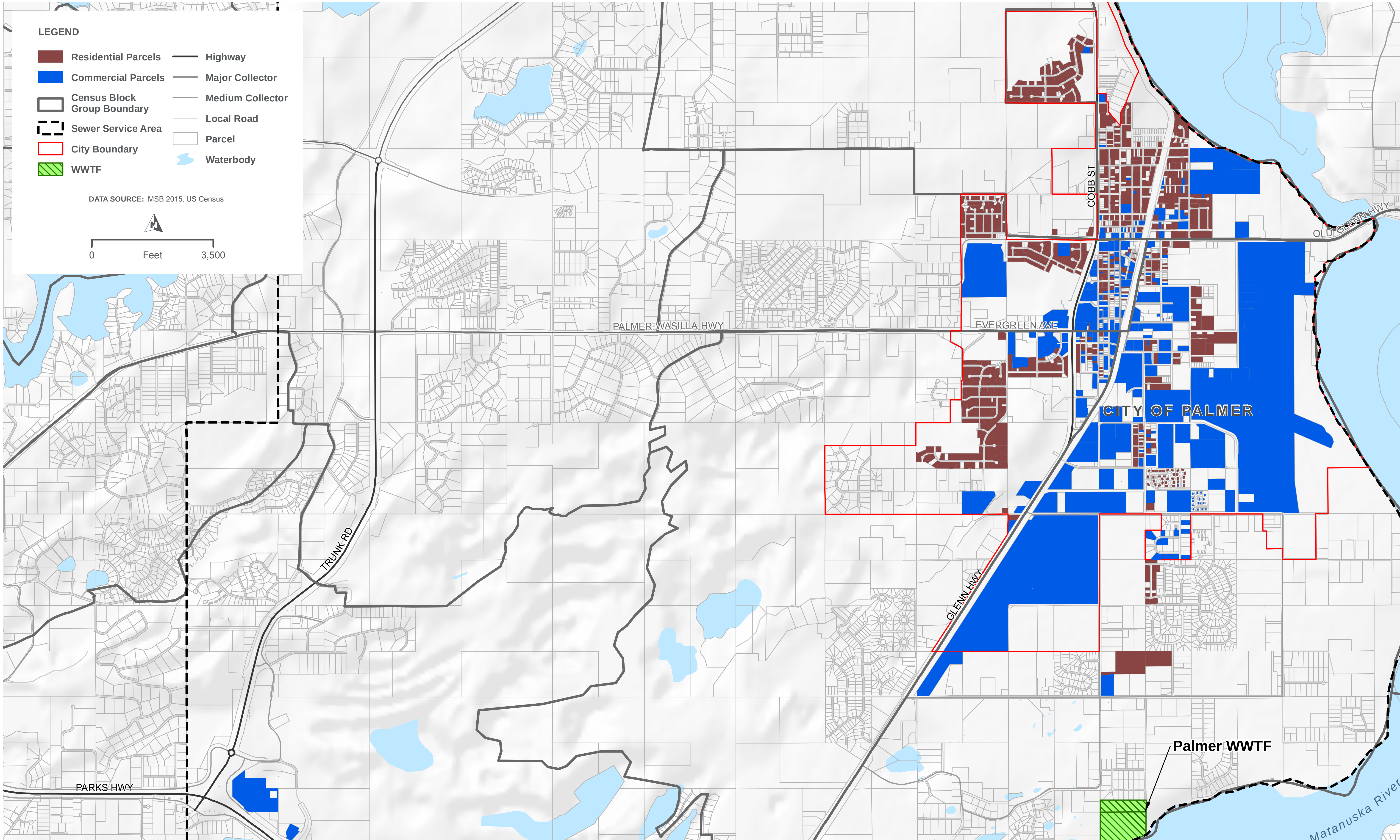
SEWER SERVICE AREA OVERVIEW

CITY OF PALMER, ALASKA

FIGURE # 1

PALMER WASTEWATER TREATMENT PLANT FACILITY PLAN UPDATE

PATH: Z:\200435 CITY OF PALMER\249258 WWTP FACILITY PLAN UPDT\GIS\MAP_DOCS\PALMERWWTF_SERVICEAREA.MXD - USER: SNORTON - DATE: 7/14/2015



HDR

SEWER SERVICE SERVED PARCELS

CITY OF PALMER, ALASKA

FIGURE #2

PATH: Z:\200435 CITY OF PALMER\249258 WWTP FACILITY PLAN UPDT\GIS\MAP_DOCS\PALMERWWTF_PARCELSERVED2.MXD - USER: SGROSENI - DATE: 2/3/2016

PALMER WASTEWATER TREATMENT PLANT FACILITY PLAN UPDATE

3.1.2 Planned Sewer System Growth

The City has no major sewer main extensions planned in the near future. The only anticipated growth in new sewer customers involve new subdivisions within City limits, service connections to existing Palmer sewer mains, and connections from two subdivisions in the PSA. There are some areas of the City where sewer and water utility service is available but must be extended a few hundred feet to connect to service. The Helen Drive area, containing an estimated 30 households is served by water service but not sewer service.

There are two residential subdivisions under construction south of the City within the PSA that will have Palmer sewer service. These are Springer Park Subdivision with 23 lots and Mountain Ranch 5 Subdivision with 13 lots.

3.2 Population Forecasts

The City population in 2010 was 5,937, according to the 2010 Census data (U.S. Department of Commerce, 2012). The total population for the Matanuska-Susitna Borough (MSB) in 2010 was 88,995 (2010 Census data), below provides the historical population in both the MSB and Palmer. The calculated historical growth rates are identified in Table 2.

Table 2: Historical Population in Palmer and the MSB, 1960 to 2010

Year	MSB	Palmer
1960	5,188	1,181
1970	6,509	1,140
1980	17,816	2,141
1990	39,683	2,866
2000	59,322	4,533
2001	62,536	4,489
2002	65,280	4,646
2003	68,087	4,807
2004	70,956	4,972
2005	73,888	5,140
2006	76,882	5,311
2007	79,939	5,486
2008	83,059	5,665
2009	86,241	5,847
2010	88,995	5,937

Notes: Years 1960 to 2000 were obtained from the Alaska Department of Labor and Workforce Development website (State of Alaska, 2012).

Source: Source for U.S. Census data: U.S. Department of Commerce, U.S. Census Bureau, 2012.

Table 3: Calculated Historical Growth Rates

Area	Growth Rate	Description
MSB	4.10%	MSB annual growth rate, 1990 to 2000
	4.14%	MSB annual growth rate, 2000 to 2010
City of Palmer	4.69%	Palmer annual growth rate, 1990 to 2000
	2.73%	Palmer annual growth rate, 2000 to 2010

The population numbers above represent the historical growth for the City. The last detailed analysis of the total population within the PSA was completed in 2007 as part of the *Palmer Annexation Study* (Northern Economics). The total PSA population was estimated to be 11,836 in 2007 and that number has been utilized as the base PSA population number for planning purposes.

The base populations from the 2010 Census shown in Table 2 (along with the 2007 PSA base population estimate) have been used as starting populations for population projections during the planning period. Population projections for the City and the PSA were developed using three different sources including:

- United States Census data – One population growth scenario has been developed based on a trend analysis (polynomial) of the historical Census data. A similar analysis was used by the MSB Planning & Land Use Department to project future population for their *Matanuska-Susitna Borough 2014 Housing Needs Assessment*. This scenario assumes moderate growth.
- State of Alaska Department of Labor and Workforce Development (DOL) projections – A second population growth scenario uses 2014 population projection rates published by the Alaska DOL. This scenario reflects the most current population projections released by the DOL and assumes a slow to moderate growth rate in the region.
- Institute of Social and Economic Research (ISER), University of Alaska Anchorage population growth rates - Prior studies for the Palmer/MSB area (2008-2010) have used the growth rates published in the 2005 ISER publication Economic and Demographic Impacts of a Knik Arm Bridge (Goldsmith, 2005). These growth rates assumed relatively fast growth in the area, which has not occurred as predicted and would require a large influx of new residents or births.

The projected City population for each scenario described above is shown Table 4 below.

Additional discussion of projected population growth as well as system development drivers is included in Chapter 3.3– Wastewater Flow & Loading Projections.

Table 4: Total Population Projections for City of Palmer, 2014 to 2035

Year	Palmer, Census Growth Scenario	Palmer, DOL Growth Scenario	Palmer, ISER Growth Scenario
2014	6,810	6,053	8,823
2015	7,014	6,205	9,035
2016	7,220	6,362	9,207
2017	7,431	6,522	9,455
2018	7,645	6,686	9,720
2019	7,862	6,855	10,031
2020	8,083	7,028	10,352
2021	8,307	7,205	10,684
2022	8,535	7,386	11,036
2023	8,767	7,557	11,411
2024	9,002	7,732	11,799
2025	9,241	7,911	12,189
2026	9,483	8,094	12,542
2027	9,728	8,282	12,893
2028	9,978	8,456	13,267
2029	10,230	8,634	13,652
2030	10,487	8,816	14,048
2031	10,746	9,002	14,455
2032	11,010	9,191	14,874
2033	11,277	9,366	15,306
2034	11,547	9,544	15,750
2035	11,821	9,725	16,206

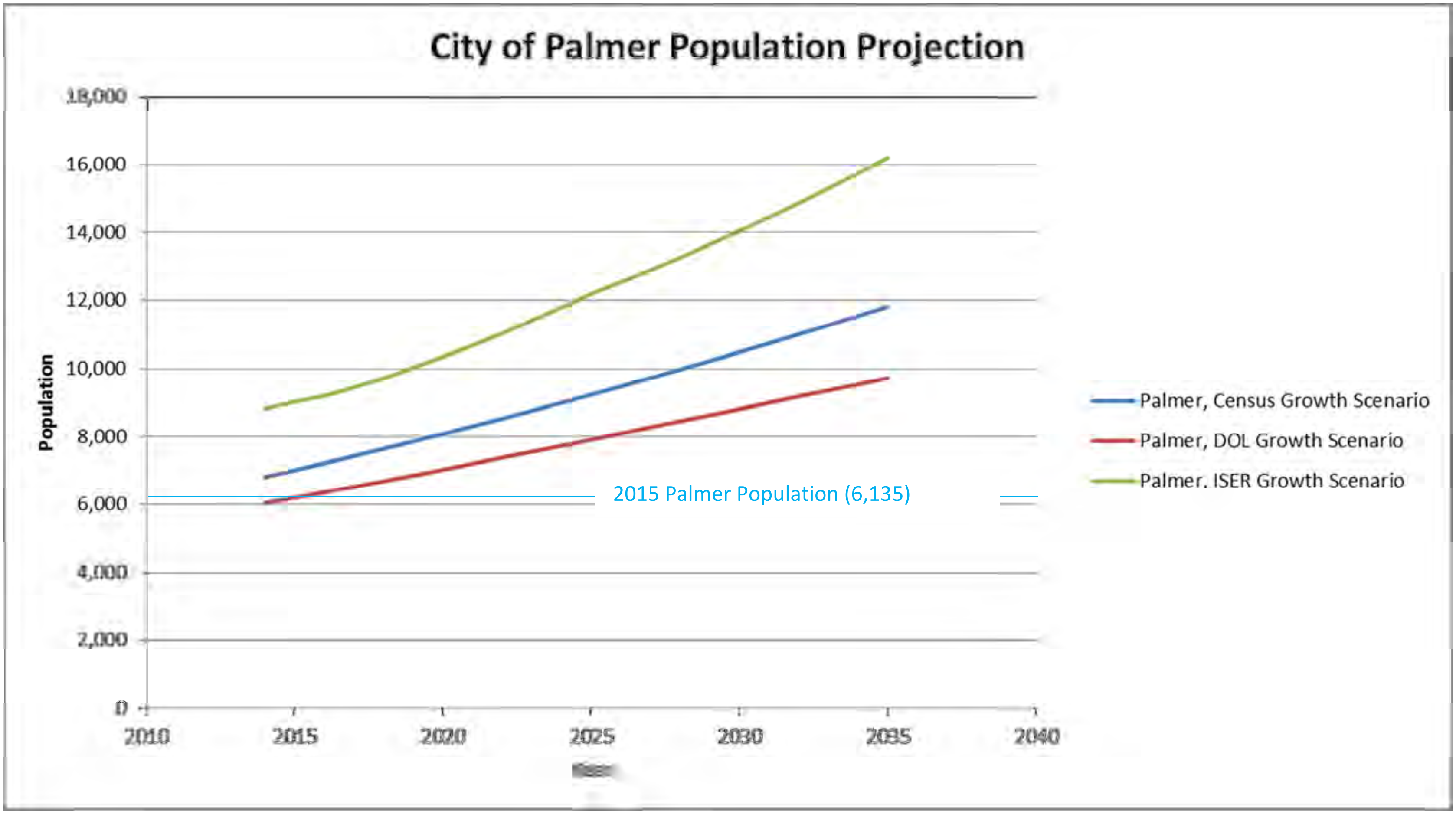


Figure 3 City of Palmer Population Projection

Table 5: Total Population Projections for Palmer Service Area, 2014 to 2035

Year	PSA, Census Growth Scenario	PSA, DOL Growth Scenario	PSA, ISER Growth Scenario
2014	13,160	12,170	17,164
2015	13,363	12,322	17,576
2016	13,570	12,479	17,910
2017	13,781	12,639	18,394
2018	13,994	12,803	18,909
2019	14,212	12,972	19,514
2020	14,433	13,145	20,138
2021	14,657	13,322	20,783
2022	14,885	13,503	21,469
2023	15,117	13,674	22,199
2024	15,352	13,849	22,953
2025	15,591	14,028	23,711
2026	15,833	14,211	24,399
2027	16,078	14,399	25,082
2028	16,328	14,573	25,809
2029	16,580	14,751	26,558
2030	16,837	14,933	27,328
2031	17,096	15,119	28,120
2032	17,360	15,308	28,936
2033	17,626	15,483	29,775
2034	17,897	15,661	30,638
2035	18,171	15,842	31,527

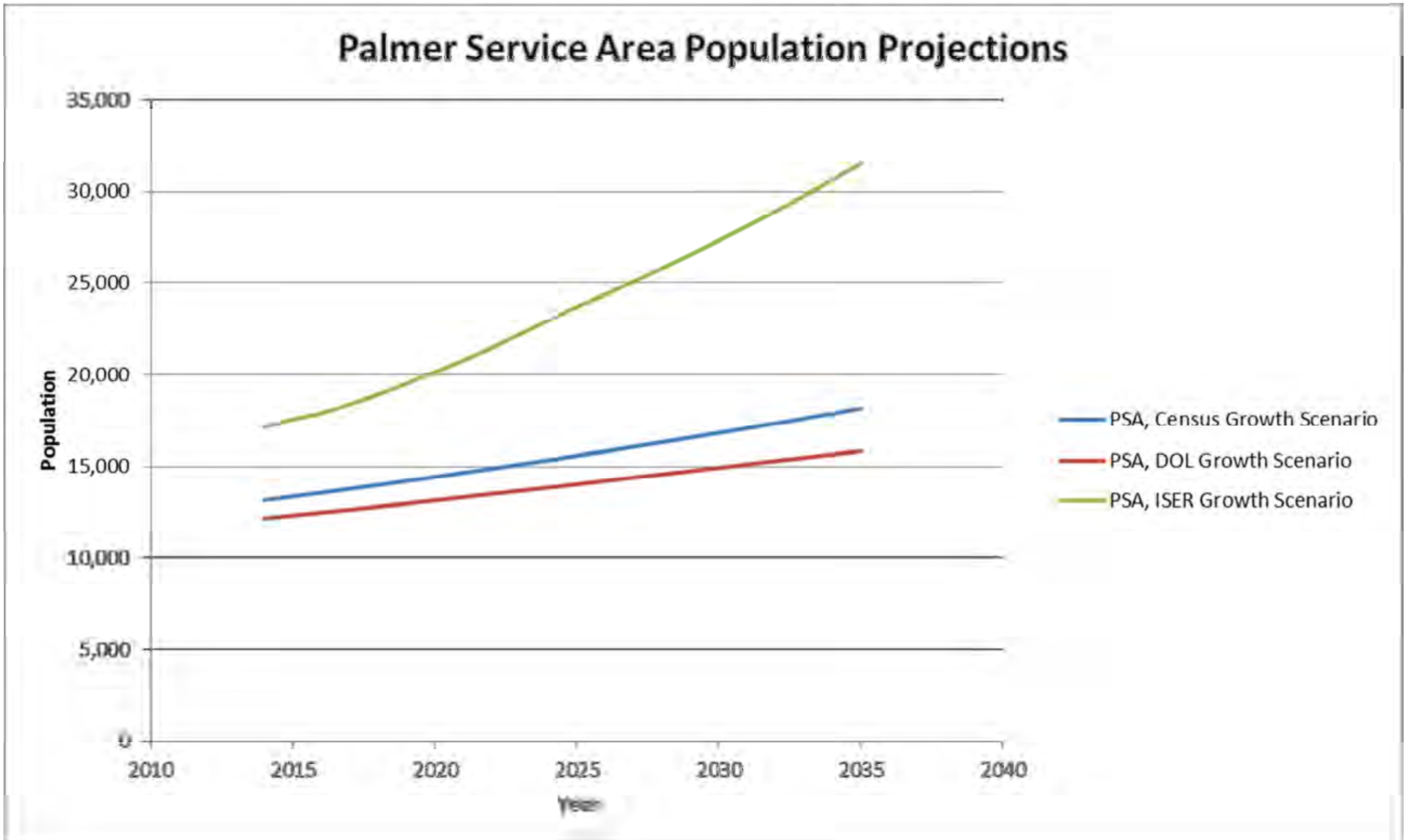


Figure 4 Palmer Service Area Population Projections

3.3 Wastewater Flow and Loading Projections

Wastewater flow projections are the fundamental criteria on which the sizing and design of collection and treatment facilities are based. To identify and characterize future wastewater flows for the planning period of the Plan, historical flow data and treatment plant records have been evaluated. This chapter presents results of an analysis of wastewater flow data and establishes annual average and peak variations in flow and loads. This chapter also includes projections of future wastewater collection and treatment requirements based on served population estimates..

Flow projections can be made by many methods, all of which involve some level of judgment and uncertainty. The following sources of data are typically used to project future wastewater flow volumes and loads:

- Wastewater treatment plant flow records
- Population projections
- Water consumption records
- Wastewater sample analyses data
- Other planning studies and technical reports

The projections presented in this section were developed primarily from population projections (Chapter 3) and existing wastewater records. The subsections below discuss various components of wastewater and other wastewater flow and load projections used in evaluating the Palmer system.

3.3.1 Existing Wastewater Flows and Waste Loads

Available data was obtained from the City staff for current wastewater flow rates and loadings. The historical records from 2007 to 2014 provided an extensive record of the quantity and quality of wastewater collected, treated, and discharged. Combined with population data and commercial/industrial flow assumptions, per capita flow and load contributions were determined for projected flows and loads. An analysis of summer and winter conditions indicated that influent flows and loads do not vary significantly between the seasons, and the higher values for influent flows and loads were used in developing design criteria. Table 5 presents a summary of the 2015 plant influent flows and loadings.

Table 5: Summary of 2015 Flows and Loads

		Average	Maximum Month	Maximum day
Flow	mgd	0.54	0.65	0.76
TSS	lb/d	1,099	1,618	2,513
VSS	lb/d	990	1,457	2,262
BOD	lb/d	1,009	1,515	2,417
TKN	lb/d	171	258	411
NH4-N	lb/d	115	173	275

Wastewater Composition:

Wastewater flows to the WWTP consist of four major components: (1) domestic sewage, (2) commercial and industrial wastewater, (3) Infiltration and Inflow (I&I), and (4) other hauled wastes introduced into the system. Domestic sewage is the principal component of flow in the Palmer wastewater system. Primary contributors of domestic sewage include residential areas. These flows are characterized by diurnal variations (higher flows in the morning and evening, lower flows at night) but remain fairly constant throughout the year. It is assumed that the commercial and industrial flow contributions are small, compared to the total flows and are generally similar in nature to domestic wastewater. It is reasonable to assume that increases in commercial and industrial flow are proportional to population increases, and that as population grows, the size and number of commercial establishments increase. For these reasons, future commercial flows have not been estimated separately; rather, they are included in the overall domestic flow projections.

Institutional flows, from such buildings as hospitals, schools, and nursing homes, are also part of the commercial flow and can vary significantly, depending on occupancy rates, the time of year, and other factors. Because institutional flows increase proportionally with population, they have been included in the domestic flow projections.

An analysis of I&I into the system was conducted for the *2010 Regional Wastewater and Septage Treatment Study* (HDL, HDR, GV Jones). The study found that typical I&I events (such as high rainfall events or high snowmelt events) can increase daily flows to the WWTP by approximately 9 to 12 %. The maximum peak day recorded influent flow for the time period between 2010 and 2014 was approximately 1.5 MGD, or approximately 2.5 times the average daily flow during the same time period.

The Palmer WWTP currently accepts minimal amounts of hauled wastes. Hauled wastes typically include septage, leachate, and sewer vacuum truck contents. Waste collection from portable toilets stationed at the State Fairgrounds each August is currently dumped into Palmer's collection system. Vacuum trucks containing septage from septic tanks (typically from the rural areas in the PSA) currently haul the waste to Anchorage. The MSB is currently evaluating the construction of a Septage and Leachate Treatment facility to handle septic tank wastes, should the option to truck wastes to Anchorage be eliminated in the future.

Wastewater Flow and Load Data Analysis

An analysis of the existing flow and load data offers insight into the raw wastewater characteristics seen at the plant and provides a general operational understanding. As illustrated in Figure 5 below, WWTP influent flows follow a fairly typical pattern seen in Anchorage and throughout the United States – they are decreasing or increasing only slightly relative to the loads as a result of water conservation as a whole (i.e. increasing saturation with more efficient fixtures and appliances). Figure 5 also shows the effluent flows for the plant and illustrates a slightly lower effluent flow likely due to evaporation from the lagoon surface. Figure 5 and Figure 6 illustrate the influent wastewater loads. The values shown in Figure 5 are typical for municipal wastewater flow and exhibit a typical total suspended soilds (TSS) and biological oxygen demand (BOD) ratio. The figure does illustrate some long-term variation in strength.

Figure 6 and Figure 7 illustrate that the influent loads have remained relatively constant over a 5-year period.

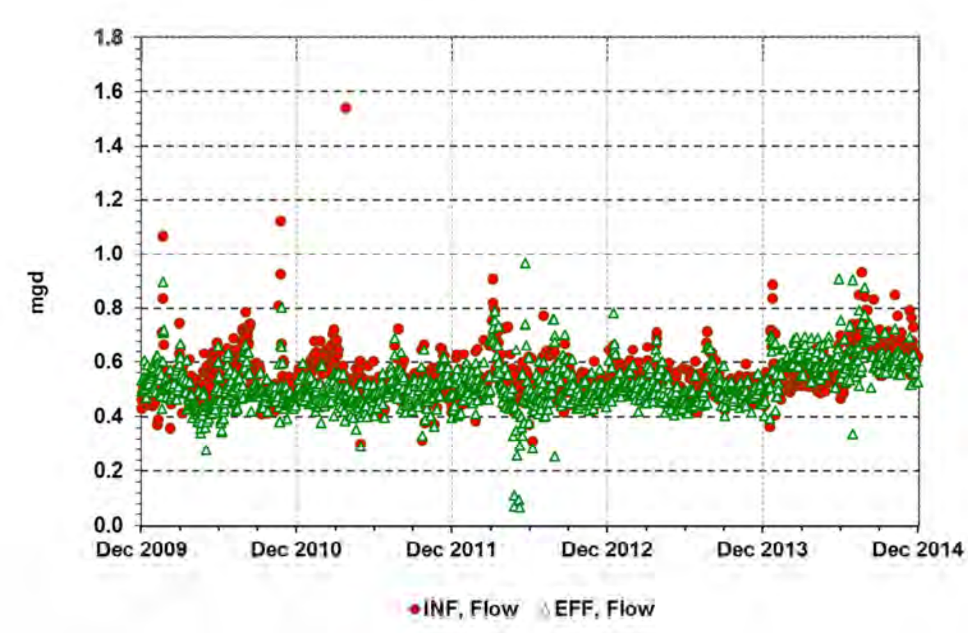


Figure 5. Existing WWTP Influent and Effluent Flows, 2009 – 2014

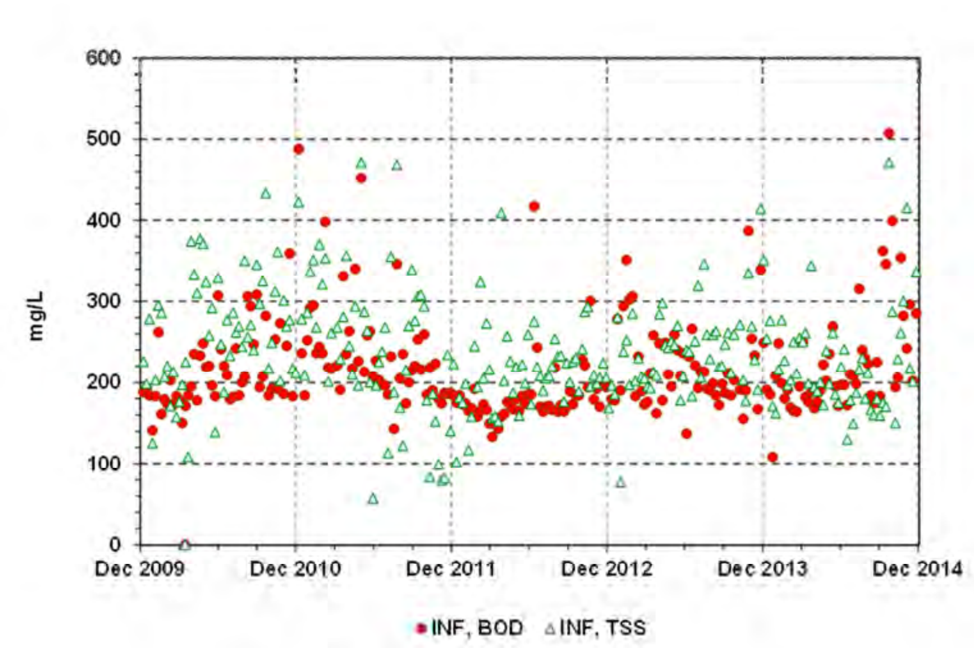


Figure 6. Existing WWTP Influent 30-Day Avg. BOD and TSS, 2009 – 2014

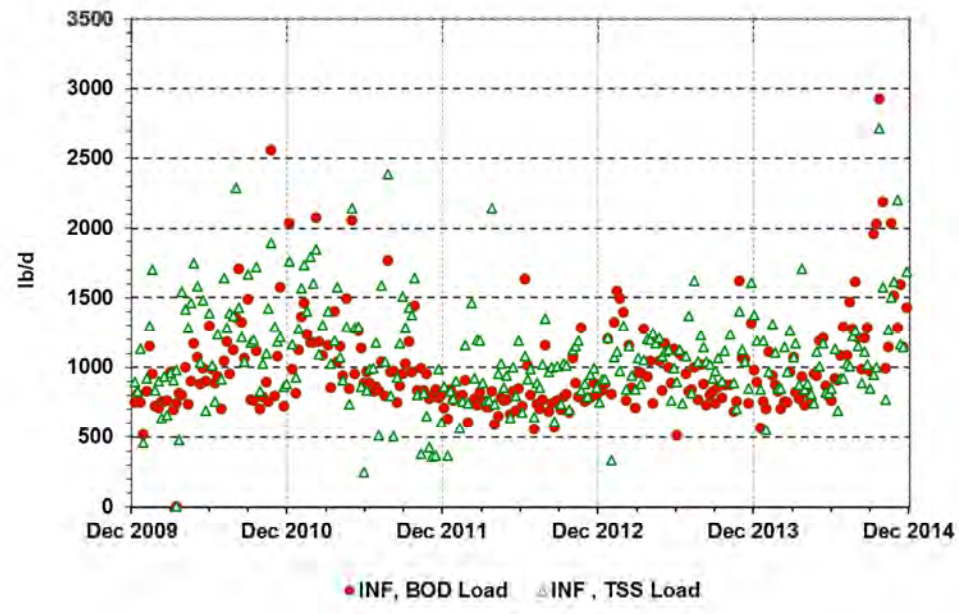


Figure 7. Existing WWTP Influent 30-Day Avg. BOD and TSS Loads, 2009 – 2014

3.3.2 Projected Wastewater Flows and Loads

Flow projections are based on population projections and per capita flow, which include residential, commercial, and industrial contributions as described above. Based on current connections, a served population of 90% is assumed in the City. Using the present population and average flows and loads, the per capita flows are approximately 100 gallons per day (gpd), which is typical of the continental United States average.

Wastewater flows and loadings were projected through the year 2035, based upon the observed flows and loading, current population, and all projected growth scenarios. A summary of flows and loadings is presented in Table 6. The table includes 20-year average daily flow projections (in MGD) based on (1) all projected population growth scenarios in the area (Chapter 3.2); and (2) projected trend line based on historical flow data.

Table 6: Flow Projections for City of Palmer, 2014 to 2035 (in MGD)

Year	Historical Flow Projection	Palmer, Census Growth Scenario	Palmer, DOL Growth Scenario	Palmer, ISER Growth Scenario
2014	0.54	0.61	0.54	0.79
2015	0.57	0.63	0.56	0.81
2016	0.58	0.65	0.57	0.83
2017	0.59	0.67	0.59	0.85
2018	0.60	0.69	0.60	0.87
2019	0.62	0.71	0.62	0.90
2020	0.63	0.73	0.63	0.93
2021	0.64	0.75	0.65	0.96
2022	0.65	0.77	0.66	0.99
2023	0.66	0.79	0.68	1.03
2024	0.67	0.81	0.70	1.06
2025	0.68	0.83	0.71	1.10
2026	0.69	0.85	0.73	1.13
2027	0.70	0.88	0.75	1.16
2028	0.71	0.90	0.76	1.19
2029	0.72	0.92	0.78	1.23
2030	0.73	0.94	0.79	1.26
2031	0.74	0.97	0.81	1.30
2032	0.75	0.99	0.83	1.34
2033	0.76	1.01	0.84	1.38
2034	0.77	1.04	0.86	1.42
2035	0.79	1.06	0.88	1.46

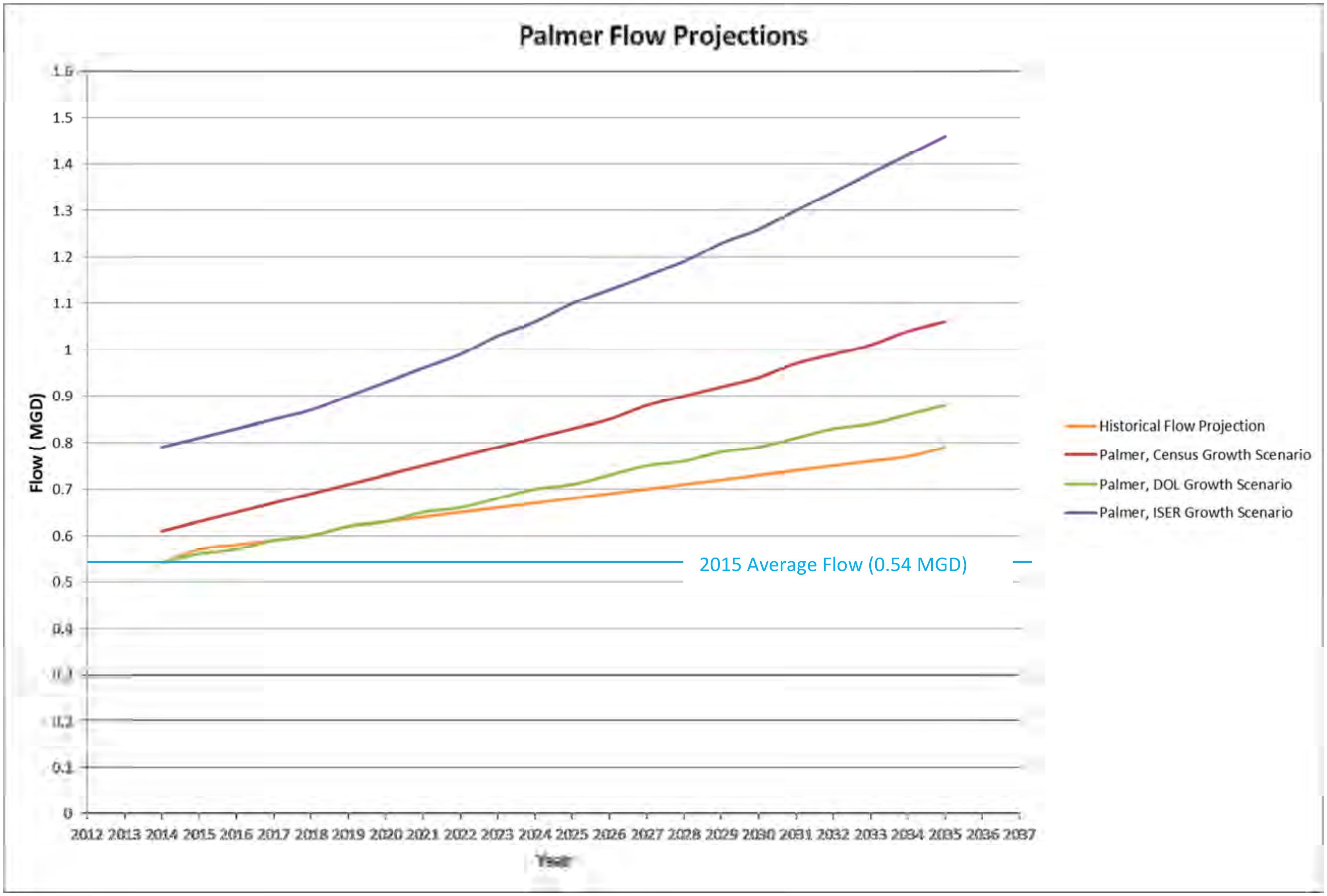


Figure 8 Palmer Flow Projections

Table 7: Flow Projections for the PSA, 2014 to 2035 (in MGD)

Year	Historical Flow Projection	PSA, DOL Growth Scenario*	PSA, ISER Growth Scenario
2014	0.54		1.54
2015	0.57	0.56	1.58
2016	0.58	0.59	1.61
2017	0.59	0.63	1.66
2018	0.60	0.67	1.70
2019	0.62	0.70	1.76
2020	0.63	0.74	1.81
2021	0.64	0.78	1.87
2022	0.65	0.82	1.93
2023	0.66	0.86	2.00
2024	0.67	0.91	2.07
2025	0.68	0.95	2.13
2026	0.69	0.99	2.20
2027	0.70	1.04	2.26
2028	0.71	1.08	2.32
2029	0.72	1.13	2.39
2030	0.73	1.18	2.46
2031	0.74	1.23	2.53
2032	0.75	1.28	2.60
2033	0.76	1.32	2.68
2034	0.77	1.37	2.76
2035	0.79	1.43	2.84

* The PSA growth projection assumes an increase in total served population from the current percentage (approx. 45%) to 90% served by the end of the planning period.

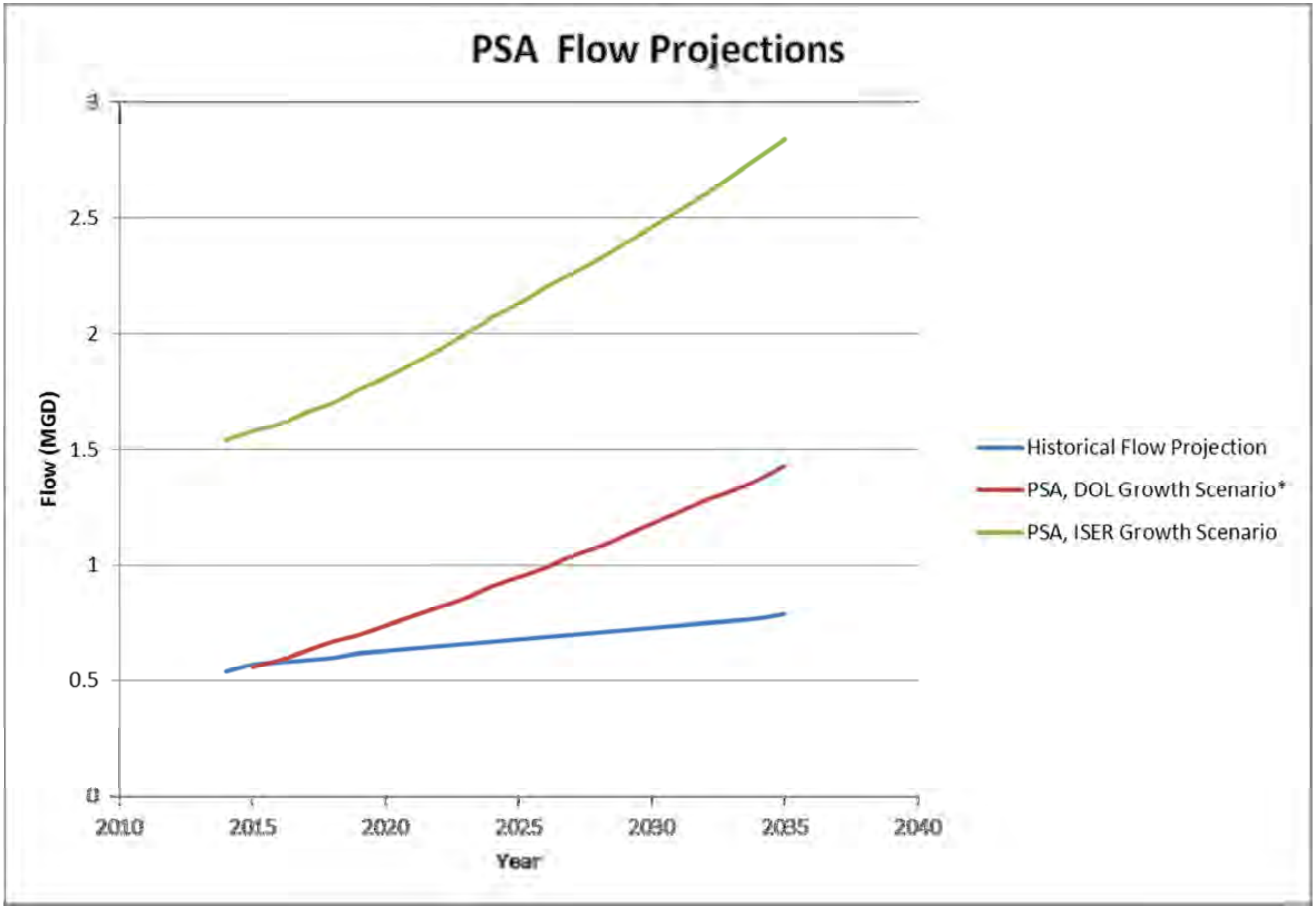


Figure 9 PSA Flow Projections

Figure 8 and Figure 9 provides a graphical representation of the annual average flow data presented in Table 6 and Table 7. Population projection scenarios can vary significantly and some may not apply. The following section discusses the applicability of the different population growth scenarios and which is selected for developing treatment alternatives.

Studies performed for upgrades to the Palmer WWTP since the 2007 permit renewal typically estimated future population growth rates based on the "Memorandum on the Economic and Demographic Impacts of a Knik Arm Bridge" study prepared by the University of Alaska-Anchorage's ISER dated September 2005. As Figure 8 and Figure 9illustrates, the ISER projections assumed an ambitious growth rate for the region. Current population and flows are considerably lower than was anticipated for the present day. Furthermore, growth within the PSA has not occurred as projected in previous reports.

Based on the 2005 ISER growth projections and an assumption that the served population within the PSA would steadily be added to the Palmer wastewater system resulted in projected average wastewater flows at the WWTP in excess of 2 MGD between 2020 and 2025. Figure 8 and Figure 9 illustrates that based on current conditions and updated projected growth rates, average daily flows to the WWTP will not reach 2 MGD in the 20-year planning period, and in fact will likely not reach 1.5 MGD by 2035. Using the most current (2014) growth rates from the Alaska DOL, flows at the WWTP may not exceed the current design capacity of 1 MGD depending on Palmer's expansion of the sanitary sewer collection system in the PSA.

Current economic and political drivers in the state suggest a general slowing of growth for the foreseeable future. So much has changed over the last several years in our economy and the world that the projections, which were conservative and reasonable based on best available planning information at the time, no longer represent the current outlook for the City and the MSB. The precipitous plunge in the price of oil, and forecast to not rebound soon, suggests a slowing of population growth and associated wastewater flows. Alaska's oil output will likely continue to decrease or remain flat and overall revenue will slowly (or rapidly) decrease. This revenue decline will put downward pressure on the state and local budgets, moderating growth in the area.

In addition to a general slowing of growth, increases to the flows at the Palmer WWTP will be dependent on expansion of the sewer service in the PSA. There have been no major sewer main extensions in the recent past nor are there any anticipated in the near future other than two known subdivisions (Springer Park Subdivision with 23 lots and Mountain Ranch 5 Subdivision with 13 lots). The only growth in new sewer customers involve new subdivisions within the City, service connections to existing Palmer sewer mains, and the two subdivisions mentioned above. This shows there is incremental growth in the number of sewer services in the PSA, but the number of new sewer service connections does not necessarily bear a direct relationship to the increase in population in the PSA. This is due to the expense of extending new sewer mains, hilly topography west of the City limits that discourages sewer main construction, and the fact that much of this area is underlain with gravelly soils with high percolation rates well suited for on-site sewer systems. These factors result in most of the development in the PSA outside the City limits using on-site septic wastewater disposal.

All of the factors discussed above underscore the need to evaluate multiple growth scenarios and develop flexible, phased improvement alternatives for the Palmer WWTP. Rather than focusing on a doubling of the plant's capacity (to 2 MGD) with any improvements, the alternatives analysis in this Facility Plan Update considers incremental capacity increases to meet changes in influent wastewater flows as the City grows, reducing the chance for stranded investment and overburdening rate payers with unnecessary treatment improvements.

3.3.3 Peaking Factors

Table 7 presents baseline and future influent flows and loads for average annual and maximum month conditions. Baseline design criteria are calculated from recorded plant data. The calculated maximum month load peaking factor (maximum month load divided by annual average load) for the data is approximately 1.22. A maximum month peaking factor of 1.22 is suitable for a treatment facility this size. This peaking factor is used for projecting maximum month flows and loads design criteria throughout this Plan.

3.3.4 Basis of Design Criteria

Based on the observed flows and loading, current population, and projected growth, design flows and loads were developed for this Plan. Table 8 below summarizes the Basis of Design Flows and Loads for the Palmer WWTP evaluation. The table presents two design conditions – an average daily flow of 1.0 MGD (current permit and design capacity) and an incremental phased increase to average daily flow of 1.5 MGD.

Table 8: Basis of Design Flows and Loads

		Phase I Influent Flows and Loads			Phase II Influent Flows and Loads		
		Average	Maximum Month	Maximum day	Average	Maximum Month	Maximum day
Flow	mgd	1.0	1.2	1.5	1.5	1.8	2.2
TSS	lb/d	2,035	3,012	4,941	3,052	4,518	7,412
VSS	lb/d	1,831	2,711	4,447	2,747	4,066	6,671
BOD	lb/d	1,868	2,818	4,754	2,802	4,228	7,131
TKN	lb/d	318	479	808	476	719	1,212
NH4-N	lb/d	213	321	541	319	482	812
TSS	mg/L	244	296	395	244	296	395
VSS	mg/L	220	266	356	220	266	356
BOD	mg/L	224	277	380	224	277	380
sBOD	mg/L	90	111	152	90	111	152
COD	mg/L	470	582	798	470	582	798
sCOD	mg/L	141	175	239	141	175	239
ffCOD	mg/L	71	87	120	71	87	120
VFA	mg/L	7.1	8.7	12.0	7.1	8.7	12.0
TKN	mg/L	38	47	65	38	47	65
NH4-N	mg/L	26	32	43	26	32	43

3.4 Wastewater Treatment System

3.4.1 Unit Process Review

The existing aerated lagoon system, when operating properly, consistently provides BOD removal. When the ambient and wastewater temperatures are sufficiently high in the summer (typically from July through October) the plant can achieve nitrification but this is inconsistent and the plant is not capable of nitrifying for the colder periods of the year in its current configuration. The aerated lagoons reduce the BOD and TSS either through biological action or settlement to the lagoon bottom.

The primary shortcoming of the existing lagoon system is the inability to treat to the required limits for ammonia due to the inability to nitrify during cold weather (November to June period). Additional treatment is required for ammonia removal or an alternate disposal method is required to avoid treated effluent reaching the discharge channel and Matanuska River.

Figure 10 provides an aerial photo of the WWTP site and surrounding area and an overview of the Palmer WWTP unit processes.

3.4.2 Existing Treatment Processes

The existing site layout of the WWTP is shown in Figure 11. Raw wastewater enters the treatment plant from the northeast corner of the facility through a 24-inch diameter gravity sewer. The wastewater then flows through a lift station consisting of two screw pumps followed by two sets of screens/grinders arranged in parallel. The screened sewage is directed to Lagoon 1 (north pond) or it can be diverted to any other pond. Typical operation allows flow in series from Lagoon 1 through Lagoon 3. All of the lagoons are aerated using a Biolac aeration system. When treatment in the ponds is complete, the wastewater is discharged into a 24-inch diameter pipe located beneath the south pond berm and conveyed to the UV disinfection building located at the southeast corner of Lagoon 3. The wastewater is disinfected with UV light and discharged to a side channel in the Matanuska River floodplain.

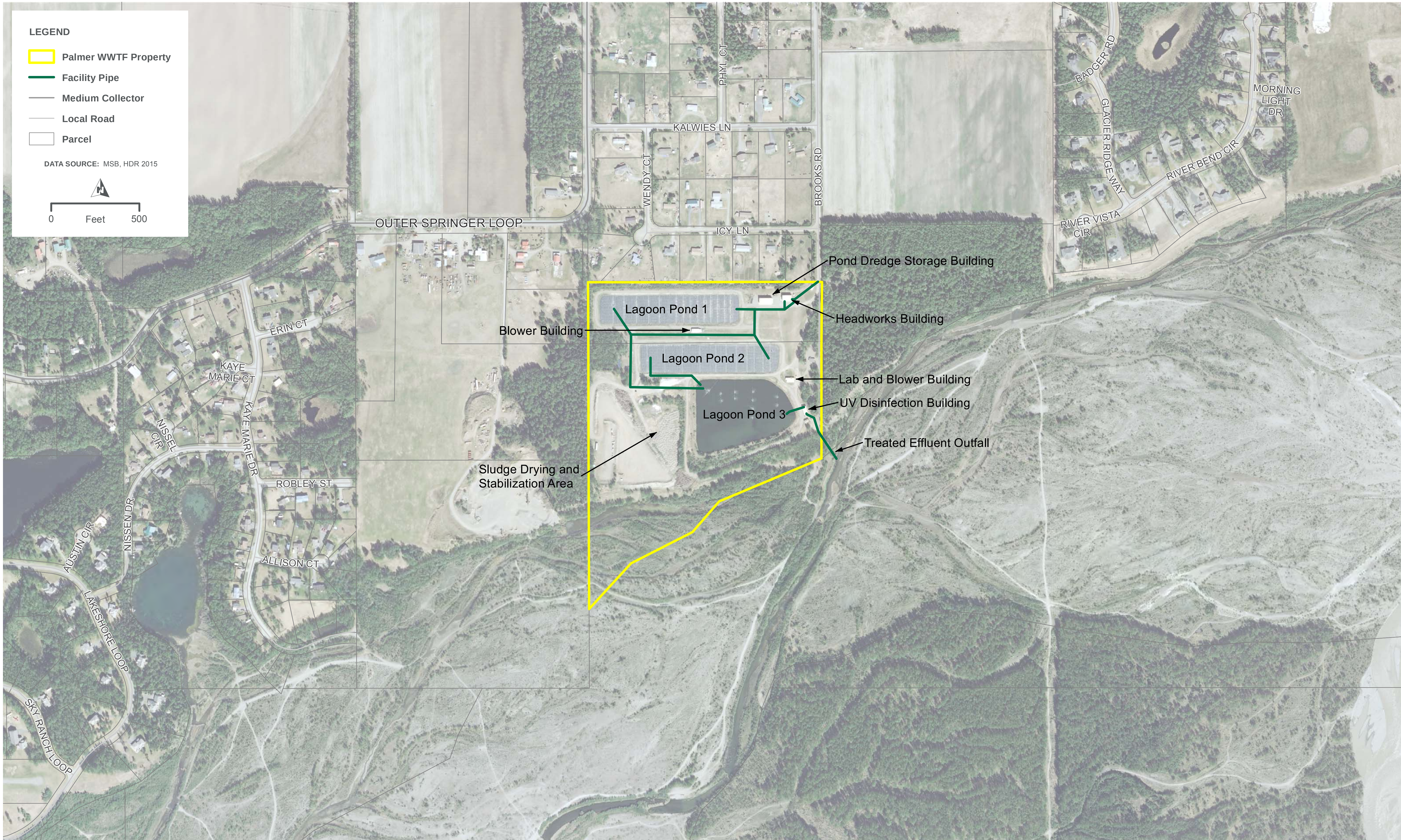
The ponds are operated in series and have a total volume of approximately 22.3 million gallons. Typical aerated ponds require a minimum of 20 days detention time under aeration. Utilizing the 2014 average flow rate (typical for both summer and winter) of 541,800 gpd, the average detention time in the aerated ponds (Lagoons 1 and 2) is approximately 23.2 days.

Treatment lagoons (i.e. aerated ponds) allow solids to settle. The accumulated sediment reduces the pond capacity. The settled solids undergo anaerobic digestion. Biosolids must be removed occasionally (typically every 2 to3 years) from the ponds to maintain pond volume. The ponds were designed for sludge depths of two feet. Lagoons 1 and 2 were retrofitted with floating covers in a 2010 upgrade, at which time sludge was removed from these ponds. The sludge from these ponds has not been removed since that time. Operators tested the sludge depth in each lagoon in June 2015 and the sludge depth was found to be several feet in some areas of the lagoons (deepest near the baffle curtains and effluent in each lagoon). Removing the solids will increase the available lagoon volume, the overall treatment capacity, minimize the amount of sludge digesting at the bottom of the ponds, and improve overall mixing conditions in the lagoons.

Sludge handling at the facility currently uses a floating dredge to transfer settled solids to a sludge drying area located to the west of Lagoon 3. The City purchased a floating dredge in 2003 for the purposes of periodically removing the sludge from the lagoons. Pumped sludge is typically allowed to dry (through evaporation) for one year before it is further stabilized through lime addition. Dried, limed sludge is mixed with topsoil and used as fill on the WWTP site.

Four new Atlas Copco high capacity positive displacement blowers were installed at the facility in 2012. The blowers operate on variable frequency drives (VFDs) and are controlled by dissolved oxygen sensors installed in the ponds to adjust the air flow rate using the VFDs to meet operator-selected oxygen setpoints. Two of the blowers are rated at 110 horsepower (hp) and are capable of supplying air at 2729 cubic feet per minute (cfm) each and two of the blowers are rated at 40 hp and are capable of supplying air at 680 cfm each.

Table 9 summarizes the design criteria of the existing facility.



HDR

WASTEWATER TREATMENT FACILITY OVERVIEW

CITY OF PALMER, ALASKA

FIGURE #10

CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

EXISTING SITE LAYOUT

DATE FEB 2016

FIGURE 11

Table 9: Existing WWTP Design Parameters

Design Parameter	Design Value
Headworks Building	
Influent Screen Type	Two 0.125-inch opening size perforated plate screens with grinders and hoppers to bins (JWC Auger Monsters)
Screen Capacity (MGD)	2.0
Lift Station	
Pumps Type	Screw Pumps
Number of Pumps	2
Capacity of Pumps (MGD)	2.0
Aerated Lagoon Pond Design	
Number of Ponds	3
Operating Surface Area (acre)	Approximately 3.80 / 3.80 / 4.81
Operating Liquid Level (feet)	9.7 / 9.7 / 8.7
Sludge Depth (feet)	1 – 4 feet with floating dredge
Freeboard (feet)	1.5 / 1.5 / 4.3
Operating Capacity (million gallons)	6.3 / 6.3 / 9.7 (including volume of seasonal ice cover and accumulated sludge)
Short-circuiting within Ponds Control Measure	Floating curtain walls
Average Detention Time (days)	11.6 / 11.6 / 17.9
BOD Loading (lb./day)	975-1000
Aeration System	
Type	Parkson Biofuser® submerged fine bubble membrane diffusers
Oxygen Requirement (lb. O_2/lb. BOD)	2.5
Dissolved Oxygen Requirement (mg/L)	2.0
Blower Type	Atlas Copco air-cooled, low-pressure, electric motor-driven screw blowers Two 110 Hp each and Two 40 Hp each (Ponds 1, 2, and 3)
Disinfection	
Type	Ultraviolet (Trojan)
Capacity (MGD)	2.0
Sludge Drying and Disposal	
Type	Sludge Drying Beds
Typical Drying Time (year)	1
Lime Addition Required pH	12.0+
Interplant Piping	
Limiting Diameter (inches)	24 ductile iron
Capacity (million gallons)	2.0

3.4.3 Plant Performance

Effluent data from 2010 through 2014 show average BOD concentrations of less then 11.7 mg/L (less than 25 mg/L 90% of the time), as well as average effluent TSS of 10.7 mg/L (less than 25 mg/L 90% of the time). Figure 12 shows the effluent TSS and BOD concentrations for the period between 2010 and 2014 as well as the average monthly limit of 30 mg/L for both.

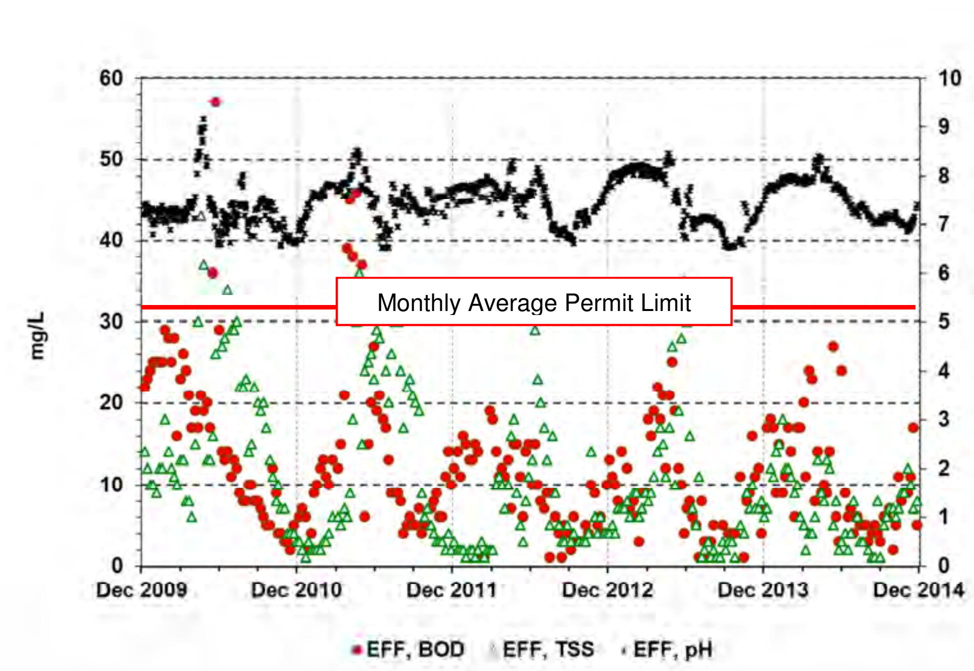


Figure 12: Effluent BOD and TSS data

The existing lagoon system only nitrifies during summer months (typically August through November), and the effluent ammonia levels often exceed the average monthly permit limits of 1.7 mg/L (July-August) and 8.7 mg/L (rest of the year) as shown below (Figure 13). Temperature has been plotted along with the effluent ammonia levels for reference.

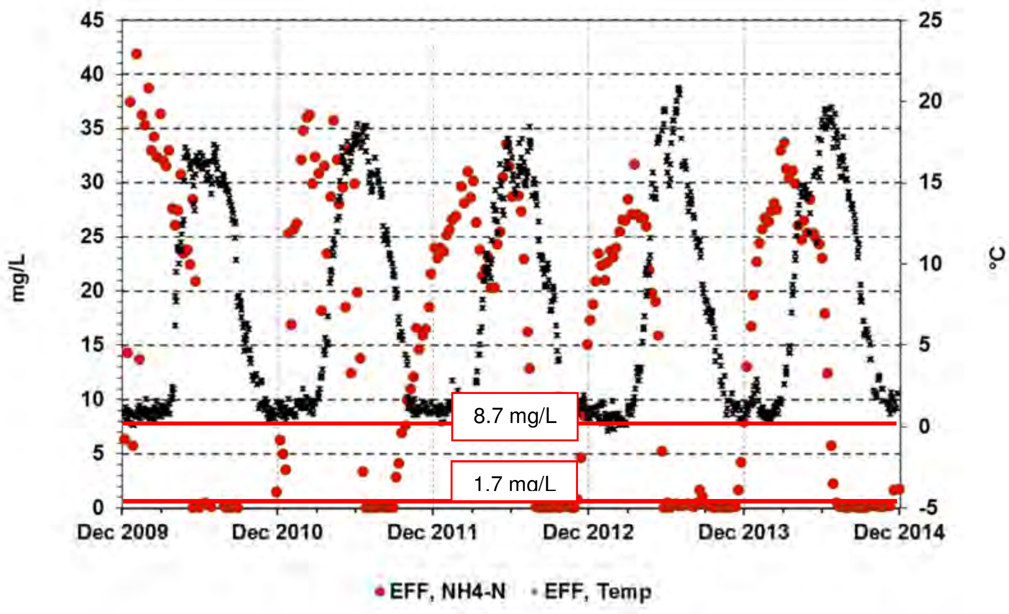


Figure 13: Effluent Ammonia and Temperature data

4.0 Alternatives Analysis

The City is working with the EPA, Department of Justice, and ADEC to improve their treatment system. This plan develops treatment alternatives to bring the WWTP into compliance with current effluent criteria.

In addition to the evaluation of alternatives, this section also includes a brief summary of the numerous alternatives that have been evaluated in previous reports.

4.1 Previous Study's Alternatives Analysis

Ammonia limits were introduced in the NPDES permit in 2001. The ammonia limits were re-considered in 2007 and became more restrictive. Palmer has performed several studies to evaluate methods to improve the existing lagoon treatment system and to add treatment capacity. In general, these studies have recommended the Palmer facility make significant changes to the treatment process in order to consistently achieve adequate nitrification in both the summer and winter months.

Previous reports and alternative evaluations provided valuable information. The previous report findings were based upon population growth projections with a significant growth in the sewered population and thus a much larger facility than current condition and projections detailed in this Plan. The plant capacity analysis in previous reports projected average annual flow of 2.0 MGD with maximum month average flows of 4.0 MGD. The resulting recommended capital outlay for previous studies varied between $25 million and $50 million dollars. The projected growth rate has not been realized and thus this report recommends considering a lower design flow rate reflecting current published population growth projections.

The alternatives previously considered include standard lagoon treatment as well as more complex treatment systems. A new mechanical treatment facility utilizing a conventional activated sludge process requires regular maintenance, advanced training for operational staff, and would be more operationally difficult to maintain. Alternative technologies are capable of achieving comparable treatment with less operational complexity and capital investment. For these reasons, the following alternatives were not evaluated further in this report.

The processes that have been evaluated in previous plans include:

- Conventional Activated Sludge – This alternative considered a conventional activated sludge process, which includes anoxic/aerobic reactors, secondary clarification, return activated sludge (RAS) facilities to recycle sludge from the clarifiers back to the reactor basins, and aerobic digestion for sludge stabilization. The alternative was removed from consideration due to high capital and maintenance costs.
- Membrane Bioreactor (MBR) – This alternative included upgraded influent fine screens, grit removal units, anoxic/aerobic reactors, membranes bioreactors, gravity belt thickeners, aerobic digestion, and belt filter presses. The alternative was removed from consideration due to high capital and maintenance costs.

- Sequencing Batch Reactor (SBR) – This option included new grit removal units, SBR basins, post-equalization tankage, gravity belt thickeners, aerobic digestion, and belt filter presses. The alternative was removed from consideration due to high capital and maintenance costs.
- Solar Aquatic System (greenhouse)-This option included a greenhouse and harvesting of plant species as a treatment alternative. The alternative was initially selected by the City. The alternative was removed from consideration due to high capital and maintenance costs.

Several outfall alternatives were also considered in previous studies and found to be non-viable options based on feasibility, land requirements, construction costs, or permitting issues. Alternate outfall or discharge locations that were considered in the previous reports include:

- Alternate Outfall – Main Channel Discharge – This option looked at extending the outfall to the main channel of the Matanuska River assuming that ammonia limits would be raised due to increased river flow for mixing and no known salmon spawning. This option was not pursued further due to the dynamic nature of the river and the fact that the discharge location could change annually, an extremely difficult and expensive construction, and the potential for getting no relief on the ammonia limits based on salmon spawning.
- Alternate Disposal – Percolation Cell Discharge on a Vegetated Island in the middle of the River Floodplain - This option looked at constructing an effluent pump station in the floodplain and pumping to a subsurface disposal cell on a vegetated island in the river floodplain. This option was not pursued further for many of the same reasons as the outfall extension: the dynamic nature of the river and the potential of stranding/losing assets when the river channel moved back to the west, an extremely difficult and expensive construction, and the risk involved in having operating facilities in a floodplain.
- Alternate Disposal – Subsurface Discharge on Adjacent Property to the West of WWTP Site – Preliminary geotechnical evaluation was performed on the property adjacent to the WWTP to the west. The site was evaluated for 2 MGD discharge and preliminary findings suggested negative impacts to the surrounding groundwater and river bank. This option was not pursued further due to the initial geotechnical recommendations and opposition from local residents fearing contamination (nitrates) of a nearby community well.

In addition to the alternatives considered in previous reports, a screening of treatment options was conducted in the preliminary stages of this Plan to determine the most viable alternatives for further evaluation. Several additional alternatives were initially considered and found to be not viable based on feasibility, land requirements, construction costs, permitting issues, etc. Several processes that were considered in a preliminary alternative screening include:

- Seasonal storage/discharge – An upgrade to the existing facilities to include full wastewater containment in combination with summer time discharge would require a considerable capital expenditure and land acquisition to construct new storage facilities. In order to store the wastewater during times of the year when the plant is out of compliance, it is estimated that approximately 240 MG of storage would be required (based on design flow of 1 MGD). The lagoon capacity envelope would need to increase to approximately 75 acres at 10 foot of depth. For this reason, this alternative will not be evaluated further.

- Land Application – Land application of treated effluent is not typically done in Alaska due in part to the short growing and irrigation season. This alternative was considered briefly for summer months due to Palmer's agricultural land availability and the possibility of beneficial reuse of the treated effluent. This option was considered in conjunction with seasonal storage and discharge (see above) as well as a snow making option during the winter months. This option was not evaluated further due to land requirements, operational logistics, project costs, and the fact that a comparable alternative (subsurface discharge) is capable of year-round disposal with less operational changes and capital investment.
- Alternate Disposal – Subsurface Discharge on an Off-site, Remote Property - A preliminary evaluation of properties within 5 miles of the existing WWTP site was conducted to determine their potential for subsurface disposal use. Evaluation criteria included size of the parcel, land use, land ownership, topography, soil type, accessibility, and proximity to drinking water wells. For the purposes of evaluating potential costs of off-site disposal options in an earlier facility plan draft, two alternatives were considered: pumping to a property near the WWTP (approximately 1 to 2 miles from WWTP) and pumping to a property relatively far from the WWTP (approximately 3 to 5 miles from WWTP). This option was not evaluated further due to land requirements, time and potential costs associated with the land purchase, high relative capital costs and operational costs (large pumps), construction/permanent easements potentially required for a long forcemain. Also, approximately 30 to40 acres would need to be purchased to provide a large enough drainfield to dispose of 1 MGD (and allow for expansion in the future to 2 MGD and beyond) and provide a buffer from surrounding properties to allow for adequate treatment at the property lines.
- Attached Growth Modules - Attached growth media/modules located within the existing lagoons offer an alternative to separate treatment units/buildings and secondary ammonia treatment downstream of the existing lagoons. Proprietary processes such as Webitat (Entex Technologies Inc.), Bio-Dome, and LemTech (Lemna Technology) use fixed media to promote an environment for attached-growth bacteria and improved nitrification. A preliminary evaluation was conducted to determine the viability of attached growth modules for long term ammonia treatment. The evaluation of in-situ attached growth options (Entex, etc.) and preliminary design calculations indicate that a large volume of media is required in most of Lagoons 1 and 2 to achieve significant nitrification – at a significant capital cost. This alternative was also evaluated as an interim treatment measure using reduced amount of attached growth media at the head of Lagoon 2. Additional information on the use of attached media as an interim option can be found in Appendix B.

4.2 Alternative Analysis

The existing lagoon WWTP system was analyzed to determine if it could adequately meet the existing and future permit requirements. Multiple alternatives were evaluated to correct any system deficiencies. This report considers identified alternatives, as well as the No Action Alternative.

In addition, facility modification to permit nitrification should take into account potential additional requirement for future removal of ammonia nitrogen. Facilities constructed to allow nitrification should be designed and laid out to accommodate future upgrades to higher levels of treatment. In addition to the long-term facility modifications, alternatives have been evaluated for short-term, or interim, measures to improve system operation and nitrification while the long-term upgrades are constructed. A memorandum on interim treatment measures can be found in Appendix B.

4.2.1 Alternative 1 – No Action

The existing WWTP lagoon system is not capable of complying with discharge requirements that include nitrification, in terms of ammonia-nitrogen removal. Depending on future limits, additional treatment may be required. Beginning in 2007, permit limits of 8.7 mg/L NH_3-N (winter monthly average) and 1.7 mg/L NH_3-N (summer monthly average) have been mandated and violations of this limit have occurred on numerous occasions. Due to these limitations, this alternative will not be evaluated further.

4.2.2 Alternative 2 – Lagoon Activated Sludge Treatment

4.2.2.1 Description

Lagoon Activated Sludge – This option considered modifying the existing lagoons into an activated sludge type process in conjunction with the current Parkson Biolac® to include clarification and the ability to return and waste activated sludge to achieve biological nitrification/denitrification. Nitrification ammonia removal can be accomplished with both suspended growth (activated sludge) or attached growth (biofilm) system, as well a hybrid of both.

Given the existing lagoon treatment system, an activated sludge system that takes advantage of the lagoon infrastructure can help minimize costs to comply with the pending effluent ammonia limit. Using such a technology would convert the existing aerated lagoon system into a more conventional activated sludge process through the use of a bioreactor, clarification, mixed liquor, and return activated sludge recycle. This type of aerated complete mix system is a low rate biological treatment process similar in shape to a lagoon but utilizing treatment equal to an oxidation ditch. Under this alternative, air is supplied through the existing fine bubble diffusers connected to suspended aeration chains.

To allow retention of biomass and control over the sludge retention time and lagoon biomass concentration, the effluent from the complete mixed reactor section enters a secondary clarifier where the solids settle to the bottom and are returned to the reactor with a pump. The return of the active biomass allows the completely mixed lagoon cell to establish higher concentrations of biomass resulting in a relatively smaller footprint in comparison to the existing lagoon system.

The smaller footprint and shorter hydraulic retention time, in combination with the ability for the operator to increase the mixed liquor suspended solids (MLSS) concentration, helps to make biological oxidation of ammonia possible in the winter months for the Biolac ® type facilities in cold regions. An example of a cold region Parkson Biolac ® type facility is located in East Helena, Montana.

4.2.2.2 Schematic Layout

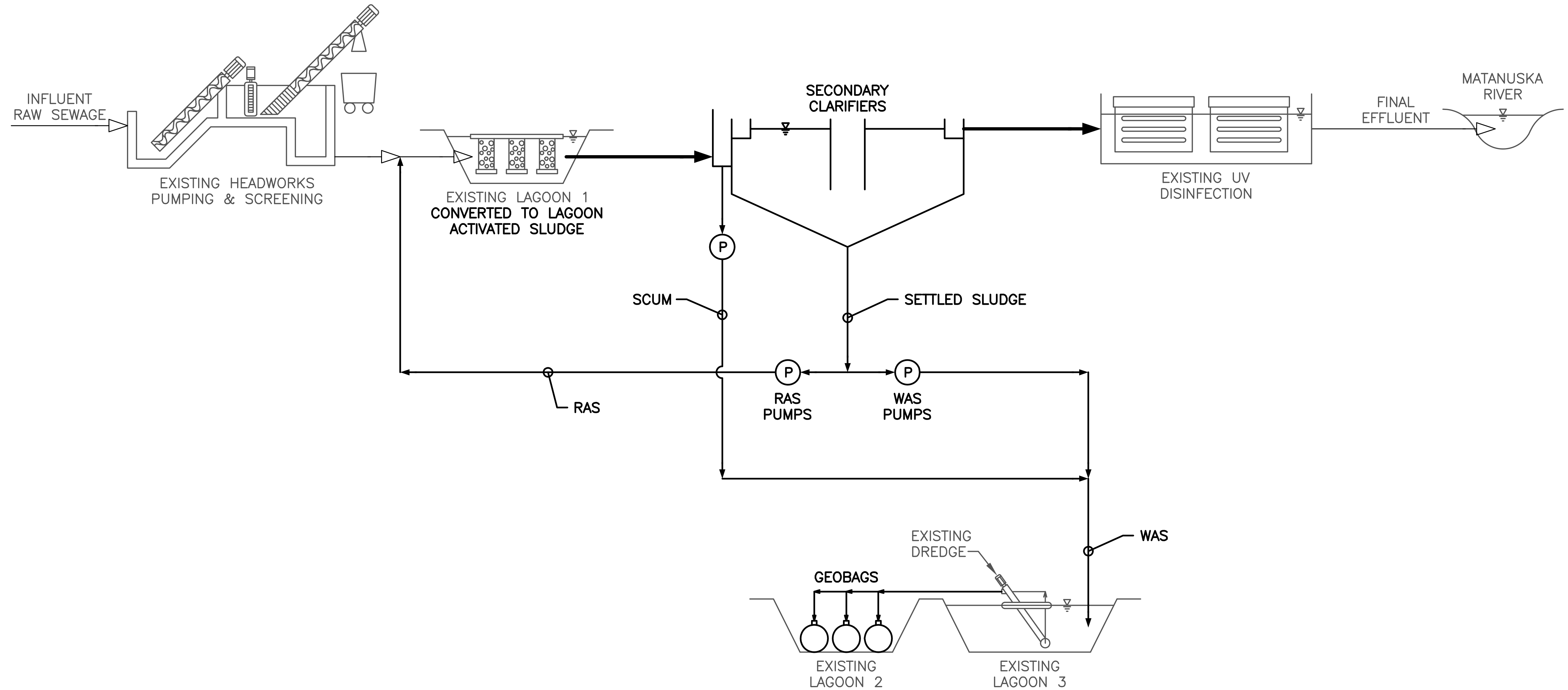
There are a number of manufacturers who supply systems to convert treatment ponds into this style of bioreactor including the Parkson Biolac®, EDI ATLAS-IS, and BioWorks OxiWorks. These systems make use of aeration chains which consist of floating headers and submerged membrane diffusers (Figure 14 and Figure 15).

Figure 14 Aeration Strips and Blower Building at a Biolac® System

Figure 15 Secondary Clarifier with Adjacent Biolac® Lagoon.

These systems have minimal operator attention, thus incorporating a safety factor in the form of a long SRT (25 – 50 days) and hydraulic retention time (24 – 48 hours). It can be designed for nitrification only or total nitrogen removal (nitrification and denitrification). Using the maximum month flows and loads as the design criteria the volume needed for the aeration section of the activated sludge system can range between 1.8 and 3.6 million gallons. Assuming a 1.5 day HRT and 40 day SRT, the volume of the aerated section of the activated sludge system would be 2.8 million gallons, which is approximately 10 % the size of the existing aerated lagoons. The mixed liquor concentration would be approximately 2,600 mg/L which requires roughly 2,600 ft^2 of secondary clarifier surface to accommodate a maximum hydraulic loading rate of 297 gpd/sqft and solids loading rate of 15 lb/ft^2/day.

Figure 16 shows the process schematic of the Lagoon Activated Sludge alternative and Figure 17 shows a potential layout of this activated sludge treatment system. Total Nitrogen removal can be incorporated by providing the ability to operate aeration in on/off cycles.

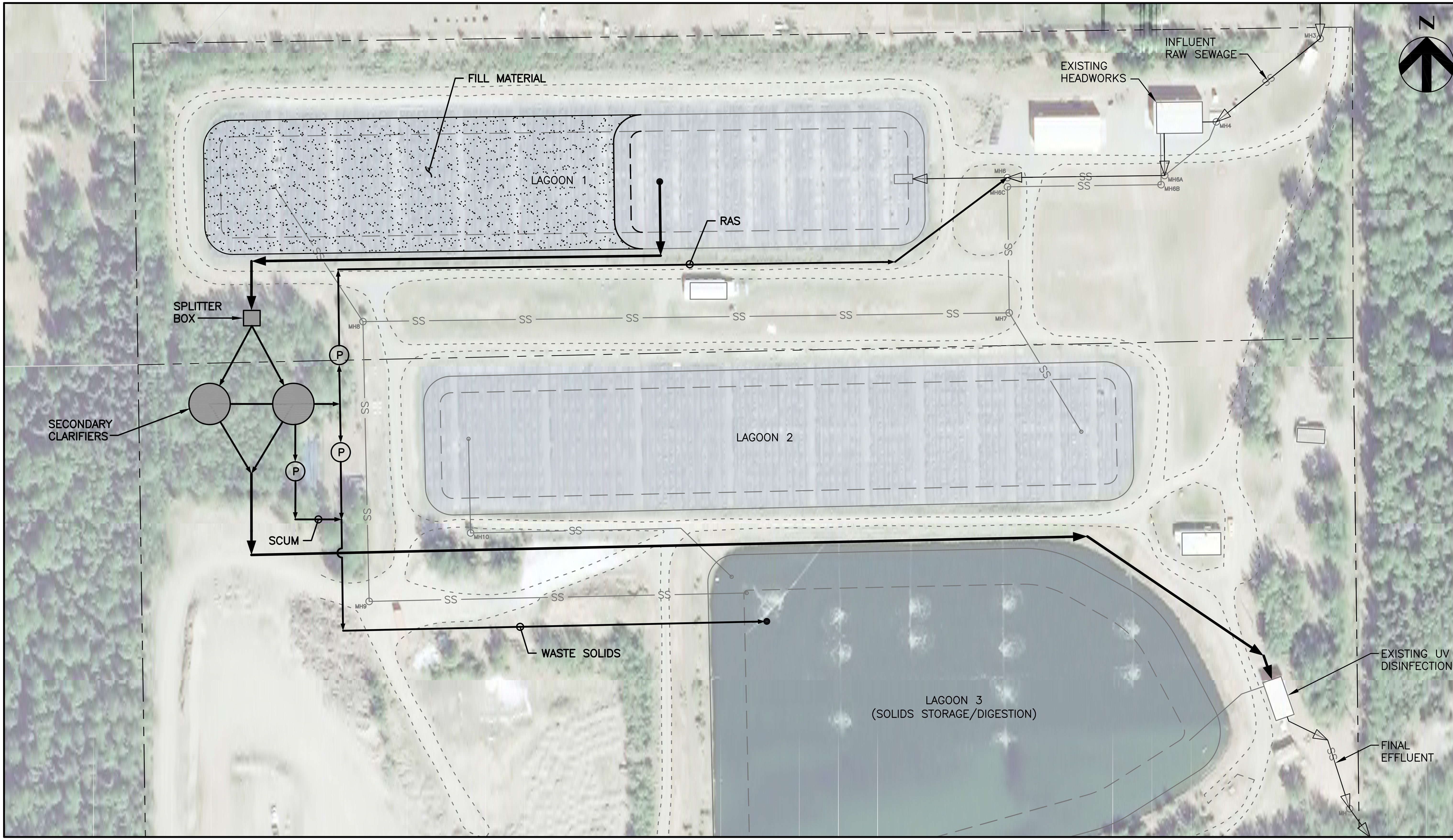


CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

PROCESS FLOW SCHEMATIC - ALTERNATIVE 2
LAGOON ACTIVATED SLUDGE

DATE
FEB 2016

FIGURE
16



CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

CONCEPTUAL SITE LAYOUT - ALTERNATIVE 2
LAGOON ACTIVATED SLUDGE

DATE
FEB 2016

FIGURE
17

4.2.2.3 Land Requirements

Lagoon 1 would be reduced in size by greater than 50%. The remaining lagoons could be abandoned, used for equalization, or biosolids storage.

4.2.2.4 Cost Analysis

In order to evaluate the overall cost of each alternative; both the cost to construct the project and the cost to operate and maintain the project must be considered. These costs are then used to calculate an equivalent annual cost which is presented in Table 10. A detailed cost estimate is provided in Appendix A.

Table 10: Alternative 2 Lagoon Activated Sludge Cost Analysis – Phase I

Alternative 2	Project Cost Range*	Annual O&M Costs	Net Present Value Range
Lagoon Activated Sludge	$9,500,000 - $14,300,000	$238,000	$13,500,000 - $18,300,000

*-Project cost assumes replacement of existing diffusers, etc. within existing lagoons. There would potentially be an opportunity to reuse some of the existing Biolac equipment but given the age of the equipment (over 15 years) it likely needs replacing. Project costs also assume that the clarifiers are constructed outside (with aluminum covers) and not in an operations building.

Cost estimates prepared as part of the Facilities Plan are order-of-magnitude, Class 5 estimates, as defined by the American Association of Cost Engineers (AACE). According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

<u>CLASS 5 ESTIMATE</u> - Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20% to –50% on the low side and +30% to +100% on the high side.

4.2.2.5 Advantages/Disadvantages

Advantages of constructing lagoon activated sludge with respect to financial, managerial, and operational resources include:

- Complies with regulatory requirements.
- Utilizes the existing aeration system.
- Smaller than the existing process footprint.
- Operates year round and is not subject to seasonal discharge.
- Lower capital cost.

Disadvantages of constructing lagoon activated sludge with respect to financial, managerial, and operational resources include:

- Operation of an activated sludge system including clarifiers and RAS/WAS pumping more complex and time intensive.
- Additional Process Monitoring
- Additional training may be required

- Additional pumping required.
- Additional maintenance of the clarifier and RAS/WAS systems.

4.2.3 Alternative 3 - Submerged Attached Growth Treatment for Ammonia Removal

4.2.3.1 System Description and Design Parameters

The permit limits for ammonia require treatment beyond what the existing aerated lagoon system can provide year round. A proven and effective treatment alternative is the use of a Submerged Attached Growth Reactor (SAGR) currently patented by Nelson Environmental. The SAGR was developed in Canada for post lagoon treatment of ammonia in cold to moderate climates. The SAGR process would operate in conjunction with the existing aerated lagoons. The aerated lagoons would continue to be utilized for BOD removal with minimal changes to the existing system (i.e. existing blowers, Biolac diffusers, etc. would not be replaced or modified). Pumps would be required to direct flow to and from the SAGR units.

Nelson Environmental has provided a preliminary proposal for their treatment system along with several operating examples. The system is designed to meet the APDES permit requirements. The system incorporates aerated lagoons and a SAGR unit for treatment. A copy of the design proposal is provided in Appendix C. The proposal contains additional description of system design parameters, treatment process, and equipment costs.

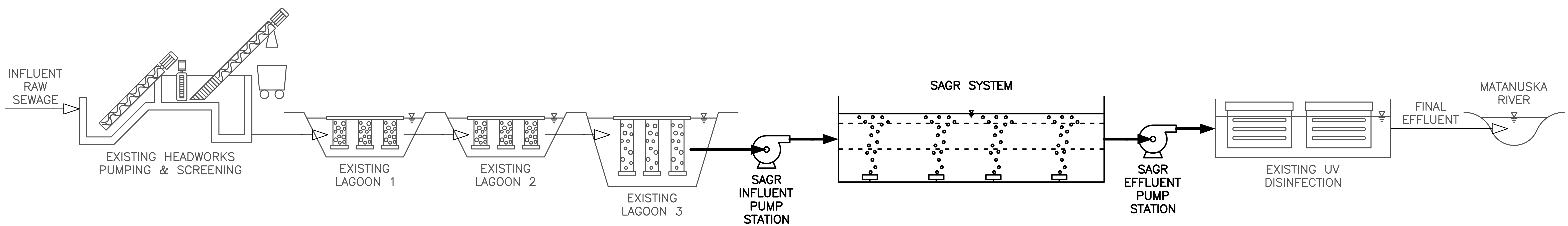
Secondary treatment improvements include constructing a dual cell aerated Horizontal Flow SAGR® (Submerged Attached Growth Reactor) for nitrification (ammonia removal) following the existing treatment process.

The Submerged Attached Growth Reactor consists of:

- Influent and effluent control structures.
- Uniform Graded Clean Rock
- Insulating Mulch
- Non-Woven Geotextile 8 oz.
- HDPE Liner 60 mil
- Wall Framing and Sheathing
- Piping, Fitting, and Valves
- Electrical, Instrumentation, & Control

4.2.3.2 Schematic Layout

Figure 18 shows the process schematic of the SAGR alternative, Figure 19 shows an approximate site layout on the WWTP property, and Figure 20 provides some installation photos from various SAGR installations in the US.



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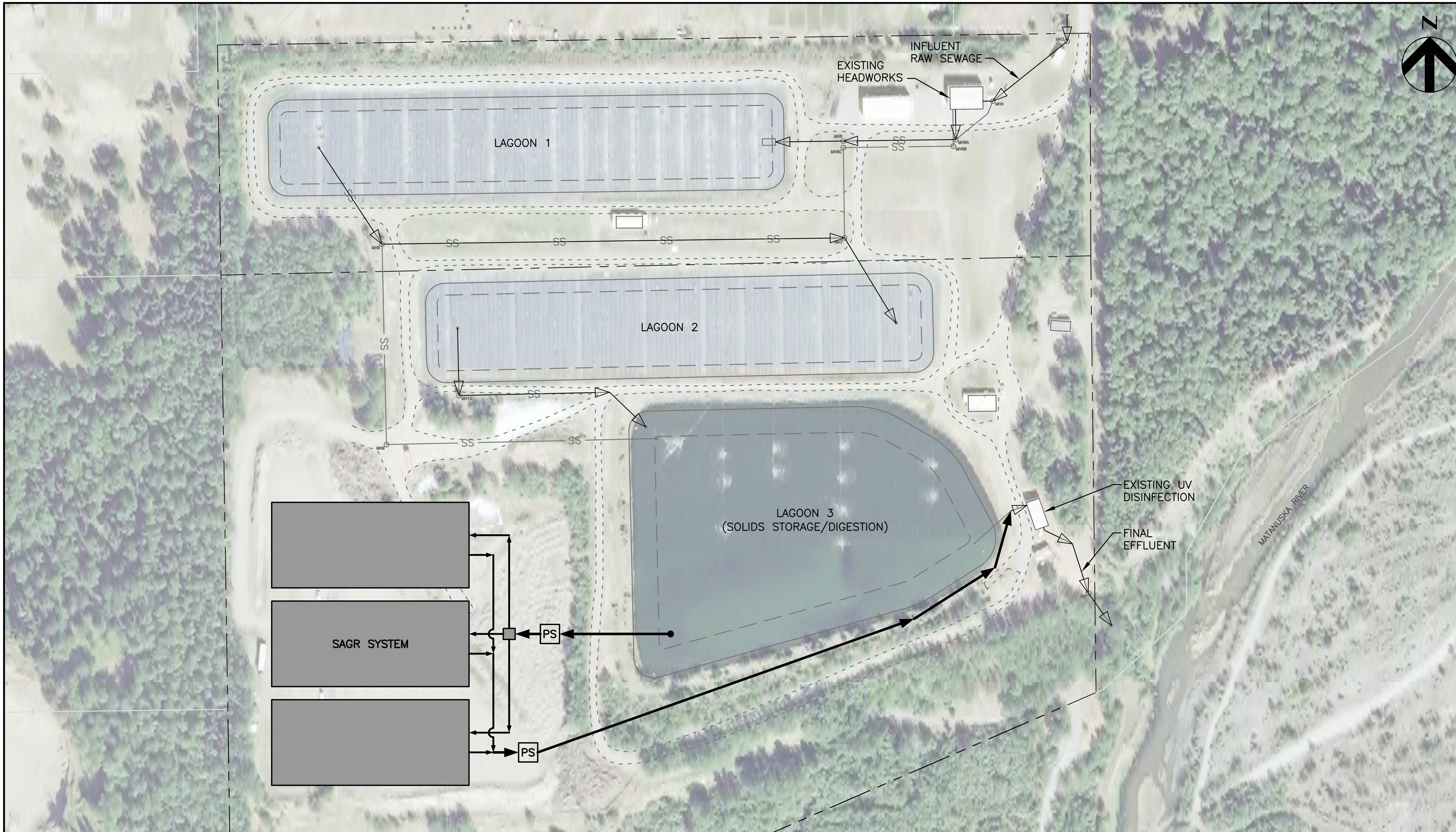
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

PROCESS FLOW SCHEMATIC - ALTERNATIVE 3
SUBMERGED ATTACHED GROWTH REACTOR

DATE
FEB 2016

FIGURE
18



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FACILITY PLAN UPDATE

CONCEPTUAL SITE LAYOUT - ALTERNATIVE 3
SUBMERGED ATTACHED GROWTH REACTOR

DATE
FEB 2016

FIGURE
19

Figure 20 Photos of SAGR Installation

4.2.3.3 Land Requirements

Addition of secondary treatment using the SAGR process to the existing lagoon facility requires a significant amount of land. An area of approximately 5-10 acres is required for this process addition. Land would be available on the existing WWTP site in the sludge disposal/firing range area but this would only accommodate a first phase of the SAGR system (1.0 MGD capacity). Expansion of the process in the future would require the acquisition of adjacent property or significant process changes to the WWTP (i.e. remove Lagoon 3, add biological treatment prior to SAGR, etc.) The City has approached both the property owners to the east and the west in the past and has been met with some reluctance by the owners to sell property.

4.2.3.4 Review of Process Performance and Suitability

HDR performed a review of the process arrangement and the predicted performance levels. The review indicated that the SAGR technology is a viable technology that is capable of meeting the discharge objectives. The review also identified additional data collection and analysis to be performed to address process concerns that were identified.

The following items are recommended to be addressed prior to selection of the SAGR system design:

- Review historical lagoon performance data from Palmer for effluent BOD and TSS concentrations. The SAGR technology is prone to fouling when effluent concentrations are above 25 and 30 mg/L, respectively.
- Review historical performance data from other SAGR installations to confirm the ability to meet low level maximum day ammonia limits such as those for Palmer.
- Compare the Palmer design nitrogen loading values and system flows against other SAGR installations.
- Verify SAGR performance for similar cold climate applications.

Appendix B contains a technical memorandum that provides a summary of HDR's review of the SAGR process, a questionnaire developed to obtain information from other SAGR installations, and responses from the survey calls to other facilities that have the SAGR process.

4.2.3.5 Cost Analysis

In order to evaluate the overall cost of each alternative; both the cost to construct the project and the cost to operate and maintain the project must be considered. These costs are then used to calculate an equivalent annual cost which is presented in Table 11. A detailed cost estimate is provided in Appendix A.

Table 11: Alternative 3 Secondary Treatment Cost Analysis

Alternative 1	Project Cost Range	Annual O&M Costs	Net Present Value Range
Secondary Treatment /SAGR	$10,200,000 - $15,400,000	$310,000	$15,300,000 - $20,500,000

Cost estimates prepared as part of the Facilities Plan are order-of-magnitude, Class 5 estimates, as defined by the American Association of Cost Engineers (AACE). According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

CLASS 5 ESTIMATE - Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20% to –50% on the low side and +30% to +100% on the high side.

4.2.3.6 Advantages/Disadvantages

Advantages of constructing secondary treatment with respect to financial, managerial, and operational resources include:

- Complies with regulatory requirements.
- Additional storage of effluent not required.
- Lower requirements for SAGR system O&M than more mechanically intensive systems.
- Operates year round and is not subject to seasonal discharge.

Disadvantages of constructing secondary treatment with respect to financial, managerial, and operational resources include:

- Pumping of effluent required.
- Operation and maintenance of the SAGR treatment systems in addition to existing lagoons.
- Potential for solids build-up and significant system rehabilitation if higher than allowed BOD, TSS and TKN is not monitored and reduced.
- Land intensive. Additional land required for flows beyond 1.2 MGD.
- Higher capital cost and O&M costs.

4.2.4 Alternative 4 - Moving Bed Bioreactor (MBBR)

4.2.4.1 System Description and Design Parameters

MBBR systems rely on a fixed film or biofilm that is attached to suspended media (Figure 21) to treat the wastewater. Such fixed film treatment systems have been around for decades in the form of trickling filters. However, trickling filters were not submerged and had difficulty with hydraulics and even loading across the media. MBBR systems are submerged in the activated sludge. Because the biomass is attached to the media, which is retained by screens (Figure 22), it is resilient against washouts and it is very operator friendly, requiring no inventory management (no SRT control), and no diffuser maintenance. For better mixing and to prevent media floatation, simple coarse bubble diffusers are used in MBBR systems which require minimal maintenance (Figure 23).

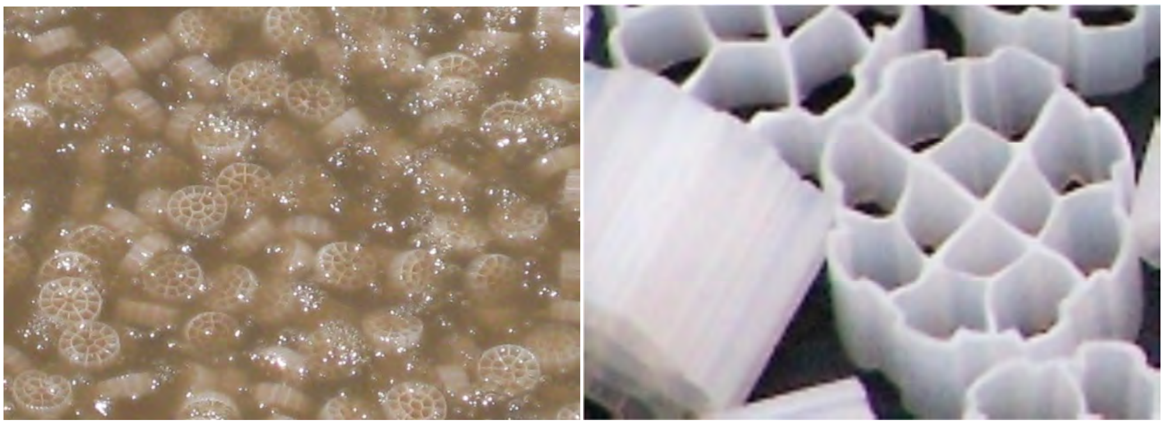


Figure 21: MBBR Suspended Media

Figure 22: MBBR Media Retention Screens

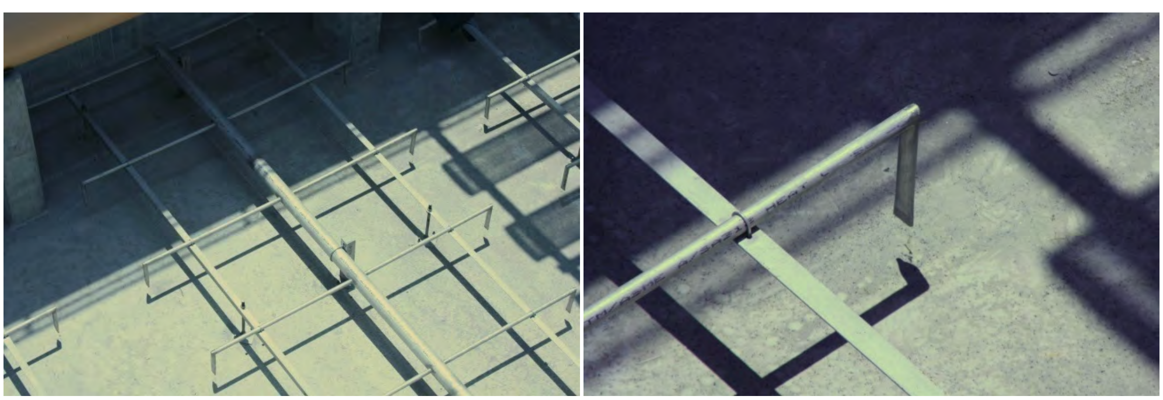


Figure 23: MBBR Coarse Bubble Diffusers

For Phase I of this alternative, two parallel complete mixed basins would be constructed with a depth of 20 ft and an approximate total volume of 525,000 gal and a media fill ratio of 50% (about 50% of media volume relative to the basin volume). The basins would be sized for a maximum month design flow of 1.2 MGD. The media would initially be installed for the average maximum month flow of 0.65 MGD. This would allow for expansion in the future by adding more media to the existing basins without the need for adding more concrete tanks until flows reach average maximum month 1.2 MGD.

The MBBR effluent would be routed directly to a solids removal process: either clarifiers, disc filtration, or the polishing lagoon. However, routing the flow through a polishing lagoon has some inherent risk. Before the flow can be routed through any of the existing lagoons as a polishing filter, they should be dredged and cleaned to prevent ammonia release from the existing sludge. Dredging the existing settling pond would be less difficult than dredging the aerated ponds because no cover is installed.

The MBBR can be designed for either nitrification alone or nitrification and denitrification. If future denitrification is necessary due to lower limits of total nitrogen, an anoxic zone would be added to the basin, either at the front (IFAS Mode) or at the end of the MBBR. If the anoxic cell is at the front of the basins, an internal recycle will return nitrate to this anoxic zone for denitrification. Alternatively, nitrogen removal could be accomplished by managing the dissolved oxygen in such a way (i.e. cyclic aeration) that promotes simultaneous nitrification and denitrification.

Another future consideration for the MBBR alternative is the addition of a grit removal system. The existing facility includes a grinder/macerator and screens in the headworks, but does not have dedicated grit removal facilities. Currently any grit that enters the facility and makes it past the influent pumps and screening equipment settles out in the first aerated lagoon. Preliminary discussions with MBBR manufacturers indicate that the MBBR process does not initially require dedicated grit removal facilities. However, the accumulation of grit in the MBBR aeration basins should be monitored closely in the future and if it becomes an issue (either impacting the treatment capability of the MBBR or becoming an O&M issue) a grit removal system may be required between the existing headworks building and the MBBR basins. A number of manufacturers (including Huber, Eutek, Wemco) provide grit removal packages that generally consist of aerated, vortex grit removal basins followed by grit classifiers/washers.

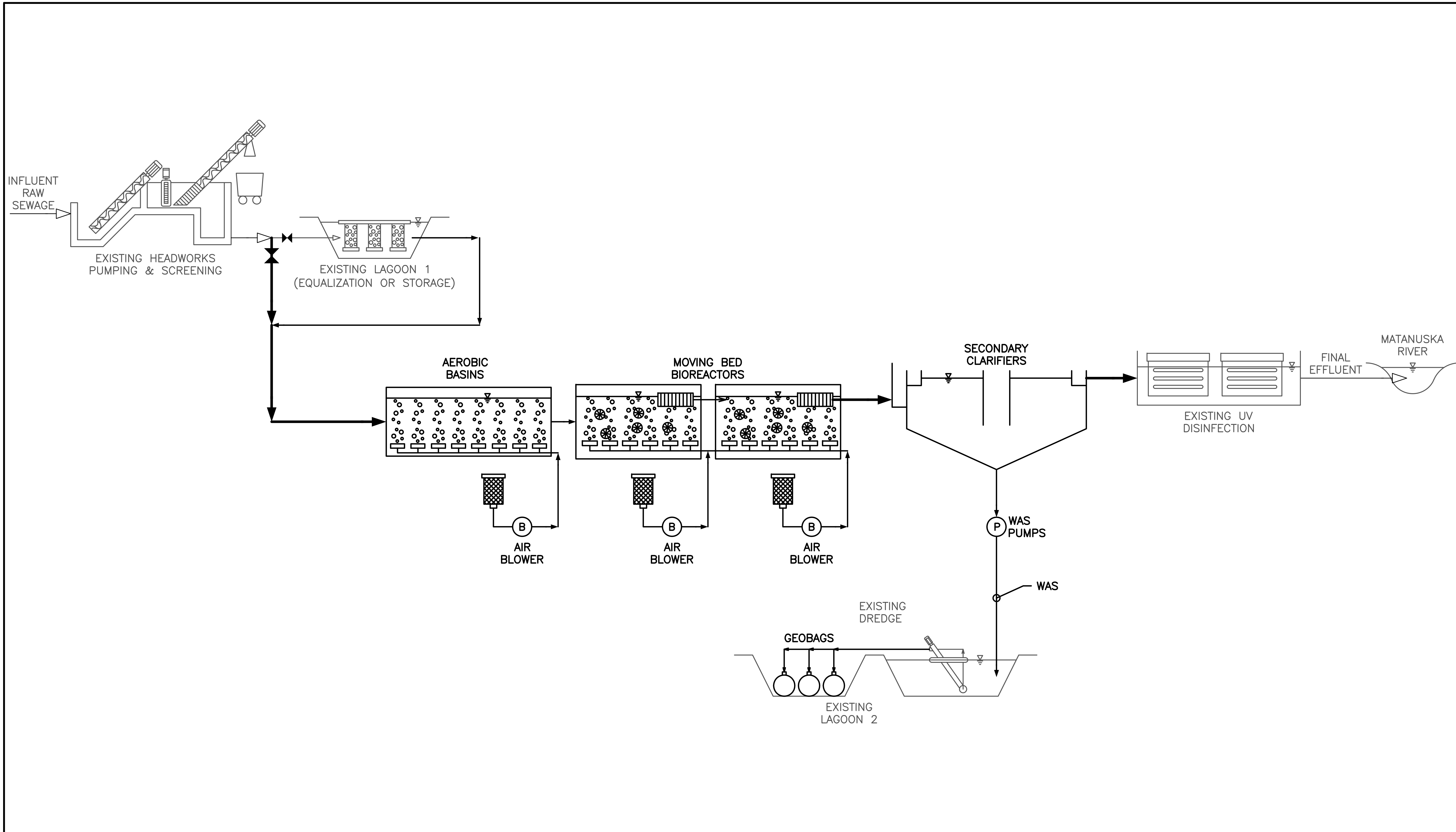
This MBBR alternative differs from MBBR options considered in previous studies in that it would treat the influent raw wastewater as it enters the plant, rather than after the existing lagoon system. The benefit of locating the MBBR process at the head of the facility is that the influent wastewater temperature is typically greater than 8ºC even during the winter months and treating the wastewater before the temperature drops as it passes through the lagoons will improve nitrification and overall treatment performance.

Additionally, the MBBR alternative offers the potential for significant annual O&M cost savings to the City. The existing lagoon system uses a large amount of process air to maintain aerated and semi-mixed conditions in the existing lagoons. The MBBR would use substantially less energy (than current plant as well as other alternatives being considered) to aerate the small concrete basins. Preliminary calculations indicate that a power cost savings of approximately $30,000-$40,000 could be expected annually based on current power costs compared to the power requirements of the MBBR process versus the existing lagoon system.

4.2.4.2 Schematic Layout

Four potential MBBR process schematics and corresponding conceptual site layouts are included below.

Figure 24 and Figure 25 show the process schematic and site layout of the MBBR alternative that uses secondary clarifiers for solids removal. Figure 26 and Figure 27 show the process with Disc Filters for secondary clarification to ensure solids are settled adequately. Figure 25 and Figure 29 show the process with a dissolved air floatation (DAFT) unit for solids removal. Figure 30 and Figure 31 show the MBBR with secondary clarifiers constructed as an initial phase for interim RAS to the existing lagoons and ultimately the potential for return flows as part of an IFAS process modification. The first three options could all be phased such that the MBBR could be constructed initially with solids sent to the existing lagoons for additional treatment with the mechanical clarification options (clarifiers, DAFT, or disc filters) being constructed at a later date when funding became available. Using an MBBR would require less footprint than additional aerated lagoons and could be used in conjunction with other alternatives considered in this Plan.

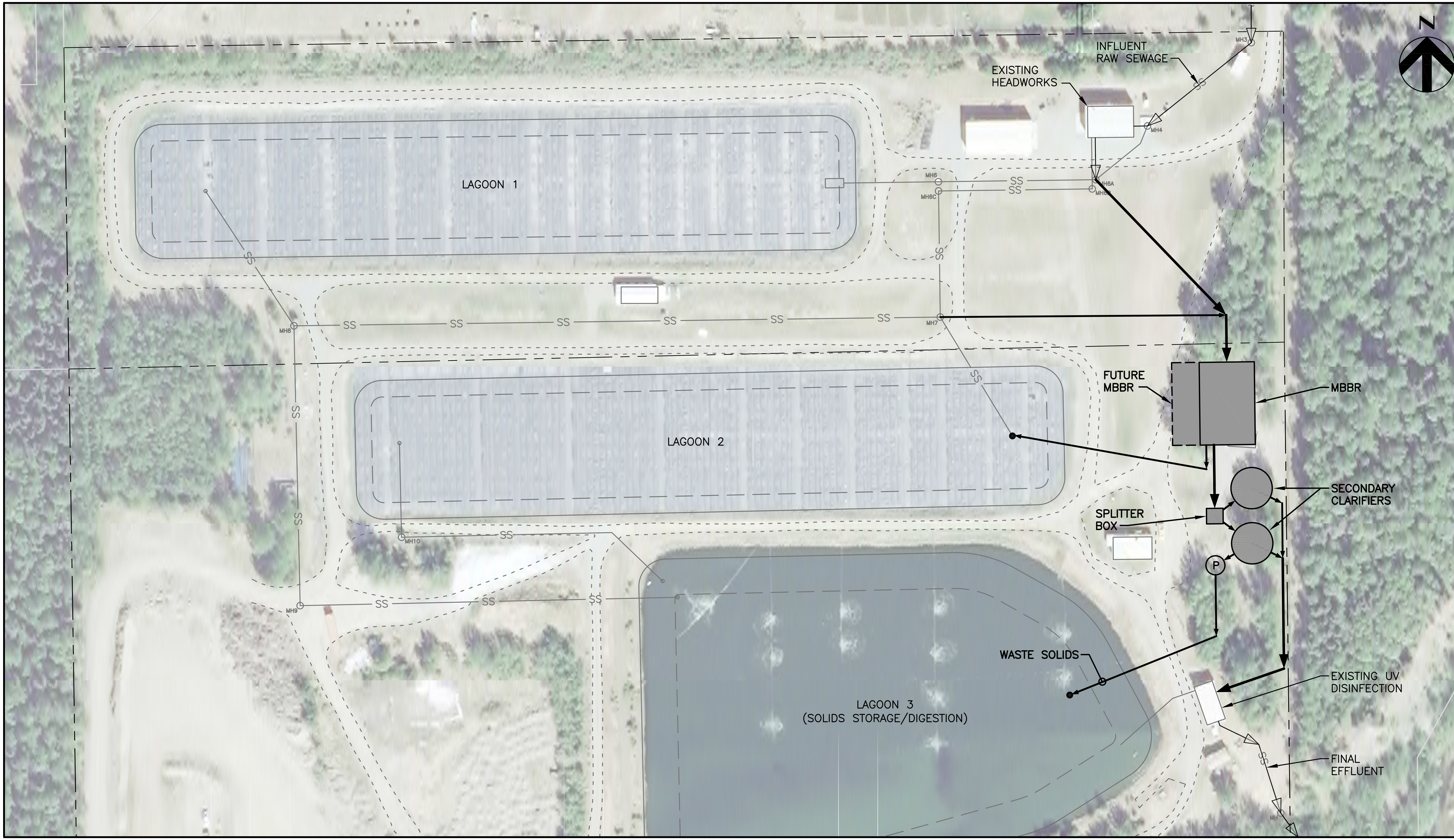


CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

PROCESS FLOW SCHEMATIC - ALTERNATIVE 4A
MBBR WITH SECONDARY CLARIFIERS

DATE FEB 2016

FIGURE 24



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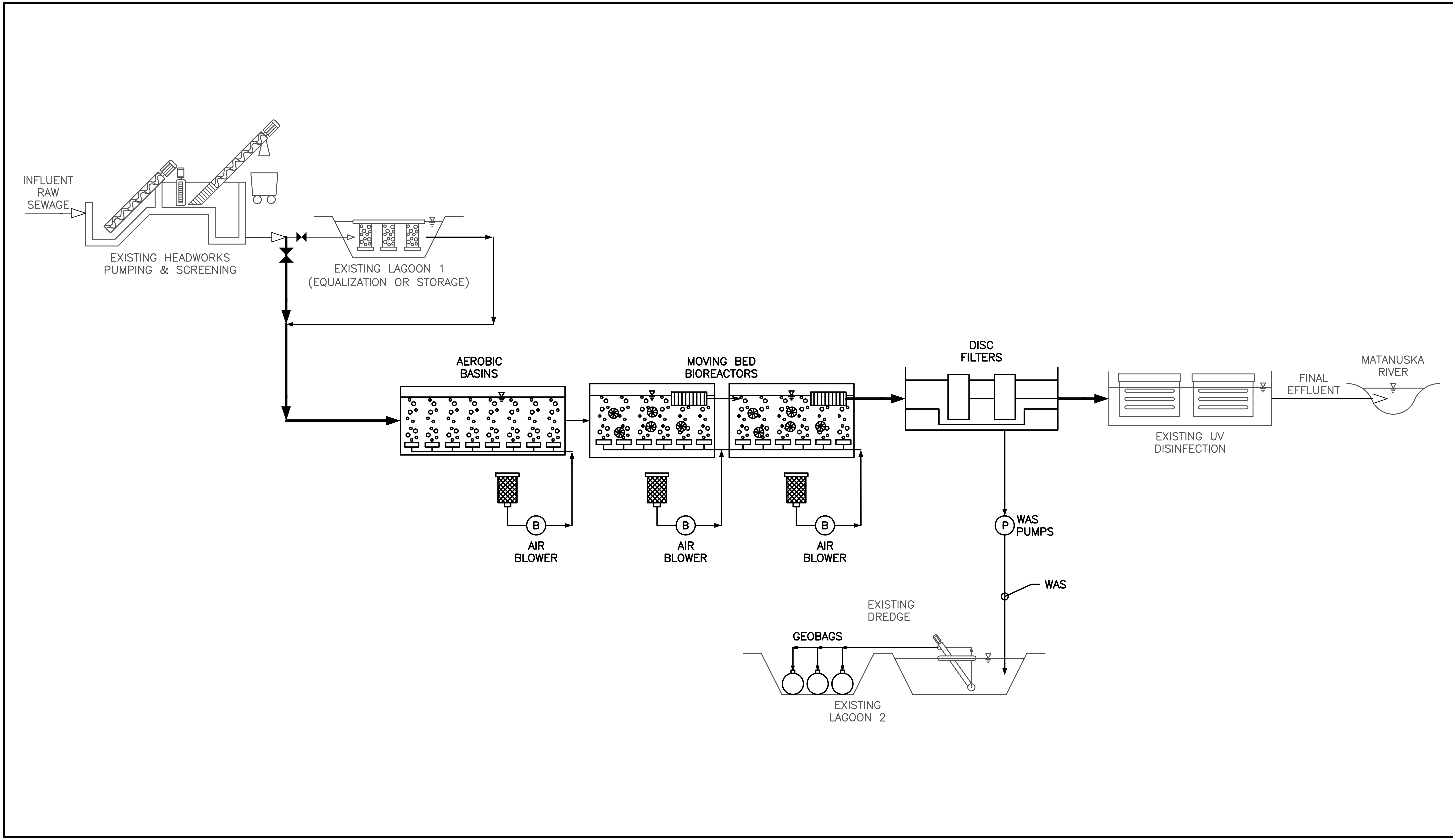
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

CONCEPTUAL SITE LAYOUT - ALTERNATIVE 4A
MBBR WITH SECONDARY CLARIFIERS

DATE
FEB 2016

FIGURE
25



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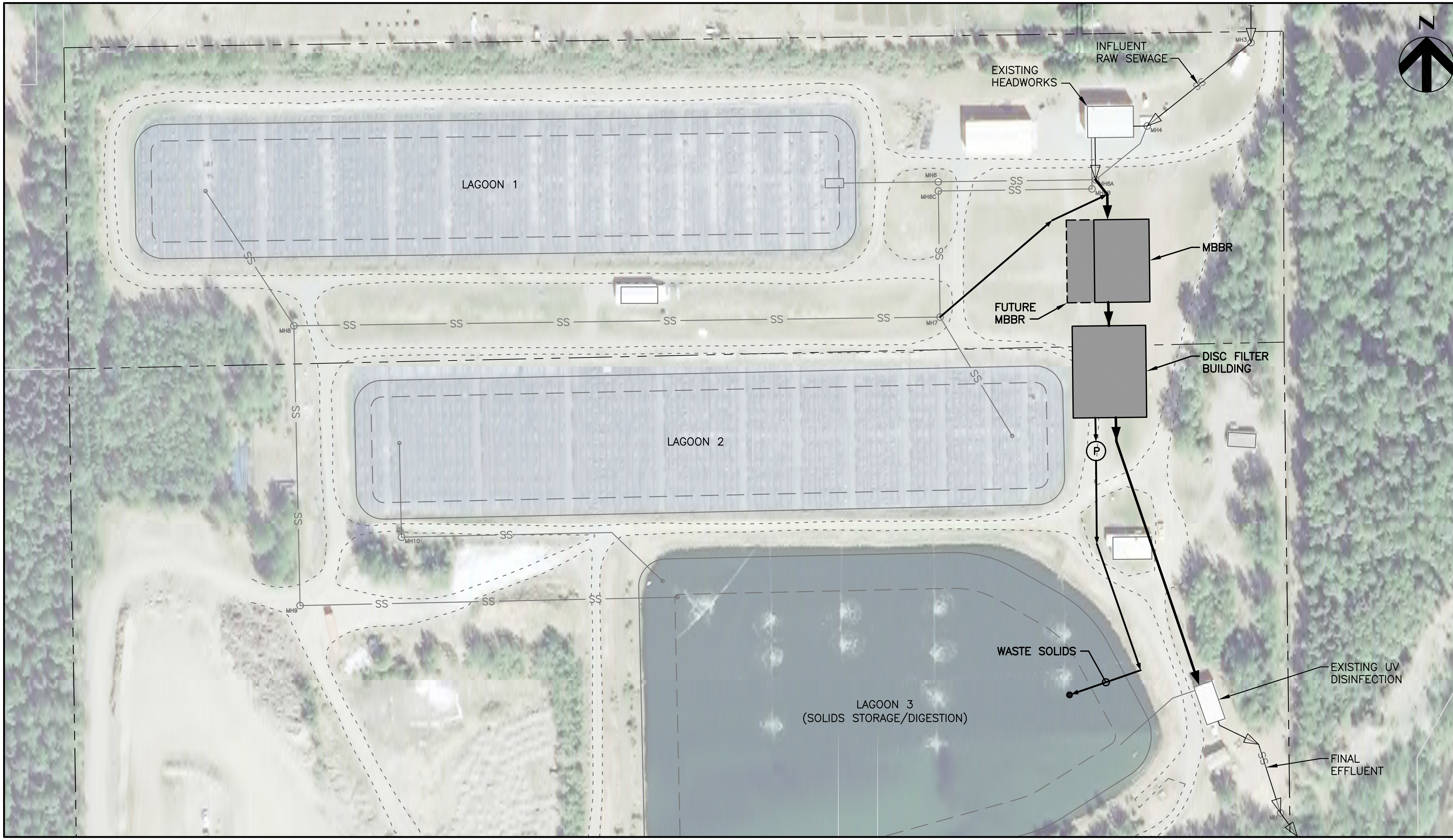
FACILITY PLAN UPDATE

PROCESS FLOW SCHEMATIC - ALTERNATIVE 4B
MBBR WITH DISC FILTERS

DATE FEB 2016

FIGURE 26



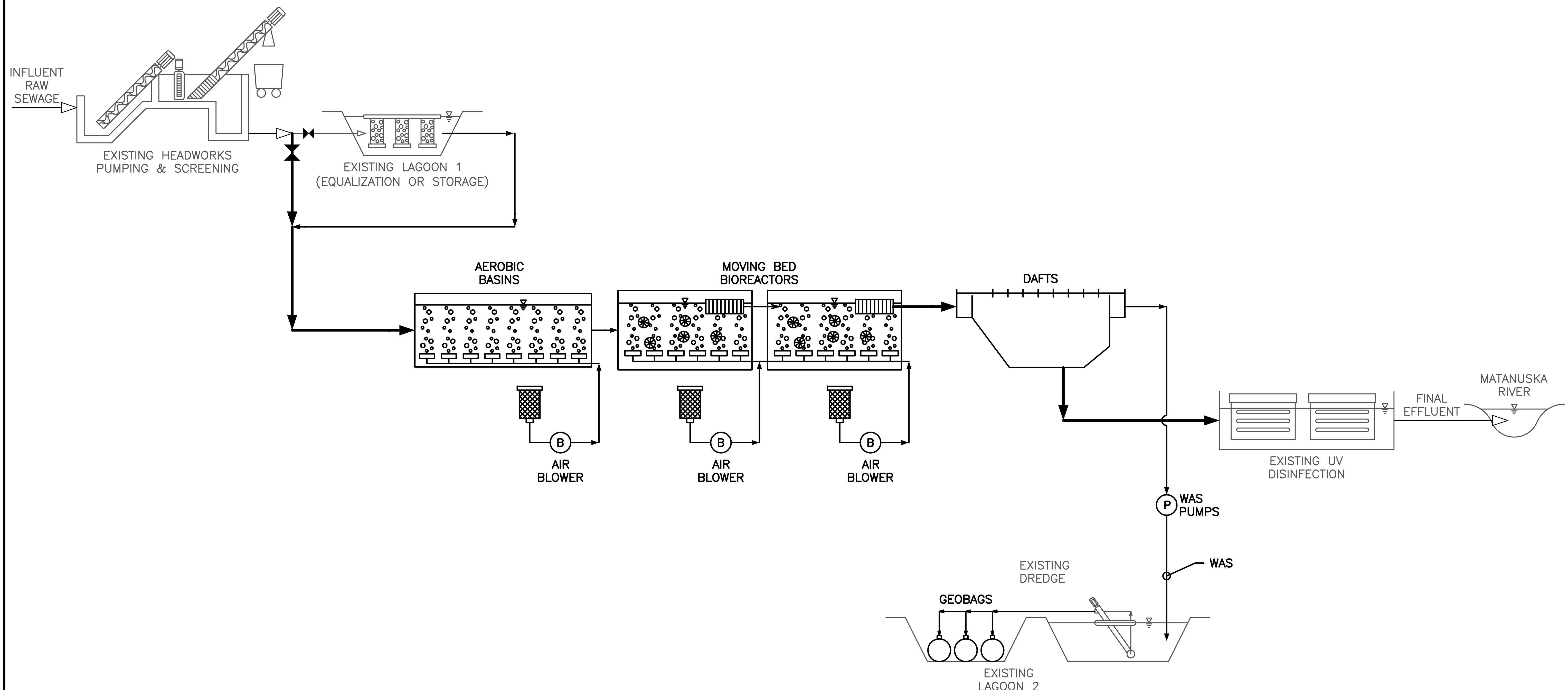
HDR

CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

CONCEPTUAL SITE LAYOUT - ALTERNATIVE 4B
MBBR WITH DISC FILTERS

DATE
FEB 2016

FIGURE
27

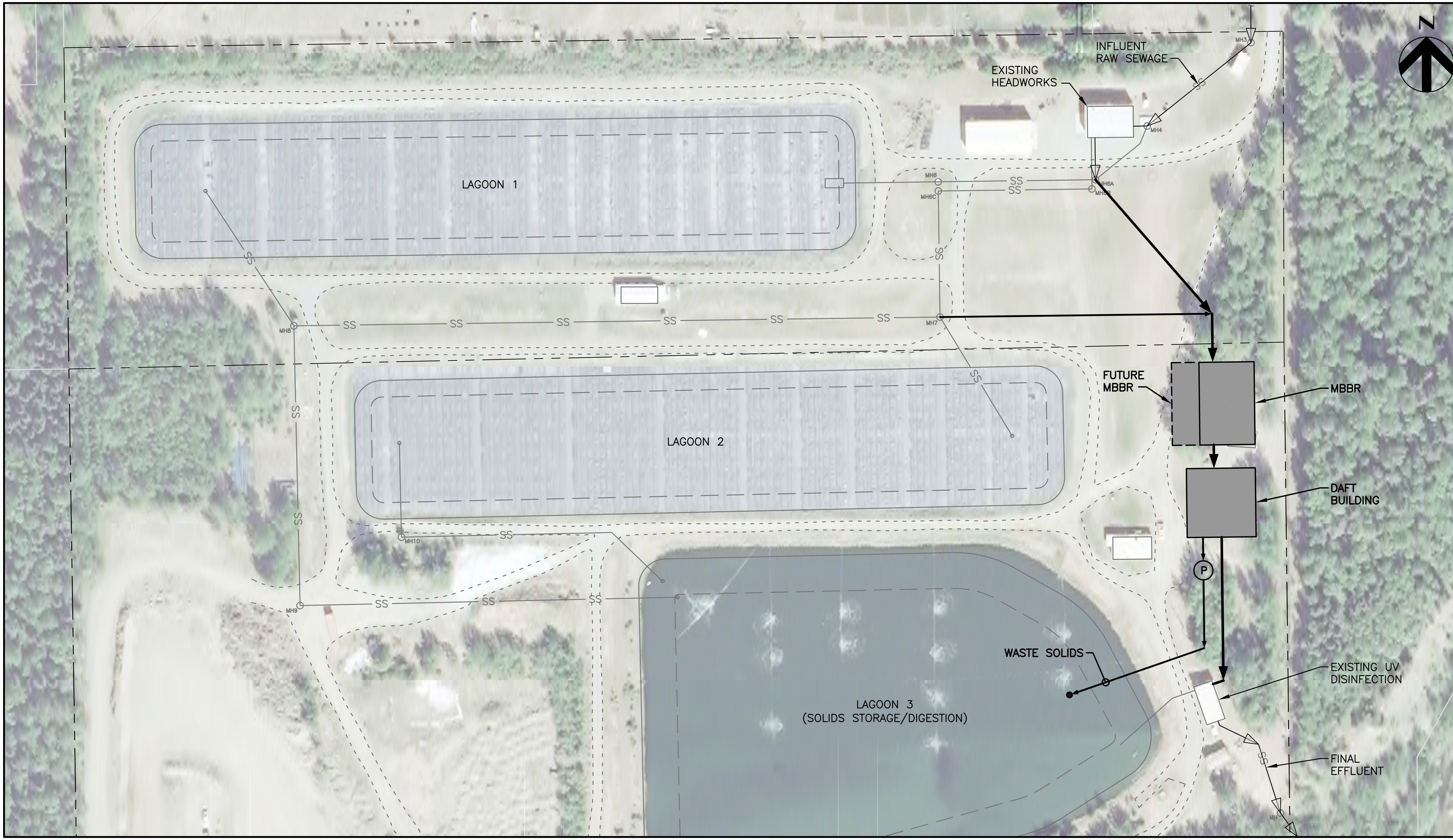


CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

PROCESS FLOW SCHEMATIC - ALTERNATIVE 4C
MBBR WITH DAFT

DATE
FEB 2016

FIGURE
28

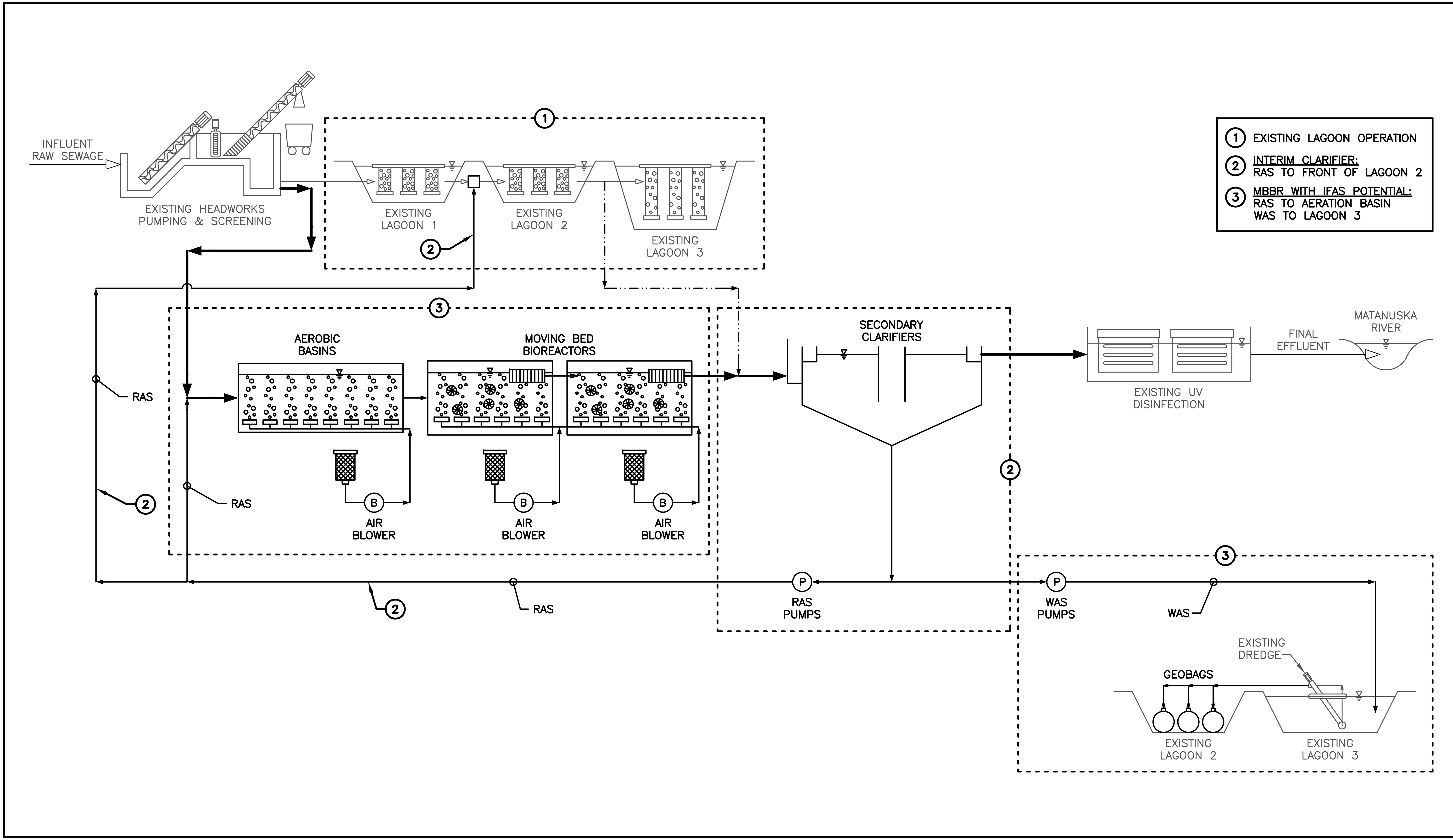


CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

CONCEPTUAL SITE LAYOUT - ALTERNATIVE 4C
MBBR WITH DAFT

DATE
FEB 2016

FIGURE
29

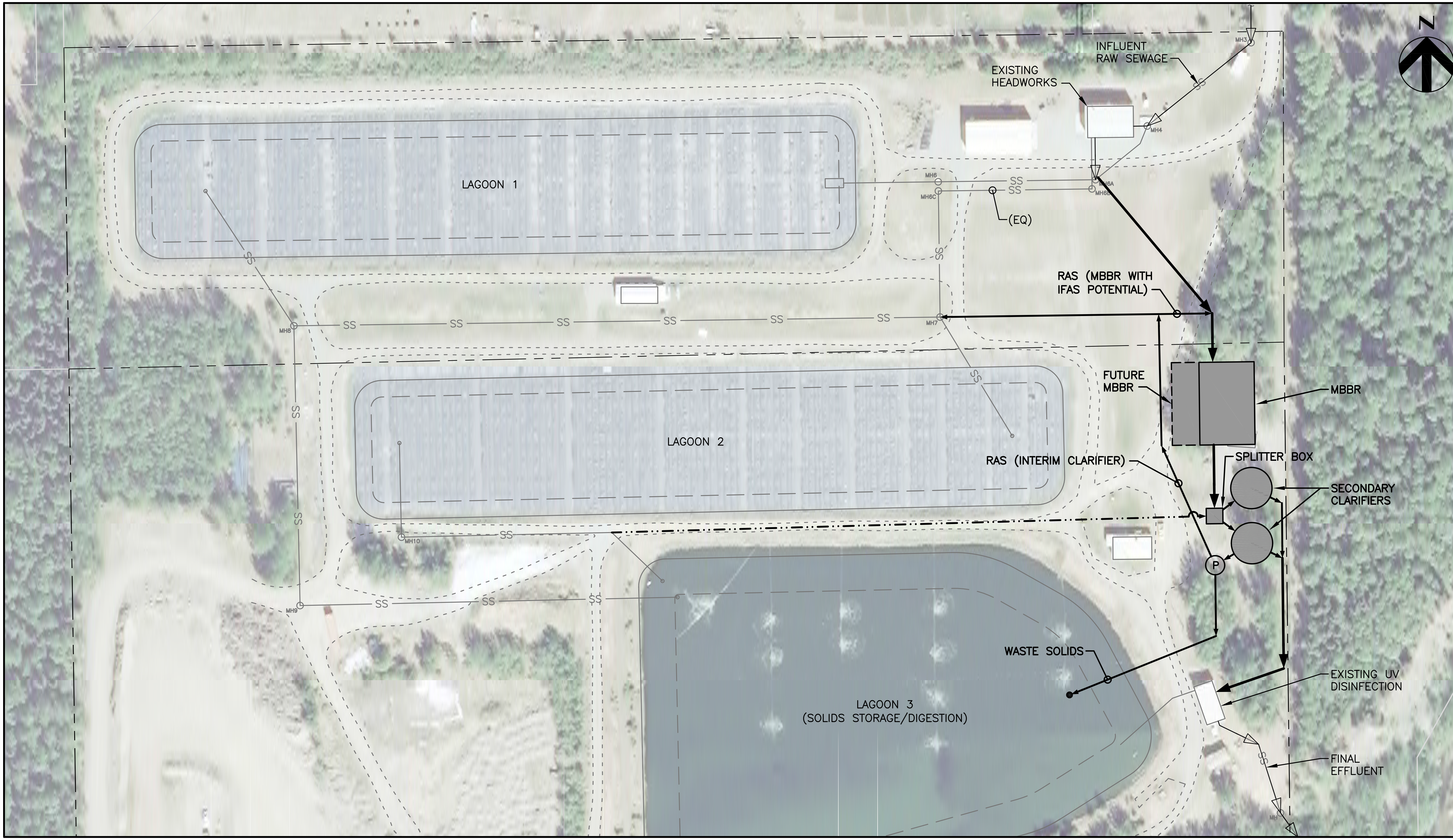


CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

PROCESS FLOW SCHEMATIC - ALTERNATIVE 4D
MBBR WITH INTERIM RAS/FUTURE IFAS

DATE FEB 2016

FIGURE 30



HDR

CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

CONCEPTUAL SITE LAYOUT - ALTERNATIVE 4D
MBBR WITH INTERIM RAS/FUTURE IFAS

DATE
FEB 2016

FIGURE
31

This MBBR alternative differs from MBBR options considered in previous studies in several ways. As previously discussed, it would treat the influent raw wastewater as it enters the plant, rather than after the existing lagoon system. This would take advantage of the relatively warm influent wastewater before the temperature drops through the lagoons. Previous studies considered post-lagoon MBBR with re-heating the wastewater. The proposed MBBR option differs from previous studies is that the MBBR basins are proposed to be located outside and covered rather than in a treatment building. Putting the MBBR basins in a building adds significant capital costs as well as annual O&M costs for power, lighting, heating, and maintaining the building.

MBBRs have been installed outside, with and without covers, and successfully operated in numerous places across the US in similar cold weather environments. Another benefit of the small basin footprint is the warm air from the blowers helps to keep the wastewater warm throughout the winter months even though the basins are open to the air. Figure 32 and Figure 33 below show a similar cold weather installation of MBBRs.

Figure 32: Cold Weather (-21F) MBBR Installation in Wisconsin

Figure 33: Cold Weather (-21F) MBBR Installation in Wisconsin

4.2.4.3 Land Requirements

Under this alternative, a concrete treatment structure would be installed consisting of two treatment trains. Each treatment train would be approximately 40 feet long by 30 feet wide by 20 feet deep, for a total dimension of approximately 60 feet wide by 70 feet long footprint of approximately 4,200 square feet. Depending on the MBBR configuration selected, the remaining lagoons could either be decommissioned or utilized for equalization or solids settling/sludge storage. The existing blower building and UV/outlet building could be reused but might need to be moved for ease of access. The existing plant property is more than adequate to construct this alternative.

4.2.4.4 Cost Analysis

In order to evaluate the overall cost of each alternative; both the cost to construct the project and the cost to operate and maintain the project must be considered. These costs are then used to calculate an equivalent annual cost which is presented in Table 12. A detailed cost estimate is provided in Appendix A.

Table 12: Alternative 4 MBBR Cost Analysis – for Phase I

Alternative 4	Project Cost Range*	Annual O&M Costs	Net Present Value Range
MBBR w/ Lagoon settling	$5,000,000 - $7,400,000	$149,000	$7,400,000 - $9,800,000
MBBR w/ Clarifiers	$9,800,000 - $14,600,000	$170,000	$12,500,000 - $17,300,000
MBBR w/ Disc Filters	$10,400,000 - $15,400,000	$186,000	$13,400,000 - $18,400,000

*-Project cost assumes that the MBBRs and clarifiers are constructed outside (with aluminum covers) and not in an operations building. The disc filters or DAFT would require a building.

Cost estimates prepared as part of the Facilities Plan are order-of-magnitude, Class 5 estimates, as defined by the American Association of Cost Engineers (AACE). According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

CLASS 5 ESTIMATE - Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20% to –50% on the low side and +30% to +100% on the high side.

4.2.4.5 Advantages/Disadvantages

Advantages of constructing an MBBR process with respect to financial, managerial, and operational resources include:

- Complies with regulatory requirements.
- Treats warmer influent wastewater before entering the lagoons – enhancing treatment.
- Additional storage of effluent not required.
- Pumping of effluent not required.
- Smaller footprint (land acquisition) relative to other alternatives.
- Operates year round and is not subject to seasonal discharge.

Disadvantages of constructing an MBBR process with respect to financial, managerial, and operational resources include:

- For greatest system confidence would install the secondary clarifier as opposed to the use of the polishing lagoon solids clarification option.
- Disc filters/DAFT solids removal is a more labor intensive and complex alternative if chosen.
- Additional training may be necessary to understand the operational parameters of a biofilm system.
- An upset to the biomass requires a long time to re-establish itself, which could lead to periods of non-compliance with the facility's discharge permit.

- Operation and maintenance of the treatment systems is more complex than the existing lagoon system.

4.3 Effluent Discharge Alternatives

4.3.1 On-Site Subsurface Disposal

A subsurface disposal system is a land application system where wastewater is passed through an adequately permeable soil profile. The soil profile must have sufficient depth above groundwater to provide adequate treatment. Key considerations are the soil profile depth, depth to groundwater, and soil permeability, hydraulic conductivity, and hydraulic gradient.

4.3.1.1 System Description

This alternative considers operation of a drain field effluent subsurface disposal system as an alternative to a surface water discharge into the Matanuska River. This option would include adding drain fields to the existing site. The drain field would be located in the area currently used for sludge drying and disposal and as a firing range for the Palmer Police Department and Federal Bureau of Investigation (FBI).

Preliminary geotechnical evaluation was performed in 2009 on the property adjacent to the WWTP to the west. The 2009 study included field investigation (borings and test pits) and laboratory analysis of the soils. The 2009 investigation did not include the installation of a well or an aquifer pumping test. The site was evaluated for 2 MGD discharge and preliminary findings suggested negative impacts to the surrounding groundwater and river bank. Purchase of the land for use as subsurface disposal for the WWTP was not pursued further due to the initial geotechnical recommendations and opposition from local residents fearing contamination (nitrates) of a nearby community well.

Preliminary evaluation by Shannon & Wilson for this plan based on geotechnical information from adjacent properties suggested that a drainfield capable of discharging current average flows (0.55 MGD) to flows over the 1 MGD would be viable on the WWTP site. Based on assumptions made on aquifer characteristics and modeling approach, it was believed that the 2009 study significantly overestimated the amount of mounding that would occur and impacts to groundwater aquifer. Both the 2009 study and the preliminary evaluation for this plan were based on assumptions about the aquifer conditions based on experience and previous studies in the area and were not based on measured, site-specific data. In order to determine if the site would be viable for subsurface discharge, additional geotechnical investigation was performed. The geotechnical investigation included:

- Aquifer pumping test. Knowing thickness of the aquifer and transmissivity are important parameters in the groundwater mounding and nitrate reduction evaluations.
- Installation of wells to evaluate groundwater flow, the hydraulic gradient, and flow direction (note a higher gradient causes more flow and more nitrate treatment).
- Preliminary analysis of the bluff stability using Slope/W.

- Analysis of the level of total nitrogen treatment required.

Based on this geotechnical investigation, soil and groundwater conditions in the area can be better understood and provide the preliminary treatment evaluation to proceed. The treatment alternatives analysis provides the level of treatment requirements to ensure the required nitrate treatment upstream of the drain fields to reduce ammonia/nitrates to meet groundwater drinking water quality standards. This alternative assumed that the point of compliance for groundwater water quality standards (10 mg/L nitrate) would be where the groundwater meets the surface/river water at the toe of the slope in the floodplain.

In order to obtain additional information on the site and characteristics of the aquifer, field work was conducted on-site from December 2015 to February 2016. The field investigation included the following work:

1. Geotechnical subsurface explorations (5 boreholes)
2. Installation of a test well
3. Aquifer drawdown tests
4. A topographic survey to support preliminary slope stability analysis of the bluff area.

The field work was completed on February 3, 2016 and the data was compiled and analyzed. This field site investigation, along with previous work experience and studies in the area, provided the input necessary to complete system modeling. Mounding analysis was performed using a spreadsheet model based on a solution of the general two-dimensional groundwater flow equation developed by Hantush (1967) and modified by USGS in 2010. In addition to the Hantush Method Model, a second model was used to determine the fate of nitrates in the soils using the simplified Minnesota Pollution Control Agency method (1984). Preliminary analysis of this field data has been included in this draft of the Plan. A full geotechnical report summarizing the results and evaluation is included in Appendix E.

4.3.1.2 Preliminary Results of On-Site Geotechnical Investigation

The initial results of the geotechnical investigation are shown in Table 13. The mounding analysis indicates a moderate, 2 to 3 feet, of groundwater mounding is expected to form beneath the infiltration area. At a subsurface discharge rate of 1.0 MGD, the predicted mound height is likely in the range of natural seasonal variations in groundwater elevation. The hydraulic gradient of the aquifer in the infiltration area is approximately 0.001 ft/ft.

This information was used as input into nitrate models. These models analyze the nitrate concentrations travelling through the soil column to the groundwater. The simplified (MPCA 1984) nitrate model indicates there will be very little reduction (about 20 %) in nitrate between the infiltration area and the property boundary.

A second model developed by HDR hydrogeologists (based on models developed by Washington Ecology, Idaho DEQ, and Montana DEQ) was used to verify the MPCA model results and estimate the nitrate concentrations. Various site-specific model inputs and results of each model are summarized in Table 12 below. Based on 0.50 MGD of effluent to the drain field and a total nitrogen concentration of 45 mg/L (based WWTP effluent data), the estimated down gradient (edge of property) nitrate concentration in groundwater will be in excess of 10 mg/L (groundwater quality standard). Both models verified that there would be approximately 30 to 40 mg/L of nitrates at the groundwater interface below the property boundary. This concentration of nitrates exceeds the groundwater drinking water standard of 10 mg/L.

Table 13 Nitrate Model Inputs and Results

Input Parameter	MPCA 1984	HDR Model
Flow from Drainfield	500,000 gpd	500,000 gpd
WWTP Effluent TN Concentration	44.71 mg/L	44.71 mg/L
Drainfield area	302,500 ft2 (550'x550')	302,500 ft2 (550'x550')
Aquifer Hydraulic Conductivity	500 ft/day	500 ft/day
Hydraulic Gradient of Groundwater	0.001 ft/ft	0.001 ft/ft
Aquifer Thickness	45 ft	20 ft
Nitrate Concentration At Property Boundary	**34.9 mg/L as N**	**34.2 mg/L as N**
Nitrate Groundwater Standard	**10 mg/L**	**10 mg/L**

The result is primarily due to the relatively low groundwater flow gradient. If the drain field discharge will be held to groundwater quality standards at the groundwater, then a drain field will not be a viable disposal option without additional treatment prior to discharge from the WWTP, such as anoxic zones for denitrification, to reduce nitrate nitrogen and total nitrogen in the effluent to meet permit levels.

The ADEC was contacted on February 11, 2016 to discuss the results of the geotechnical investigation and provide an indication whether or not more analysis is needed to help answer the question of the ability to permit nitrate levels of 35 to 40 mg/L in the groundwater. In other words ADEC was asked whether these levels of nitrates in the groundwater would be acceptable. ADEC determined that it would be very difficult for the ADEC to permit these levels of nitrates in the groundwater and such a permit would go against previous precedents set in other areas of the state.

Figure 34 provides a conceptual profile of the drainfield discharge area and illustrates several key considerations in the nitrate treatment analysis (hydraulic gradient, mounding, 'property boundary', etc.).

Figure 35 illustrates the location of the test well, boreholes, and general topography of the drain field and slope areas.

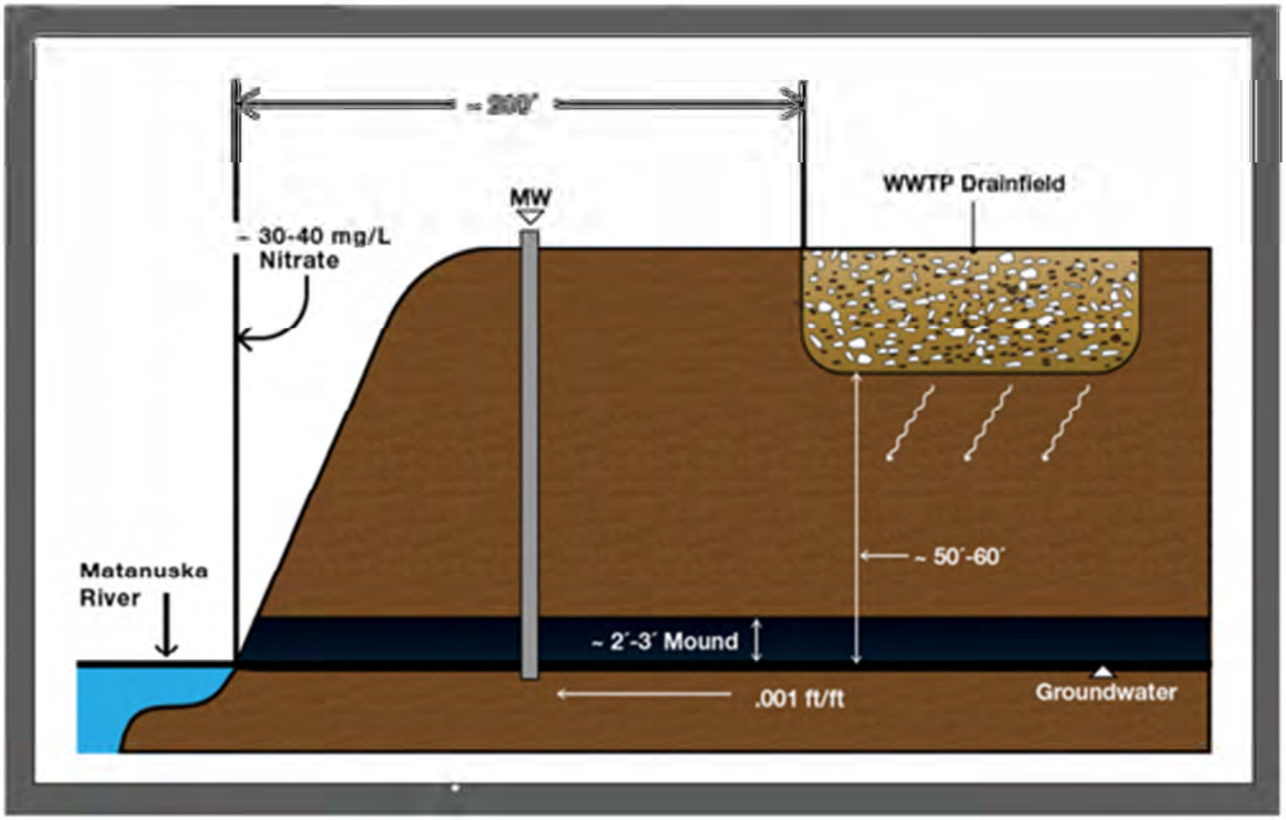
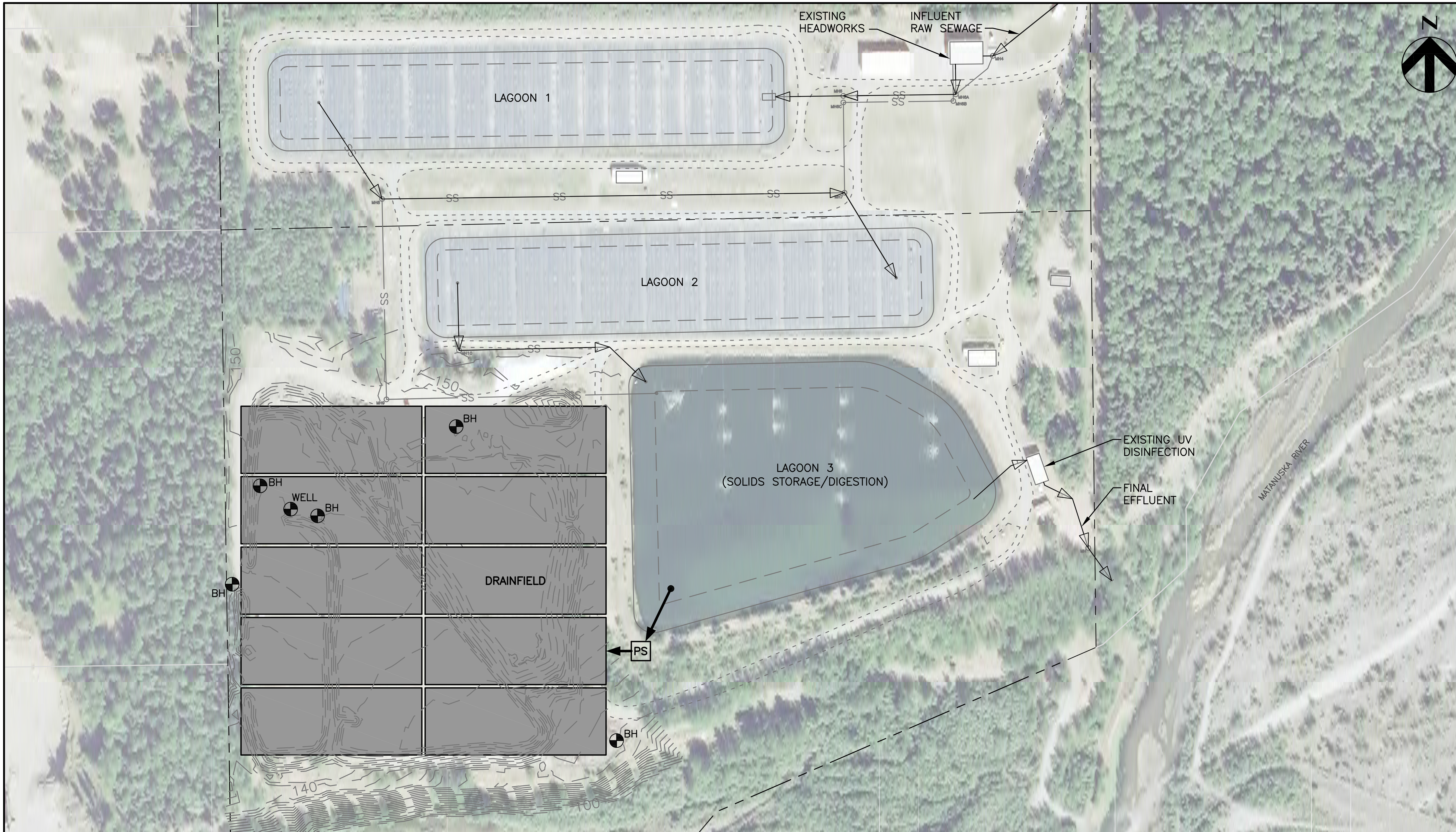


Figure 34: Palmer WWTP Drainfield Discharge Profile



CITY OF PALMER
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE

CONCEPTUAL SITE LAYOUT
SUBSURFACE DISPOSAL

DATE
FEB 2016

FIGURE
35

4.3.1.3 Other Site Considerations

Slope Stability:

The preliminary slope stability evaluation indicates that the existing slope has a factor of safety of less than 1.0 for shallow, surface raveling failure. Observations of the sloped area indicate that in areas where the vegetation is undisturbed the slope appears to be stable but areas without vegetation indicate progressive raveling failures. The slope was also evaluated for deeper-seated failures under static and seismic conditions. These evaluations indicate that there is an adequate factor of safety against deep-seated failure under static conditions but that the factor of safety is less than 1.0 under seismic conditions. The increase in groundwater height due to infiltration of the wastewater has a slight negative effect on the existing slope stability. Figure 37 provides a photo of the bluff area from near the edge of the potential drain field.

More analysis is required in order to determine the slope stability with regards to the potential for additional groundwater flow in the area. This analysis could include:

- A seepage evaluation should be added to the slope stability model to confirm the impact of the increased groundwater height on slope stability.
  Preliminary permitting would be needed to evaluate options for slope stabilization (flattening, reinforcement, etc). Preliminary permitting should determine if floodplain analysis will be required for filling in/modifying the floodplain in the area.

Figure 36 Slope Area near edge of potential Drainfield

Firing Range Closure:

A portion of the infiltration basin area is currently been used as a firing range by the Palmer Police Department and FBI. Figure 37: Existing Palmer PD Firing Range provide photos of the existing firing range area.

The presence of bullets in the soil matrix may indicate lead contamination. If levels exceeded allowable limits, RCRA requirements would be triggered and soil would need to be removed from the ground in the area.

If the City wishes to pursue the subsurface alternative, a firing range characterization study is recommended to be completed in order to determine the level of contamination in the area and estimate the costs to close/cleanup the range. The first step for characterization of the range would be to develop a history (length of usage, calibers used, training exercises conducted, configuration changes, etc) to help guide the characterization.

Figure 37: Existing Palmer PD Firing Range

4.3.1.4 Land Requirements

On-site subsurface disposal on the existing WWTP site would not require additional land acquisition but would use most of the remaining treatment plant site and limit room for future expansion. Monitoring wells would be required up-gradient and down-gradient along the property lines to ensure neighboring properties were not be adversely impacted by the subsurface discharge. Note that the sludge drying area would need to be relocated to the area adjacent to Lagoon 2 and a new location/property would need to be established for the Palmer Police Department firing range.

4.3.1.5 Cost Analysis

Preliminary Costs for the on-site subsurface disposal alternative were not completed as this alternative is non-viable based on the analysis results and discussions with the Alaska Department of Environmental Conservation (ADEC).

4.3.1.6 Advantages/Disadvantages

Advantages of constructing an on-site subsurface discharge with respect to financial, managerial, and operational resources include:

- Utilizes existing aerated lagoons and minimizes system operational changes.
- Lowest relative capital costs.
- Additional storage of effluent not required.
- Operation and maintenance similar to the existing lagoon system.
- May be able to seasonally discharge to the side channel in the Matanuska River floodplain.

Disadvantages of constructing an on-site subsurface discharge with respect to financial, managerial, and operational resources include:

- In order to meet potential nitrate permit levels additional treatment shall be required including anoxic/denitrification zones to reduce the nitrates to acceptable levels.
- Potential costs associated with Firing Range closure.
- Potential costs and permitting requirements associated with Slope Stability improvements.
- Potential resistance from neighboring property owners concerned about drinking water wells
- Limited opportunity for expansion – would use most of remaining WWTP site for 0.5 to 1.0 MGD.
- Additional evaluation/study required to show APDES applicability.
- Drain fields can plug over time and may require repair or replacement.

4.4 Alternatives Summary

Table 14 below summarizes the project costs, advantages and disadvantages, and phasing opportunities for the alternatives evaluated in Chapter 4.

Table 14 Summary of Palmer WWTP Treatment Alternatives

Alternative	Biological Reactor	Clarification/Solids Removal	Disposal/Level of Treatment	Description/Notes	Phasing	Estimated Costs*	Advantages/Disadvantages: Advantages:	Advantages/Disadvantages: Disadvantages:
Treatment Alternatives								
1	Lagoon Activated Sludge	Secondary Clarifiers – two (2) separate circular clarifiers rather than Biolac rectangular integral clarifier design	River or Subsurface Disposal	This alternative would convert the existing aerated lagoon system into a more conventional activated sludge process through the use of a bioreactor, clarification, mixed liquor and return activated sludge recycle. Reduced size of Lagoon #1 for complete mix bioreactor. Secondary clarifiers could be located in a building or cold weather design for outdoors.	Could be phased from current design 1.2 MGD (ADMM); to 1.8 MGD (ADMM) to minimize initial investment	Phase I – 1.2 MGD Assumes no building Project Cost Range = $9,500,000 - $14,300,000 O&M = $246,000 **NPV Range = $13,500,000 - $18,300,000** Phase II – 1.8 MGD Assumes no building Project Cost Range = $800,000 - $1,200,000 O&M = $287,000	• Complies with regulatory requirements. • Utilizes the existing aeration system. • Smaller than the existing process footprint. • Operates year round and is not subject to seasonal discharge modifications. • Lower capital cost.	• Operation of an activated sludge system including clarifiers and RAS/WAS pumping more complex and time intensive. • Additional Process Monitoring • Additional training may be required • Additional pumping required. • Additional maintenance of the clarifier and RAS/WAS systems.
2	SAGR	SAGR	River	Submerged Attached Growth Reactor (SAGR) currently patented by Nelson Environmental was developed for post lagoon treatment of ammonia in cold climates. The aerated lagoons would continue to be utilized for BOD removal with minimal changes to the existing system (i.e. existing blowers, Biolac diffused aeration would not be replaced or modified). Pumps would be required to direct flow to and from the SAGR units. Concerns with solids buildup and limited number of plants this size.	Limited phasing available on the existing site. 1.2 MGD phase would be constructed in the area identified for subsurface disposal. Adjacent property would be required for future phases or process changes to eliminate Lagoon #3.	Phase I – 1.2 MGD Project Cost Range = $10,200,000 - $15,400,000 O&M = $310,000 **NPV Range = $15,300,000 - $20,500,000**	• Complies with regulatory requirements. • Additional storage of effluent not required. • Lower requirements for SAGR system O&M than more mechanically intensive systems. • Operates year round and is not subject to seasonal discharge modifications.	• Pumping of effluent required. • Operation and maintenance of the SAGR treatment systems in addition to existing lagoons. • Potential for solids build-up and significant system rehabilitation if higher than allowed BOD, TSS and TKN is not monitored and reduced. • Land intensive. Additional land required for flows beyond 1.2 MGD. • Higher capital cost and O&M costs.
3	Moving Bed Biofilm Reactor (MBBR)	Secondary Clarifiers, (with disc filter or DAFT option)	River or Subsurface Disposal	MBBRs are typically high rate biofilm process systems. Their primary benefit is a small foot print. Bioflims are particularly suited for nitrification as nitrifiers are slow growing, non-floc forming bacteria that grow slowly in cold water and tend to develop best as a biofilm. Biofilms allow for more biomass per unit volume than conventional suspended activated sludge processes. Thus, more treatment can be provided in a smaller process volume. Solids removal following the MBBR could be accomplished with secondary clarifiers.	Easily phased from current flows (0.65 MGD ADMM); to 1.2 MGD (ADMM) by simply adding more media to tanks; upgrade to1.8 MGD (ADMM) would require additional treatment train and media	**Phase I – 0.65 MGD** Assumes no building and clarifier with WAS only Project Cost Range = $9,800,000 - $14,600,000 O&M = $170,000 **NPV Range = $12,500,000 - $17,300,000** Phase II – 1.2 MGD Assumes no building Project Cost Range = $500,000 - $700,000 O&M = $171,000 Phase III – 1.8 MGD Assumes no building Project Cost Range =	• Complies with regulatory requirements. • Treats warmer influent wastewater by bypassing the lagoons where historical cooling of the wastewater impacted treatment. Treatment of the warmer influent wastewater provides additional insurance of complete nitrification in the winter. • Biofilms are less sensitive to system changes in system waste loading variations and shock loading. • Pumping of effluent not required. This is a flow-through process without SRT control and recycling of activated sludge. • Smallest footprint (provides the ability for plant expansion) relative	• For greatest system confidence would install the secondary clarifier as opposed to the use of the polishing lagoon solids clarification option. • DAF solids removal is a more labor intensive and complex alternative if chosen. • Additional training may be necessary to understand the operational parameters of a biofilm system.

Alternative	Biological Reactor	Clarification/Solids Removal	Disposal/Level of Treatment	Description/Notes	Phasing	Estimated Costs*	Advantages/Disadvantages: Advantages:	Advantages/Disadvantages: Disadvantages:
						$2,300,000 - $3,500,000 O&M = $218,000	to other alternatives. • Operates year round and is not subject to seasonal discharge. • Aeration is much less with this alternative and thus saves annual operating costs (power).	
Alternative Disposal								
	Subsurface Disposal	-	-	This alternative would involve the development and construction of a subsurface drainfield on the existing WWTP site. Based on available land on the site, the drainfield would be located in the area currently used for sludge drying and disposal/Palmer police firing range. Geotechnical field work was completed on the WWTP property on 2/2/2016. Preliminary geotech investigation/evaluation suggests: 1) additional on-site data would need to be collected to support more detailed nitrate modeling to determine how much of the effluent water would reach the river versus becoming part of the groundwater system (and potentially impacting drinking water wells in the area); and 2) a drainfield disposal system would need to be designed to ensure all ammonia would convert to nitrate in the soils system.	Limited phasing available on the existing site beyond 0.5 to 1 MGD	Costs will be updated based on results of geotechnical investigations	• Provides an alternative to APDES-regulated surface discharge • Additional storage of effluent not required. • Operation and maintenance similar to the existing lagoon system. • May be able to seasonally discharge to the side channel in the Matanuska River floodplain.	• In order to meet potential nitrate permit levels additional treatment may be required including anoxic/denitrification zones to reduce the nitrates to acceptable levels. • Firing Range closure • Slope Stability improvements • Potential resistance from neighboring property owners concerned about drinking water wells • Limited opportunity for expansion – would use most of remaining WWTP site for 0.5 to 1.0 MGD. • Additional evaluation/study required to show APDES applicability. • Drainfields can plug over time and may require replacing.
Interim Measures								
	Lagoon Treatment	Secondary Clarifier with recycle	River or Subsurface Disposal	WWTP is currently recycling flows around Lagoon 1 and 2 as an interim measure. Current configuration is likely not significantly increasing the MLSS in Lagoon 2 but may have some benefit.	Could be constructed as an interim measure and incorporated into long term treatment solution for solids handling	Assumes no building and clarifiers with RAS/WAS Project Cost Range = $5,000,000 - $7,600,000 O&M = $32,000 **NPV Range = $5,500,000 - $8,100,000**	• Improve MLSS in Lagoon 2 and potentially effluent quality. • Interim measure that would not be all sunk cost in long term treatment upgrades. • Could be constructed outside with cold weather design and allow for later construction of building if desired.	• Operation of an activated sludge system including clarifiers and RAS/WAS pumping more complex and time intensive. • Additional Process Monitoring • Additional training may be required • Additional pumping required. • Additional maintenance of the clarifier and RAS/WAS systems.
	Fixed Film Media in Lagoon #2	Existing Solids Removal	River or Subsurface Disposal	Preliminary analysis looked at media required to fully treat wastewater and included media in most of Lagoon 1 and 2. Revised alternative includes reduced square footage at head of Pond #2; after BOD has been knocked down in Lagoon 1(Entex Webitat, example)	Could be constructed as an interim measure but would likely be a sunk cost as the fixed film media is not recommended in the long term upgrade.	Project Cost Range = $3,500,000 - $5,300,000 O&M = $63,000 **NPV Range = $4,500,000 - $6,300,000**	• Biofilms are less sensitive to system changes in system waste loading variations and shock loading.	• Interim measure that would be a significant sunk cost in long term treatment upgrades.
	Lime or Magnesium Hydroxide Feed/Alkalinity	-	-	Considering quicklime, Ca(OH)2 or magnesium hydroxide (Mg(OH)2) to supplement the alkalinity consumed by the nitrification process. FloMag® H (magnesium hydroxide slurry, 60% solution, 12.8lbs/gals) – evaluated as lime/soda ash alternative but not readily available in AK.	Could be constructed as an interim measure and incorporated into long term treatment solution	Included in Project Costs above	• Interim measure that would not be a sunk cost in long term treatment upgrades.	• Both lime and Mg(OH)2 can be challenging to handle/work with.

Alternative	Biological Reactor	Clarification/Solids Removal	Disposal/Level of Treatment	Description/Notes	Phasing	Estimated Costs*	Advantages/Disadvantages	
							Advantages:	**Disadvantages:**
	Removal of Lagoon Solids	-	-	Remove the sludge/solids that have accumulated on the bottom of Lagoons 1 and 2. Sludge has not been removed from Lagoons 1 and 2 since 2010, when the covers were installed.		No significant capital investment will be required for this short term measure; however a significant time investment will be required from the City operators to uncover and dredge the ponds, while performing normal operation and maintenance duties at the facility (approximately 2 weeks or operator time)	• Removing the solids will increase the available lagoon volume, the overall treatment capacity, minimize the amount of sludge digesting at the bottom of the ponds, and improve overall mixing conditions in the lagoons.	

* The project costs presented in this Facilities Plan Update include estimated construction dollars, contingencies, permitting, administration, engineering fees, etc. Construction costs are based on preliminary layouts for treatment alternatives, and suggested unit process sizes.

Cost estimates prepared as part of the Facilities Plan are order-of-magnitude, Class 5 estimates, as defined by the American Association of Cost Engineers (AACE). According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

CLASS 5 ESTIMATE Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20% to –50% on the low side and +30% to +100% on the high side.

5.0 Alternative Selection and Decision-Making Process

The wastewater treatment system alternatives, including Lagoon Activated Sludge (LAS), SAGR, subsurface disposal, and an MBBR system, were developed by the Consultant Team with direction from the City. An evaluation and ranking of alternatives presented in this Facility Plan took place during an Alternative Selection and Decision-Making Workshop held on February 16, 2016 with project team members and the City of Palmer staff.

This section provides the different evaluation criteria that were used to complete the assessment of each alternative. Evaluation criteria are broken into two main categories of non-monetary criteria and monetary criteria.

The following non-monetary evaluation criteria were developed to support evaluation:

- Permit compliance
- System reliability
- Ease of operation and maintenance
- Adaptability and phasing
- Environmental sustainability
- Social impacts

Definitions for the six criteria are presented in the following sections (quantity metrics were also developed for each criterion).

5.1.1 Permit Compliance

All the preliminary alternatives have been evaluated with the appropriate level of reliability and redundancy to ensure that all design processes presented can meet permit and other regulatory requirements. One exception is the subsurface disposal option, which has been determined, through field investigation and preliminary modeling, would likely not meet the groundwater requirements for nitrates at the discharge point (property line).

5.1.2 Land Requirements

The alternatives were compared based on the footprint of the proposed process and its ability to fit on the existing WWTP site, effective use of the available space on site, and whether additional land would be required for this upgrade or future improvements.

5.1.3 Ease of Operation and Maintenance

Ease of operation was examined from two points of view: (1) how many tools does the process provide to operations staff to deal with unusual process conditions; and (2) how complicated is the process to operate. The number and complexity of equipment was considered as well as the flexibility of process operation to accommodate varying treatment situations. Additionally, the propensity of each system for upsets and the ramifications of those upsets were considered for the planning criteria.

5.1.4 Adaptability and Phasing

Because of the uncertainty in the extent and timing of future growth in the area and the prospect of more stringent limits in future ADEC permits, particularly for ammonia, the ability to phase in the elements as required to meet future conditions was considered when assembling alternatives. A detailed analysis of the phasing and implementation of selected alternative was performed as part of the capital improvement planning. For more information on phasing and implementation see Chapter 7.

5.1.5 Environmental Sustainability

The energy and chemical costs of each alternative are incorporated into the operational costs and were therefore not directly considered in the non-monetary benefit analysis. Green House Gases (GHGs) and carbon footprint were considered important elements, and thus energy and chemical use are included with this criterion.

5.1.6 Social Impacts

The alternatives were compared to determine potential levels of public support as well as factors such as potential impacts to neighboring wells and potential for increased odor from the facility. The Social criteria also included the project's ability to increase efficiency within the Public Works Department and provide a good working environment for City staff.

5.1 Evaluation of Non-Monetary Benefits and Cost

The relative importance or ranking of the criteria was determined so that the criteria could be applied in evaluating alternatives. Comparison and relative ranking was done using a pair wise comparison, as presented in Table 15. The criteria listed in the left column are compared with each of the other criteria, listed again across the top of the table. If the criterion in the left column is significantly more important than the one listed at the top, the value 5 would be entered into the yellow cell. The highest total score (summed across the row) corresponds with the criterion in the left column that is the most important. Permit compliance scored the highest, followed by adaptability and phasing, social impacts, ease of operation and maintenance, and environmental sustainability and land requirements, in that order.

The recommended approaches for estimating and comparing the monetary costs of alternatives are to use a net present value (NPV) analysis. Capital and operating costs have been estimated for each set of project alternatives, as described in Section 2.2 and presented in Chapter 4.0.

Table 15 Non monetary Evaluation Criteria and Weights

		A	B	C	D	E	F			
	Criteria	Permit Compliance	Land Requirements	Operational Flexibility/Complexity	Adaptability and Phasing	Environmental Sustainability	Social Impacts	Total Scores	Weighting Percentage	Relative Weights
A	**Permit Compliance**	A	5	5	4	5	4	23	**25.6%**	2.09
B	**Land Requirements**	1	B	3	2	3	2	11	**12.2%**	1.00
C	**Operational Flexibility/Complexity**	1	3	C	2	4	3	13	**14.4%**	1.18
D	**Adaptability and Phasing**	2	4	4	D	4	3	17	**18.9%**	1.55
E	**Environmental Sustainability**	1	3	2	2	E	3	11	**12.2%**	1.00
F	**Social Impacts**	2	4	3	3	3	F	15	**16.7%**	1.36
								90	**100.0%**	8.18

Scores

5 = Significantly More Important
4 = More Important
3 = Equal in Importance
2 = Less Important
1 = Significantly Less Important

The comparison of alternatives for needed WWTP improvements identified in the Facilities Plan are on a benefit-to-cost basis. The benefits of an alternative were assigned by City staff using the five non-monetary criteria identified above. Each non-monetary criterion for each alternative was rated using the following numerical score system:

1 = Significantly negative score

2 = Negative score

3 = Neutral score or no impact

4 = Positive score

5 = Significantly positive score

The total benefit for an alternative will be the sum of individual criterion scores times their respective weightings to produce a weighted benefit score. The benefit-to-cost rating of an alternative will be determined by dividing its total weighted benefit score by its normalized NPV cost. The normalized NPV cost for each alternative is the NPV cost of that alternative divided by the lowest NPV cost of the alternatives.

5.1.1 Scoring Treatment Alternatives

During the alternatives evaluation workshop, City staff determined non-monetary criteria scores for the five principal treatment alternatives. The results of this scoring are summarized in Table 16 and Table 17; with the former providing the raw scores and the latter providing weighted scores based on the prioritization of each criterion per Table 15.

Staff gave a score of 4 or 5 for permit compliance to all alternatives, with the exception of subsurface disposal, because they would provide a very high quality effluent, readily capable of reliably meeting permit requirements.

The MBBR with Secondary Clarifiers scored the highest for land requirements as it has the smallest overall footprint of the alternatives, could readily be constructed on available space at the existing site, and would ultimately allow for the closure and reuse of the land currently used for one or multiple lagoons. The SAGR and subsurface disposal alternatives received the lowest scores because they are land intensive alternatives that would use up the remaining land on the existing site (including the firing range area) and would require the purchase of additional property for future expansion.

Subsurface disposal scored the highest for operational flexibility/complexity, followed by the two MBBR alternatives. The LAS alternative was considered the most complicated to operate and maintain because it incorporates a return activated sludge and has the most parts and pieces.

The MBBR alternatives were considered to be equal with respect to adaptability and phasing, followed by the LAS process and the SAGR. Subsurface disposal ranked lower than the others for this criterion because of its limited initial capacity and limited feasible options for expansion in the future.

Environmental sustainability scores were driven primarily by the GHG emissions and carbon footprint associated with energy use. In this regard, the alternatives with more projected energy use based on aeration requirements, number of pumps, and energy for building electrical/mechanical were scored lower.

City staff gave similar scores on social impacts to all alternatives except subsurface disposal. The subsurface alternative scored the lowest based on previous public concern regarding impacts to adjacent wells and the closure and relocation of the police firing range.

Table 16 Raw Non-Monetary Scores for Treatment Alternatives

Criteria	Treatment Alternatives				
	Lagoon Activated Sludge	SAGR	MBBR w/ Secondary Clarifiers	MBBR w/ DAFT/Discfilters	Subsurface Disposal
Permit Compliance	4	5	5	5	1
Land Requirements	3	1	5	4	1
Operational Flexibility/Complexity	2	3	4	4	5
Adaptability and Phasing	3	2	4	4	1
Environmental Sustainability	3	2	4	3	2
Social Impacts	4	3	4	4	1

Table 17 Weighted Non-Monetary Scores for Treatment Alternatives

Criteria	*Criteria Weighting*	Treatment Alternatives				
		Lagoon Activated Sludge	SAGR	MBBR w/ Secondary Clarifiers	MBBR w/ DAFT/Discfilters	Subsurface Disposal
Permit Compliance	25.6%	1.02	1.28	1.28	1.28	0.26
Land Requirements	12.2%	0.37	0.12	0.61	0.49	0.12
Operational Flexibility/Complexity	14.4%	0.29	0.43	0.58	0.58	0.72
Adaptability and Phasing	18.9%	0.57	0.38	0.76	0.76	0.19
Environmental Sustainability	12.2%	0.37	0.24	0.49	0.37	0.24
Social Impacts	16.7%	0.67	0.50	0.67	0.67	0.17
Weighted Score =		**3.28**	**2.96**	**4.38**	**4.13**	**1.70**

The normalized NPV costs and benefit to cost ratios for each alternative are shown in Table 18 and Figure 38. Overall, the MBBR with Secondary Clarifiers alternative had the highest non-monetary score and the highest benefit to cost ratio. This is because the alternative had high benefit scores and low normalized NPV scores (i.e., higher overall non-monetary benefits and relatively lower costs).

Table 18 Normalized NPV Costs for Treatment Alternatives

		Treatment Alternatives				
		Lagoon Activated Sludge	SAGR	MBBR w/ Secondary Clarifiers	MBBR w/ DAFT/Discfilters	Subsurface Disposal
Net Present Value range($)						
	high	18,300,000	20,500,000	17,300,000	18,400,000	10,000,000
	low	13,500,000	15,300,000	12,500,000	13,400,000	6,000,000
Normalized NPV						
	high	3.05	3.42	2.88	3.07	1.67
	low	2.25	2.55	2.08	2.23	1.00
Benefit to Cost Ratio						
	high	1.5	1.2	2.1	1.9	1.7
	low	1.1	0.9	1.5	1.3	1.0

NOTE: The normalized NPV cost for each alternative is the NPV cost of that alternative divided by the lowest NPV cost of the alternatives, The benefit to cost ratio is the ratio of the weighted non-monetary score divided by the normalized NPV cost score.

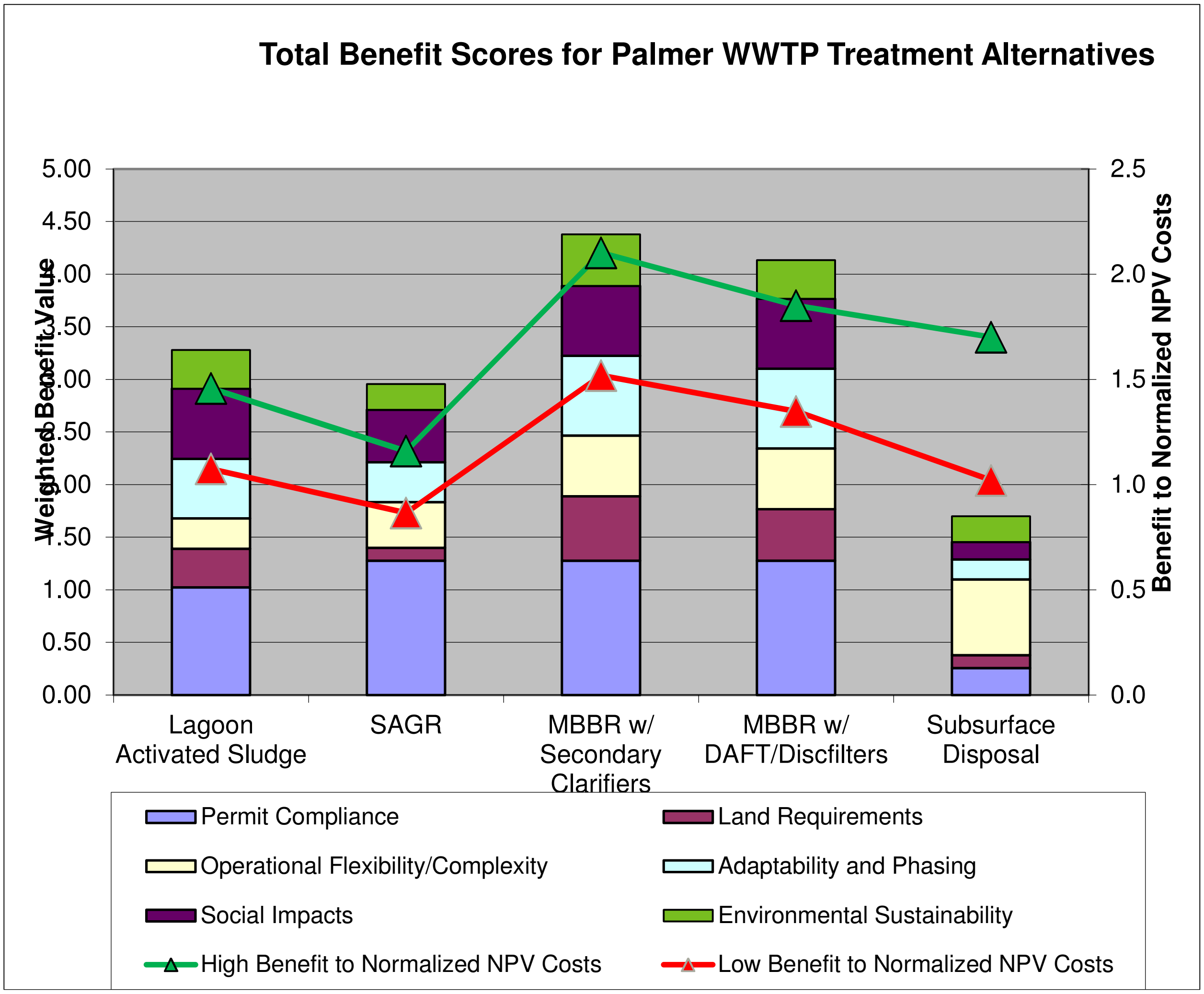


Figure 38 Total Benefit Scores for Palmer WWTP Treatment Alternatives

6.0 Recommendations

Based on the evaluation performed for this Plan, the following recommendations are made to bring the WWTP into compliance with current and potential future permit limits (particularly the effluent limit for ammonia).

1. Discontinue consideration of on-site subsurface treated wastewater disposal as it will likely not meet groundwater water quality standards.
    a. Geotechnical investigation was necessary to accurately characterize the aquifer. Results of on-site field investigation, mounding and nitrate modeling, and ADEC permitting discussions indicate that further analysis of the on-site subsurface disposal is not warranted.
    b. Nitrate treatment is the main issue with the drainfield alternative. The ADEC groundwater standards for drinking water limit nitrate nitrogen to be below 10 mg/l at 'property boundary'. The modeling analysis shows levels at 30-40 mg/l could be expected at the property boundary, exceeding the drinking water standard.
2. Revise Palmer population served by the sewer system and projected wastewater flows from previous planning studies.
    a. Current economic and population growth trends suggest this is a reasonable approach. Based on the population growth analysis and projected flows to the WWTP, the 1.0 MGD average design capacity could be adequate through 2035.
    b. The City of Palmer should monitor growth through collection system improvements planning and the associated impacts to increased flows at the WWTP. Even if significant area population growth occurs (KABATA bridge is constructed, or new oil opportunities arise, etc.), this would not necessarily result in a rapid increase in flows to the plant. Sanitary sewer service expansion in the PSA will be required to see significant flow increases and there are currently no plans for large expansion projects. Rapid increases in flow will not sneak up on the City and there should be plenty of time to plan for unforeseen growth scenarios. Figure 39 below illustrates a potential phasing of WWTP upgrades based on flow increases over the 20-year planning period. As shown, an upgrade to 1.0 MGD average daily design flow would need to occur around 2018-2021, and an increase in capacity to 1.5 MGD average daily design flow may need to occur need the end of the planning period.
3. Implement improvements at the WWTP for the current average maximum month flow at the plant (0.65 MGD) with plans for phased expansion to average maximum month flow of 1.2 MGD and 1.8 MGD.

It is recommended that the City of Palmer look at phasing out the existing lagoon treatment facility over the next 5 years and replacing the treatment system the following recommended Phase I: Near-Term (before 2018 the Palmer wastewater system program:

- Initiate grant-funding requests for a new WWTP
- Construct a new pipeline from the existing Headworks to the new treatment facilities, bypassing the existing lagoon system.
- Construct a Moving Bed Bioreactor (MBBR) with aeration basin volume capacity for an average maximum month treatment capacity of 1.2 MGD.
- Purchase and install MBBR media to treat the projected 2018 average maximum month wastewater flow of 0.65 MGD.
- Construct two secondary clarifiers to remove the solids from the MBBR effluent.
- Construct waste activated sludge (WAS) pumping facilities.
- Waste solids will be pumped to Lagoon 3 for aerobic digestion and storage.
- Solids Removal on an annual basis shall be accomplished with a dredge operation pumping to dewatering geotubes. Sludge will continue to be limed for elevated pH and applied on- site.

The following are recommended Phase II and Phase III: Long Term changes to the Palmer wastewater system:

- Phase II - Additional media should be added to match Palmer's population growth and wastewater flow until the flows near an average maximum month flow of 1.2 MGD (1.0 MGD Annual Average).
- Phase III - Once wastewater flow reaches an average maximum month of 1.2 MGD, an additional MBBR train (concrete tanks, aeration grid, diffusers, retention screens an media) shall be required. An additional MBBR cell system as proposed will provide up to an average maximum month flow of 1.8 MGD (1.5 MGD Annual Average)
- Grit removal facilities should be considered in the future to reduce maintenance and potential grit accumulation in the aeration basins.

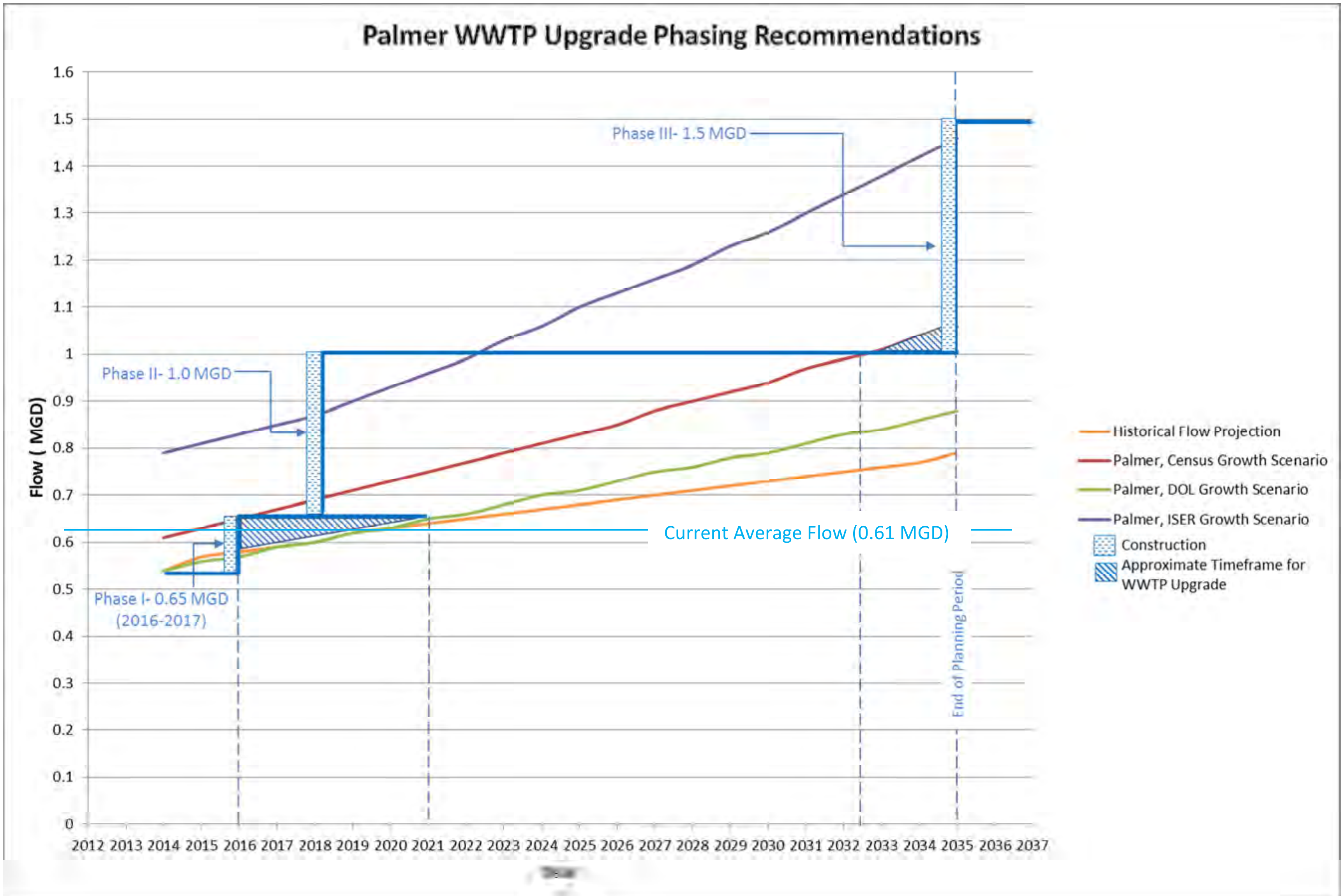


Figure 39: Phasing Figure

7.0 Financial Management and Implementation

7.1 Implementation Plan

The City plans to implement improvements at the WWTP for the current average flow at the plant (0.65 MGD) with plans for phased expansion to 1.0 MGD and 1.5 MGD. The City has developed a preliminary schedule for the implementation of improvements over the next several years based upon the ability to meet the current and proposed APDES permit limits, the estimated growth in sewer services, the City's treatment plant capacity requirements, and available funding sources.

It is recommended to construct the project under a phased approach as it is possible that a lack of funding may not allow the construction of the entire project at one time. The following sections outline how the phases may be completed and identifies an implementation plan for the project.

7.1.1.1 Project Phasing Schedule

Based on potential funding and the phasing alternatives discussed above, a recommended schedule is provided in Table 19. The phased approach presented is based on the possibility that funding may not be available to allow for the construction of the entire project at one time. If funding is available, it is preferred to phase the project with the construction of the MBBR system and secondary clarifiers as one construction project.

Table 19 MBBR System – Phased Implementation Recommendation

Action	Design Schedule	Construction Schedule	Estimated Cost (2016$)
Interim Measures	-	Winter 2015 - Fall 2016	-
Phase Ia - MBBR system	Summer 2016 – Fall 2016	Summer 2017 – Summer 2018	$5.0M - $7.4M
Phase Ib - Secondary Clarifiers	Summer 2016 – Fall 2016	Approx. 2022 (or as needed based on lagoon settling performance)	$4.8M - $7.2M
Phase II – Additional MBBR Media (1.0 MGD)	-	City to order and install media as required based on flow increases (Approx. 2021)	$500,000 - $700,000
Phase III – Additional MBBR Train (1.5 MGD)	Growth dependent (approx. 180 days before construction)	Growth dependent (Approx. 2035)	$2.3M - $3.5M

Cost estimates prepared as part of the Facilities Plan are order-of-magnitude, Class 5 estimates, as defined by the American Association of Cost Engineers (AACE). According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

CLASS 5 ESTIMATE - Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20% to –50% on the low side and +30% to +100% on the high side.

7.1.1.2 Funding Strategy

The overall financial strategy is to finance the recommended improvements through a combination of grants and loans. Loans will be repaid through user rates.

Preliminary discussions with funding agencies indicate that financial assistance in the form of grants and low interest loans should be available. A discussion of various probable grant and loan programs is included herein to identify potential funding sources. In some cases, the City will have to take various actions to determine if they are eligible or not. The funding strategy presented below is not final and will need to be amended to incorporate the new information as the City finalizes the funding strategy.

State of Alaska grant (Grant No. 13-DC-527)

In 2013, the City received a $2.5 million State of Alaska grant (Grant No. 13-DC-527) for acquisition of property adjacent to the WWTP to provide an area for treatment plant expansion. The recommended treatment upgrade option does not require the purchase of additional property. The City is currently seeking the State Legislature's approval to revise the grant scope of work to allow expenditure of these grant funds on other project expenses, such as wastewater treatment facility design and construction. If the grant money is reappropriated by the Legislature these funds would be available as early as May 2016 and as late as August 2016.

Alaska Clean Water Fund (ACWF)/State Revolving Fund Loan Programs

The State of Alaska has established two State Revolving Fund (SRF) Loan Programs one of which is for wastewater projects – the Alaska Clean Water Fund. This program provides at or below market interest rate loans to entities that qualify. They are funded with capitalization grants from the EPA and are matched with State issued general obligation bonds.

Loans can finance up to 100 % of a project's eligible costs for planning, design and construction of publicly owned facilities. In addition, loans can serve as local match for the ADEC Municipal Water, Sewer and Solid Waste Matching Grants Program or most other federal or state funding sources. The Alaska Municipal Matching Grant program provides partial funding and engineering support for drinking water, wastewater (sewer), solid waste and non-point source pollution projects. In addition, grants can serve as local match for the Alaska Clean Water Fund program that offers low interest loans to Alaskan municipalities.

In order to become eligible for this type of funding, the project must be added to the ACWF/SRF Project Priority List and Intended Use Plan. Early notification by the applicant is important in order to get on the priority list. A project remains on the list until it has been completed regardless of the funding sources used to finance the project. The deadline for the ACWF program Loan Questionnaire is January 2017; loan funds would be available in June 2017. The deadline for the Grant Questionnaire is June 2016; grant funds would be available in 2017.

ACWF/SRF loans have a current average interest rate of 1.5% for twenty years. Loan amounts are limited to the borrower's ability to repay the loans and by the ACWF funds available.

U.S. Department of Agriculture Rural Development.

U.S. Department of Agriculture Rural Development (RD) provides grants and loans for communities of not more than 10,000 people to be used to construct, repair, improve, expand or modify rural sewer collection and treatment facilities. Priority is given to communities of less than 5,500 people. Eligible communities are those that are unable to obtain financing at reasonable rates and terms. The maximum term on these loans is 40 years. All loans will be secured with bonds or notes pledging taxes, assessments, or revenues as security. Grants are only available if they are required to reduce user fees to a target level commensurate with the amount other similar communities pay. The rate is based on comparable communities established by actual surveys of users.

RD has an open application cycle; applications may be received and funded at any time during the year. Each project is given a priority score based on income, population, health, and other considerations. The applicants with the highest priority points are selected to proceed with the application process. Rates are tiered based on the median household income. Preliminary discussion with US Department of Agriculture (USDA) RD staff indicates that funds are currently available. This program could be considered by Palmer.

Each funding source should be evaluated to determine the potential for success. Funding alternatives and amounts which should be considered for the project have been evaluated and summarized in the following sections.

7.1.1.3 Sewer Rate Study Update:

Palmer will rely on low interest loans and grants to pay the costs of construction. Financing to repay the loans for the recommended improvements will require an increase in sewer user rates. The Palmer sewer rate study has been updated based on the most current financial information and the proposed WWTP improvements.

The previous sewer rate study, completed by HDR, was updated with revenues and O&M expenses from the 2016 budget. Annual rate revenues were projected using historical growth factors (e.g., new customers). O&M expenses were then projected forward by inflating the expenses annually by historical escalation factors. This was the same approach as was used in the development of the prior sewer rate study. The City's current annual debt service payments were then incorporated as well as the payment in lieu of taxes which the sewer utility pays to the general fund. Finally, the rate funded capital component was added to complete the revenue requirement.

The revised capital plan was provided by the City and a series of alternative funding plans (Options A – E) were developed with the assistance of the City of Palmer staff. Based on these discussions, five alternatives were developed for comparison purposes. Each option has different funding mechanisms and with combinations including funding from grants, loans, and rates. It is important to note that the capital costs have been inflated by 2.7% annually to reflect the average annual increase in costs (based on ENR CCI data). Each alternative results in a different rate transition plan to adequately fund the capital projects and maintain the sewer utility. Below is a brief description of funding plan options.

Option A

Phase I: MBBR and Secondary Clarifiers constructed as one project (Construction 2017)

- Assumes that the existing City grant of $2.50 million will be reassigned to the treatment plant upgrade.
- Assumes voters approve additional debt issuance authority;
- Assumes $3.08 million in debt will be used in the USDA program and will be matched by $2.52 million in grant funds (55% of proceeds are in the form of a low interest loan, assumed @ 3.4%, and 45% as a grant).
- Assumes the City procures $1.68 million from the ADEC loan program and another $3.92 million will be given as grant from the ADEC program.

Option B

Phase Ia: MBBR (Construction 2017)

- Assumes that the existing City grant of $2.50 million will be reassigned to the treatment plant upgrade.
- Assumes voters approve additional debt issuance authority;
- Assumes $2.76 million in debt will be used in the USDA program and will be matched by $2.26 million in grant funds (55% of proceeds are in the form of a low interest loan, assumed @ 3.4%, and 45% as a grant).

Phase Ib: Secondary Clarifiers (Construction 2022)

- Additional voter approved debt issuance authority is granted.
- Assumes the City procures $3.82 million from the USDA program and will be matched with $3.12 million as a grant.

Option C

Phase Ia: MBBR (Construction 2017)

- Assumes that the existing City grant of $2.50 million will not be reassigned and the funding will be unavailable.
- Assumes voters approve additional debt issuance authority;
- Assumes $1,510,000 in debt will through the ADEC program. Another $3.52 million will be given as a grant from the ADEC program.

Phase Ib: Secondary Clarifiers (Construction 2022)

- Additional voter approved debt issuance authority is granted.
- Assumes a $2,080,000 loan will be issued via the ADEC program and will be match with $4.86 million in the form of a grant.

Option D

Phase Ia: MBBR (Construction 2017)

- Assumes that the existing City grant of $2.50 million will be reassigned to the treatment plant upgrade.

- Assumes voters approve additional debt issuance authority;
- Assumes $1.88 million in debt will be used in the USDA program and will be matched by $1.54 million in grant funds (55% of proceeds are in the form of a low interest loan, assumed @ 3.4%, and 45% as a grant).
- Assumes the City procures $1.23 million from the ADEC loan program and another $2.87 million will be given as grant from the ADEC program.

Phase Ib: Secondary Clarifiers (Construction 2022)

- Assumes voters approve additional debt issuance authority;
- Assumes $1.19 million in debt will be used in the USDA program and will be matched by $0.98 million in grant funds (55% of proceeds are in the form of a low interest loan, assumed @ 3.4%, and 45% as a grant).
- Assumes the City procures $1.43 million from the ADEC loan program and another $3.34 million will be given as grant from the ADEC program.

Option E

Phase Ia: MBBR (Construction 2019)

- Assumes that the existing City grant of $2.50 million will not be reassigned and the funding will be unavailable.
- Assumes the existing authority to issue $1.6 million in debt will be in the form of a low interest loan.
- Voters do not approve additional debt issuance powers.
- Assumes remainder of funding for project is through rates and reserves.

Phase Ib: Secondary Clarifiers (Construction 2023)

- Voters do not approve additional debt issuance powers.
- Assumes remainder of funding for project is through rates and reserves.

The results of the sewer rate study update for each of the five funding options are summarized in Appendix F.

7.2 Administrative Plan

7.2.1 Staffing

7.2.1.1 Current Workload

The Palmer utilities system, the combined water supply and distribution system, wastewater collection system, and wastewater treatment plant are operated and maintained by the same staff pool. Operators are cross trained between water and wastewater operations, and the staff works between each utility component.

The water and wastewater utility staff is responsible for the following activities:

- Inspection of new water and sewer service connections installed by developers;

- Fulfillment of water and sewer pipe location requests;
- Operation and maintenance of the water supply and distribution systems, including cross-connection surveillance;
- Annual water main flushing;
- Fire hydrant maintenance, flushing, and testing;
- Operation, cleaning, and maintenance of the sanitary sewer collection system;
- Operation and maintenance of the wastewater treatment plant;
- Sampling and monitoring to meet all regulatory requirements, including:
- Water supply sampling,
- Wastewater plant influent and effluent sampling, and
- Dewatered wastewater sludge sampling;
- Reporting as required by water and wastewater regulations and permits;
- Development and management of budgets and staff; and
- Maintenance of grounds, including snowplowing, at all water and wastewater utility sites.

7.2.1.2 Current and Proposed Staffing

In 2016, the operations and maintenance staff for the water and wastewater utility consisted of one manager and three certified operators. The Palmer WWTP is currently operated by staff with certification levels as indicated in Table 20 below.

Table 20 Current Palmer Water/Wastewater System Operators

Name	Wastewater Treatment Certification Level	Other Certifications*
John Berberich (Utilities Foreman)	Level 2	WT, WD, WWC – Level 2
Paul Gibbs	Level 2	WT, WD, WWC – Level 2
Alycia Anderson	Level 1	WT – Level 1 WD, WWC – Level 2
Dane Shaver	Level 2	WT, WD, WWC – Level 1

*-WT – Water Treatment; WD – Water Distribution; WWC – Wastewater Collection

Additional labor for utility-related tasks and special projects is obtained from the following:

- Staff overtime;
- Local contractors (typically for electrical and mechanical work);
- Temporary hire staff (approximately 2 people from the Alaska Job Corps for ½ to ¾ of the year).

HDR used the *Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants* (2008) developed by New England Interstate Water

Pollution Control Commission to evaluate the staffing requirements for the existing plant as well as for the proposed MBBR system. This guide was developed to build upon the U.S. Environmental Protection Agency reference guide titled *Estimated Staffing for Municipal Wastewater Treatment Facilities* (1973). Using this guidance, a 2016 analysis of plant staffing recommends 2.4 full-time staff at the existing WWTP and 2.7 full-time staff for the MBBR system (with secondary clarifiers). See Appendix G for results of the staffing analysis for the existing and proposed facilities.

7.2.1.3 Staffing Recommendations

The existing staff consists of one full-time supervisor and three operators plus temporary labor help from the Alaska Job Corps. The staffing analysis presented above indicates that an increase in staff will not be required when considering solely the WWTP upgrade from the aerated lagoons to the MBBR process. It should be noted that a system-wide analysis of staffing of the entire water and wastewater utility was not conducted for this WWTP facility plan and operator responsibilities and time required for operations outside of the WWTP have not been included. As the system expands to serve additional customers and when the APDES permit is renewed, staff requirements should be reevaluated.

7.2.2 WWTP ADEC System Classification

ADEC has classified the existing Palmer WWTP as a Level 2 facility per the 18AAC74, Water and Wastewater Operator Certification and Training regulations. Preliminary discussions with ADEC - Operator Training and Certification staff indicate that the upgraded MBBR facility would also be classified as a Level 2 facility. The preliminary analysis of the recommended MBBR system classification has been based on the following:

- The MBBR system is being considered a “biological or combined chemical and biological nutrient removal” process for classification scoring.
- The existing lagoon #1 is being considered as flow equalization.
- The aerobic basin prior to the MBBR system (two nitrogen cells) is not being counted as activated sludge (as there is no return activated sludge recycled to the tanks).
- Assumes that the headworks are remaining the same.

Table 21 below provides a draft classification scoring for the proposed MBBR alternative (specifically Alternative 4A in this Facility Plan).

Score Category	Score
Size (Peak day design capacity, gallons per day) – 1,000,001 – 5,000,000	16
Pretreatment – Influent pumping	2
Pretreatment – Flow equalization basin	1
Pretreatment – Comminutor, barminutor, grinders	2
Secondary Treatment – Secondary clarifiers	4
Advanced Waste Treatment – Biological or combined chemical and biological nutrient removal	12
Sludge Thickening and Dewatering – sludge bagger	3
Solids Disposal – Sludge lagoon	3
Solids Disposal – Off-site disposal	1
Disinfection – Ultraviolet light	3
Total	47

Total Score	**System Classification**
1-30	Class 1
31- 55	Class 2

The analysis above is based on the preliminary MBBR alternative outlined in this facility plan. As the final design for the facility is developed and when the APDES permit is renewed, the WWTP classification requirements should be reevaluated and coordinated with ADEC.

PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - Lagoon Activated Sludge Alternative 2 (1.0 MGD)

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
2	Excavation	CY	$12	3,500		$42,000
	Remove Excavated Material	CY	$10	3,500		$35,000
3	Backfill	CY	$15.00	20,000		$300,000
	Geotextile Fabric	SY	$0.80	1,100		$880
4	Repurpose and Reinstall Existing Lagoon Baffles/Covers	LS	$50,000	1	20%	$60,000
	Lagoon Liner	SF	$3	57,000		$171,000
5	LAS Basin Internals	LS	$850,000	1	50%	$1,275,000
	Diffusers					
	Motor actuated butterfly valves/covers					
	Blowers (reuse existing)					
	Process I&C (DO probes, switches, PLC)					
11	Alkalinity Feed System	LS	$94,000	1		$94,000
12	Polymer Feed System	LS	$120,000	1		$120,000
13	Yard Piping	LF	$200	1,280		$256,000
14	Emergency Power Generator	LS	$120,000	1		$120,000
15	Sludge Loading Geotube	LS	$2,000	1		$2,000
	Subtotal:					**$2,500,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$2,500,000
B	Electrical/I&C	(% of A)	20%	$500,000
C	Mechanical	(% of A)	10%	$250,000
D	Ancillary Equipment	(% of A)	5%	$125,000
E	Freight	(% of A)	6%	$150,000
F	Misc. Site/Civil	(% of A)	5%	$125,000
G	Subtotal			$3,650,000
H	Mob/Bond/Insurance	(% of G)	4%	$146,000.00
I	Contingency	(% of G)	25%	$912,500
K	Engineering-SDC	(% of G)	20%	$730,000
L	City Admin/Legal	(% of G)	5%	$182,500
M	**Total Estimated Project Costs:**			**$5,600,000** *

Project Cost range($)

High (+20%) = $6,700,000
Low (-20%) = $4,500,000

Operation & Maintenance Costs					
Alkalinity Feed	35000	lbs/yr	$0.21	0%	$7,350
Alkalinity Operator Labor	5	mnhr/wk	$25.00	0%	$6,500
Power Alkalinity	154	kwh/day	$0.13	0%	$7,288
Polymer Feed	1400	lbs/yr	$3.01	0%	$4,214
Polymer Operator Labor	2	mnhr/wk	$25.00	0%	$2,600
Power Polymer	29	kwh/day	$0.13	0%	$1,367
Lagoon Operator Labor	15	mnhr/wk	$25.00	0%	$19,500
Blower Power	3,103	kwh/day	$0.13	0%	$147,247
Pump Power	0	kwh	$0.03	0%	$0
Equipment Replacement	$1	LS	$17,800	0%	$17,800
SUBTOTAL O & M Costs					$214,000

Net Present Value (NPV) Assumptions

Interest rate 2%
Life cycle 20 yr
Factor P/A 16.3514

$P_{total} =$ Pcapital + AO&M(P/A,i,n)

NPV (low) =	**$8,000,000**
NPV (high) =	**$10,200,000**

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PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - Lagoon Activated Sludge Alternative 2 (Ph II - 1.5 MGD)

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
1	LAS Basin Internals	LS	$350,000	1	20%	$420,000
	Diffusers					
	Motor actuated butterfly valves/covers					
	Blowers (reuse existing)					
	Process I&C (DO probes, switches, PLC)					
2	Yard Piping	LF	$200	100		$20,000
	Subtotal:					**$440,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$440,000
B	Electrical/I&C	(% of A)	25%	$110,000
C	Mechanical	(% of A)	5%	$22,000
D	Ancillary Equipment	(% of A)	10%	$44,000
E	Freight	(% of A)	6%	$26,400
F	Misc. Site/Civil	(% of A)	5%	$22,000
G	Subtotal			$664,400
H	Mob/Bond/Insurance	(% of G)	4%	$26,576
I	Contingency	(% of G)	25%	$166,100
K	Engineering-SDC	(% of G)	20%	$132,880
L	City Admin/Legal	(% of G)	5%	$33,220
M	**Total Estimated Project Costs:**			**$1,000,000** *

Project Cost range($)

High (+20%) = $1,200,000
Low (-20%) = $800,000

Operation & Maintenance Costs					
Alkalinity Feed	35000	lbs/yr	$0.21	0%	$7,350
Alkalinity Operator Labor	5	mnhr/wk	$25.00	0%	$6,500
Power Alkalinity	154	kwh/day	$0.13	0%	$7,288
Lagoon Operator Labor	15	mnhr/wk	$25.00	0%	$19,500
Blower Power	4,080	kwh/day	$0.13	0%	$193,596
Pump Power	0	kwh	$0.03	0%	$0
Equipment Replacement	$1	LS	$20,800	0%	$20,800
SUBTOTAL O & M Costs					$255,000

Net Present Value (NPV) Assumptions

Interest rate 2%
Life cycle 20 yr
Factor P/A 16.3514

P_{total} = Pcapital + AO&M(P/A,i,n)

NPV (low) = $5,000,000
NPV (high) = $5,400,000

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PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - SAGR Alternative

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
1	Pump Station to SAGR (Includes Pumps, Panel, Wet Wells, Valve Vaults)	LS	$125,000	2	20%	$300,000
2	SAGR System Package	LS	$1,529,000	1	20%	$1,834,800
3	Excavation	CY	$6	46,667		$280,000
4	New Berm Construction	CY	$10	10,389		$103,889
5	SAGR Piping	LS	$80,000	1		$80,000
6	Uniform Graded Clean Rock	CY	$40	42,900		$1,716,000
7	Insulating Woodchips or Mulch	CY	$15	5,280		$79,200
8	Non-Woven Geotextile	SF	$0.20	290,000		$58,000
9	HDPE Liner (60mil)	SF	$1.90	160,000		$304,000
10	Wall Framing and Sheathing	LF	$20.00	2,700		$54,000
11	Influent Flow Splitter, Effluent Control Structures (3)	LS	$80,000	1		$80,000
12	Yard Piping	LF	$200	2,500		$500,000
13	Emergency Power Generator	LS	$120,000	1		$120,000
14	Sludge Loading Geotube	LS	$2,000	1		$2,000
	Subtotal:					**$5,500,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$5,500,000
B	Electrical/I&C	(% of A)	25%	$1,375,000
C	Mechanical	(% of A)	10%	$550,000
D	Ancillary Equipment	(% of A)	5%	$275,000
E	Freight	(% of A)	6%	$330,000
F	Misc. Site/Civil	(% of A)	5%	$275,000
G	Subtotal			$8,305,000
H	Mob/Bond/Insurance	(% of G)	4%	$332,200
I	Contingency	(% of G)	25%	$2,076,250
K	Engineering-SDC	(% of G)	20%	$1,661,000
L	City Admin/Legal	(% of G)	5%	$415,250
M	**Total Estimated Project Costs:**			**$12,800,000** *

Project Cost range($)

High (+20%) = $15,400,000
Low (-20%) = $10,200,000

Operation & Maintenance Costs					
Alkalinity Feed	35000	lbs/yr	$0.21	0%	$7,350
Alkalinity Operator Labor	5	mnhr/wk	$25.00	0%	$6,500
Power Alkalinity	154	kwh/day	$0.13	0%	$7,288
Lagoon Operator Labor	20	mnhr/wk	$25.00	0%	$26,000
Blower Power	2,592	kwh/day	$0.13	0%	$122,990
Pump Power	250	kwh/day	$0.13	0%	$11,844
SAGR Operator Labor	4	mnhr/wk	$25.00	0%	$4,875
SAGR Blower Power	2,592	kwh/day	$0.13	0%	$122,990
SAGR Equipment Replacement	1	LS	$0.13	0%	$47
SUBTOTAL O & M Costs					$310,000

Net Present Value (NPV) Assumptions

Interest rate 2%
Life cycle 20 yr
Factor P/A 16.3514

$P_{total} =$ Pcapital + AO&M(P/A,i,n)

NPV (low) = $15,300,000
NPV (high) = $20,500,000

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PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - MBBR Alternative 4A (Phase I - 0.65 MGD)

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
1	Influent Flow Splitter	LS	$20,000	1		$20,000
2	Excavation	CY	$6	15,600		$93,600
3	Backfill	CY	$15.00	5,700		$85,500
4	Aeration Basins (Concrete)	CY	$850	650		$552,500
5	Aeration Basin Internals	LS	$885,000	1	20%	$1,062,000
	Diffusers and Drop Pipe					
	Cylindrical Screens					
	Media (for 0.65 MGD ADMM flow)					
	Process I&C (DO probes, switches, PLC)					
6	Wall Openings	LS	$30,000	1	20%	$36,000
7	Misc Metals (handrails, stairs, etc.)	LS	$50,000	1		$50,000
8	Aeration Basin Pumps (drain)	EA	$15,000	3	20%	$48,000
9	MBBR Covers	SF	$80	3,400		$272,000
10	Alkalinity Feed	LS	$94,000	1		$94,000
11	Polymer Feed	LS	$120,000	1		$120,000
12	Yard Piping	LF	$200	970		$194,000
13	Emergency Power Generator	LS	$120,000	1		$120,000
14	Sludge Loading Geotube	LS	$2,000	1		$2,000
	Subtotal:					**$2,750,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$2,750,000
B	Electrical/I&C	(% of A)	20%	$550,000
C	Mechanical	(% of A)	10%	$275,000
D	Ancillary Equipment	(% of A)	5%	$137,500
E	Freight	(% of A)	6%	$165,000
F	Misc. Site/Civil	(% of A)	5%	$137,500
G	Subtotal			$4,015,000
H	Mob/Bond/Insurance	(% of G)	4%	$160,600
I	Contingency	(% of G)	25%	$1,003,750
K	Engineering-SDC	(% of G)	20%	$803,000
L	City Admin/Legal	(% of G)	5%	$200,750
M	**Total Estimated Project Costs:**			**$6,200,000** *

Project Cost range($)

High (+20%) = $7,400,000
Low (-20%) = $5,000,000

Operation & Maintenance Costs					
Alkalinity Feed	35000	lbs/yr	$0.21	0%	$7,350
Alkalinity Operator Labor	5	mnhr/wk	$25.00	0%	$6,500
Power Alkalinity	154	kwh/day	$0.13	0%	$7,288
Polymer Feed	1400	lbs/yr	$3.01	0%	$4,214
Polymer Operator Labor	2	mnhr/wk	$25.00	0%	$2,600
Power Polymer	29	kwh/day	$0.13	0%	$1,367
MBBR Operator Labor	10	mnhr/wk	$25.00	0%	$13,000
Blower Power	1,930	kwh/day	$0.13	0%	$91,560
Building Power		kwh/day	$0.13	0%	$0
Equipment/Media Replacement	$1	LS	$15,600	0%	$15,600
SUBTOTAL O & M Costs					$149,000

Net Present Value (NPV) Assumptions

Interest rate 2%
Life cycle 20 yr
Factor P/A 16.3514

$P_{total} =$ Pcapital + AO&M(P/A,i,n)

NPV (low) = $7,400,000
NPV (high) = $9,800,000

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PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - MBBR Alternative 4A (Phase II - 1.0 MGD)

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
1	Additional Media (from 0.65 MGD to 1.2 MGD)	LS	$400,000	1	20%	$480,000
	Subtotal:					**$480,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$480,000
B	Electrical/I&C	(% of A)	0%	$0
C	Mechanical	(% of A)	0%	$0
D	Ancillary Equipment	(% of A)	0%	$0
E	Freight	(% of A)	6%	$28,800
F	Misc. Site/Civil	(% of A)	0%	$0
G	Subtotal			$508,800
H	Mob/Bond/Insurance	(% of G)	0%	$0.00
I	Contingency	(% of G)	25%	$127,200
K	Engineering-SDC	(% of G)	0%	$0.00
L	City Admin/Legal	(% of G)	0%	$0.00
M	**Total Estimated Project Costs:**			**$600,000** *

Project Cost range($)
High (+20%) = $700,000
Low (-20%) = $500,000

Operation & Maintenance Costs					
Alkalinity Feed	35000	lbs/yr	$0.21	0%	$7,350
Alkalinity Operator Labor	5	mnhr/wk	$25.00	0%	$6,500
Power Alkalinity	154	kwh/day	$0.13	0%	$7,288
Polymer Feed	1400	lbs/yr	$3.01	0%	$4,214
Polymer Operator Labor	2	mnhr/wk	$25.00	0%	$2,600
Power Polymer	29	kwh/day	$0.13	0%	$1,367
MBBR Operator Labor	10	mnhr/wk	$25.00	0%	$13,000
Blower Power	1,930	kwh/day	$0.13	0%	$91,560
Building Power		kwh/day	$0.13	0%	$0
Equipment/Media Replacement	$1	LS	$16,600	0%	$16,600
SUBTOTAL O & M Costs					$150,000

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PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - MBBR Alternative 4A (Phase III - 1.5 MGD)

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
2	Excavation	CY	$6	10,400		$62,400
3	Backfill	CY	$15.00	6,500		$97,500
4	Aeration Basins (Concrete)	CY	$850	270		$229,500
5	Aeration Basin Internals	LS	$590,000	1	20%	$708,000
	Diffusers and Drop Pipe					
	Cylindrical Screens					
	Media (for 0.65 MGD ADMM flow)					
	Process I&C (DO probes, switches, PLC)					
6	Wall Openings	LS	$15,000	1	20%	$18,000
7	Misc Metals (handrails, stairs, etc.)	LS	$25,000	1		$25,000
8	Aeration Basin Blowers - Existing					
9	Aeration Basin Pumps (drain)	EA	$15,000	1	20%	$18,000
10	MBBR Covers	SF	$80	1,700		$136,000
12	Yard Piping	LF	$200	50		$10,000
	Subtotal:					**$1,300,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$1,300,000
B	Electrical/I&C	(% of A)	20%	$260,000
C	Mechanical	(% of A)	10%	$130,000
D	Ancillary Equipment	(% of A)	5%	$65,000
E	Freight	(% of A)	6%	$78,000
F	Misc. Site/Civil	(% of A)	5%	$65,000
G	Subtotal			$1,898,000
H	Mob/Bond/Insurance	(% of G)	4%	$75,920
I	Contingency	(% of G)	25%	$474,500
K	Engineering-SDC	(% of G)	20%	$379,600
L	City Admin/Legal	(% of G)	5%	$94,900
M	**Total Estimated Project Costs:**			**$2,900,000** *

Project Cost range($)
High (+20%) = $3,500,000
Low (-20%) = $2,300,000

Operation & Maintenance Costs					
Alkalinity Feed	45000	lbs/yr	$0.21	0%	$9,450
Alkalinity Operator Labor	6	mnhr/wk	$25.00	0%	$7,800
Power Alkalinity	154	kwh/day	$0.13	0%	$7,288
MBBR Operator Labor	12	mnhr/wk	$25.00	0%	$15,600
Blower Power	2,904	kwh/day	$0.13	0%	$137,795
Building Power		kwh/day	$0.13	0%	$0
Equipment/Media Replacement	$1	LS	$18,600	0%	$18,600
SUBTOTAL O & M Costs					$197,000

Net Present Value (NPV) Assumptions

Interest rate 2%
Life cycle 20 yr
Factor P/A 16.3514

$P_{total} =$ Pcapital + AO&M(P/A,i,n)

NPV (low) = $5,500,000
NPV (high) = $6,700,000

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PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - Secondary Clarifier (WAS Only) - Alternative 4A

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
	Secondary Clarifiers					
1	Excavation	CY	$6	30,000		$180,000
2	Backfill	CY	$15.00	12,000		$180,000
3	Under Drainage	CY	$100	500		$50,000
4	Clarifier (Concrete)	CY	$850	1,300		$1,105,000
5	Claifier Internals	LS	$155,000	2	20%	$372,000
	Clarifier Mechanisms					
	Weirs & Baffles					
6	Influent/Effluent Structures	LS	$100,000	1		$100,000
7	Misc Metals (handrails, stairs, etc.)	LS	$50,000	1	20%	$60,000
8	Clarifier covers	LS	$180,000	2		$360,000
9	Influent/Effluent Piping	LF	$150	150		$22,500
10	Clarifier Pumps (drain)	EA	$13,000	2	20%	$31,200
	WAS Pump Station					
1	Excavation	CY	$6	600		$3,600
2	Backfill	CY	$15.00	125		$1,875
3	Under Drainage	CY	$100	7		$700
4	Slabs (Concrete)	CY	$850	35		$29,750
5	WAS/Scum Pumps	EA	$13,000	2	20%	$26,000
6	Wetwells/Hatches	LS	$50,000	1		$50,000
7	WAS Piping	LF	$200	250		$50,000
8	Control Building	SF	$125	300		$37,500
	Subtotal:					**$2,660,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$2,660,000
B	Electrical/I&C	(% of A)	20%	$532,000
C	Mechanical	(% of A)	10%	$266,000
D	Ancillary Equipment	(% of A)	5%	$133,000
E	Freight	(% of A)	6%	$159,600
F	Misc. Site/Civil	(% of A)	5%	$133,000
G	Subtotal			$3,883,600
H	Mob/Bond/Insurance	(% of G)	4%	$155,344.00
I	Contingency	(% of G)	25%	$970,900
K	Engineering-SDC	(% of G)	20%	$776,720.00
L	City Admin/Legal	(% of G)	5%	$194,180.00
M	**Total Estimated Project Costs:**			**$6,000,000** *

Project Cost range($)
High (+20%) = $7,200,000
Low (-20%) = $4,800,000

Operation & Maintenance Costs					
Operator Labor	7	mnhr/wk	$25.00	0%	$9,100
Clarifier Drive Motor	18	kwh/day	$0.13	0%	$854
WAS Pump Power	180	kwh/day	$0.13	0%	$8,541
WAS Pump Maintenance/Parts	1	LS	$2,500.00	0%	$2,500
SUBTOTAL O & M Costs					$21,000

Net Present Value (NPV) Assumptions

Interest rate 2%
Life cycle 20 yr
Factor P/A 16.3514

$P_{total} =$ Pcapital + AO&M(P/A,i,n)

NPV (low) = **$5,100,000**
NPV (high) = **$7,500,000**

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PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - Secondary Clarifier (RAS/WAS) - Alternative 2

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
			Secondary Clarifiers			
1	Excavation	CY	$6	30,000		$180,000
2	Backfill	CY	$15.00	12,000		$180,000
3	Under Drainage	CY	$100	500		$50,000
4	Clarifier (Concrete)	CY	$850	1,300		$1,105,000
5	Claifier Internals	LS	$155,000	2	20%	$372,000
	Clarifier Mechanisms					
	Weirs & Baffles					
6	Influent/Effluent Structures	LS	$100,000	1		$100,000
7	Misc Metals (handrails, stairs, etc.)	LS	$50,000	1	20%	$60,000
8	Clarifier covers	LS	$180,000	2		$360,000
9	Influent/Effluent Piping	LF	$150	150		$22,500
10	Clarifier Pumps (drain)	EA	$13,000	2	20%	$31,200
			RAS/WAS Pump Station			
1	Excavation	CY	$6	600		$3,600
2	Backfill	CY	$15.00	200		$3,000
3	Under Drainage	CY	$100	10		$1,000
4	Slabs (Concrete)	CY	$850	50		$42,500
5	RAS Pumps	EA	$20,000	3	20%	$60,000
6	WAS/Scum Pumps	EA	$13,000	2	20%	$26,000
7	Wetwells/Hatches	LS	$100,000	1		$100,000
8	RAS/WAS Piping	LF	$200	300		$60,000
9	Control Building	SF	$125	400		$50,000
	Subtotal:					**$2,800,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$2,800,000
B	Electrical/I&C	(% of A)	20%	$560,000
C	Mechanical	(% of A)	10%	$280,000
D	Ancillary Equipment	(% of A)	5%	$140,000
E	Freight	(% of A)	6%	$168,000
F	Misc. Site/Civil	(% of A)	5%	$140,000
G	Subtotal			$4,088,000
H	Mob/Bond/Insurance	(% of G)	4%	$163,520.00
I	Contingency	(% of G)	25%	$1,022,000
K	Engineering-SDC	(% of G)	20%	$817,600.00
L	City Admin/Legal	(% of G)	5%	$204,400.00
M	**Total Estimated Project Costs:**			**$6,300,000** *

Project Cost range($)
High (+20%) = $7,600,000
Low (-20%) = $5,000,000

Operation & Maintenance Costs					
Operator Labor	7	mnhr/wk	$25.00	0%	$9,100
Clarifier Drive Motor	18	kwh/day	$0.13	0%	$854
RAS Pump Power	180	kwh/day	$0.13	0%	$8,541
RAS Pump Maintenance/Parts	1	LS	$2,500.00	0%	$2,500
WAS Pump Power	180	kwh/day	$0.13	0%	$8,541
WAS Pump Maintenance/Parts	1	LS	$2,500.00	0%	$2,500
SUBTOTAL O & M Costs					$32,000

Net Present Value (NPV) Assumptions

Interest rate 2%
Life cycle 20 yr
Factor P/A 16.3514
P_{total} = Pcapital + AO&M(P/A,i,n)

NPV (low) = $5,500,000
NPV (high) = $8,100,000

* - Cost estimates prepared as part of the Facilities Plan are order-of-magnitude, Class 5 estimates, as defined by the American Association of Cost Engineers (AACE). According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

CLASS 5 ESTIMATE Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20% to –50% on the low side and +30% to +100% on the high side.

PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - Discfilter (Phase I - 0.65 MGD) - Alternative 4B

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
			Secondary Clarifiers			
1	Excavation	CY	$6	3,000		$18,000
2	Backfill	CY	$15.00	1,700		$25,500
4	Concrete slabs/structural	CY	$850	900		$765,000
5	Discfilter Equipment	LS	$464,200	1	20%	$557,040
	Discfilter					
	Backwash pumps					
	Coagulant Feed Skid/Mixer					
	Polymer Feed Skid/Mixer					
	Chem Feed Tankage/Rapid Mixer					
	Process I&C (DO probes, switches, PLC)					
6	Additional Media (from 0.65 MGD to 1.2 MGD)	LS	$55,000	0		$0
7	Misc Metals (handrails, stairs, etc.)	LS	$50,000	1	20%	$60,000
8	Influent/Effluent Piping	LF	$150	150		$22,500
9	Discfilter Building (100'x80')	SF	$150	8,000		$1,200,000
10	DF Building Misc. (10% of 9)	LS	$120,000	1		$120,000
	Subtotal:					**$2,800,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$2,800,000
B	Electrical/I&C	(% of A)	25%	$700,000
C	Mechanical	(% of A)	15%	$420,000
D	Ancillary Equipment	(% of A)	5%	$140,000
E	Freight	(% of A)	6%	$168,000
F	Misc. Site/Civil	(% of A)	5%	$140,000
G	Subtotal			$4,368,000
H	Mob/Bond/Insurance	(% of G)	4%	$174,720
I	Contingency	(% of G)	25%	$1,092,000
K	Engineering-SDC	(% of G)	20%	$873,600
L	City Admin/Legal	(% of G)	5%	$218,400
M	**Total Estimated Project Costs:**			**$6,700,000**

Project Cost range($)

High (+20%) = $8,000,000
Low (-20%) = $5,400,000

Operation & Maintenance Costs					
Coagulant	1.0	gal/day	$25.00	0%	$9,125
Polymer	0.25	gal/day	$26.00	0%	$2,373
Operator Labor	7	mnhr	$25.00	0%	$9,100
Rapid Mix Zone Power	89	kwh/day	$0.13	0%	$4,214
Coagulation Zone Mixer Power	35.76	kwh/day	$0.13	0%	$1,697
Flocculation Zone Mixer Power	18	kwh/day	$0.13	0%	$854
Backwash Pump Power	180	kwh/day	$0.13	0%	$8,541
SEW Drive Motor Power	26.88	kwh/day	$0.13	0%	$1,275
Building Elec/HVAC	83,840	$/yr	$1.00	0%	$83,840
SUBTOTAL O & M Costs					$37,000

Net Present Value (NPV) Assumptions

Interest rate	2%	
Life cycle	20	yr
Factor P/A	16.3514	

$P_{total} =$ Pcapital + AO&M(P/A,i,n)

NPV (low) =	**$6,000,000**
NPV (high) =	**$8,600,000**

* - Cost estimates prepared as part of the Facilities Plan are order-of-magnitude, Class 5 estimates, as defined by the American Association of Cost Engineers (AACE). According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

CLASS 5 ESTIMATE Generally prepared based on very limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes, such as but not limited to market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, long-range capital planning, etc. Some examples of estimating methods used would be, estimating methods such as cost/capacity curves and factors, scale-up factors, parametric and modeling techniques. Typically very little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate are –20% to –50% on the low side and +30% to +100% on the high side.

PALMER WWTP FACILITY PLAN UPDATE
Rough Order of Magnitude Opinion of Probable Cost - Discfilter (Phase II - 1.0 MGD) - Alternative 4B

Item #	Item	Unit	Unit Price	Quantity	Installation Markup	Total
			Discfilters			
1	Additional Media (from 0.65 MGD to 1.2 MGD)	LS	$55,000	1	20%	$66,000
	Subtotal:					**$66,000**

	MARK-UPS:	Percentage	QTY	
A	Subtotal			$66,000
B	Electrical/I&C	(% of A)	5%	$3,300
C	Mechanical	(% of A)	15%	$9,900
D	Ancillary Equipment	(% of A)	10%	$6,600
E	Freight	(% of A)	6%	$3,960
F	Misc. Site/Civil	(% of A)	0%	$0
G	Subtotal			$89,760
H	Mob/Bond/Insurance	(% of G)	4%	$3,590
I	Contingency	(% of G)	25%	$22,440
K	Engineering-SDC	(% of G)	5%	$4,488
L	City Admin/Legal	(% of G)	5%	$4,488
M	**Total Estimated Project Costs:**			**$120,000**

Project Cost range($)
High (+20%) = $140,000
Low (-20%) = $100,000

Operation & Maintenance Costs					
Coagulant	1.3	gal/day	$25.00	0%	$11,406
Polymer	0.50	gal/day	$26.00	0%	$4,745
Operator Labor	7	mnhr	$25.00	0%	$9,100
Rapid Mix Zone Power	89	kwh/day	$0.13	0%	$4,214
Coagulation Zone Mixer Power	35.76	kwh/day	$0.13	0%	$1,697
Flocculation Zone Mixer Power	18	kwh/day	$0.13	0%	$854
Backwash Pump Power	180	kwh/day	$0.13	0%	$8,541
SEW Drive Motor Power	26.88	kwh/day	$0.13	0%	$1,275
Building Elec/HVAC	83,840	$/yr	$1.00	0%	$83,840
SUBTOTAL O & M Costs					$42,000

APPENDIX B: INTERIM MEASURES TECHNICAL MEMORANDUM

Memo

Date:	Tuesday, November 24, 2015 (Revised 12/9/2015)
Project:	City of Palmer Clean Water Act Negotiations
To:	Tom Healy, City of Palmer Director of Public Works
From:	HDR
Subject:	**EPA-DOJ Task List – Interim Measures Technical Memorandum**

The EPA/DOJ has asked the City of Palmer to evaluate short term wastewater treatment options that could be implemented as short term measures prior to the treatment plant upgrade. These short term alternatives were described to the City as alternatives that would require minor modifications to the current Palmer WWTP operations yet provide improved treatment plant performance. These short term alternatives may offer some operational benefits and improved performance while the City develops plans and constructs a long term solution. The options evaluated include:

1) Additional Recirculation around Lagoons 1 and 2,
2) Cover Lagoon 3,
3) Removal of Lagoon solids,
4) Alkalinity addition,
5) Add biomass carrier media to the lagoons to develop biofilm/attached growth treatment,
6) Additional pre-treatment to the meat processing plant that discharges to the City sewer system.

EPA/DOJ has requested a list of options and an implementation timeline and cost for each. Table 1 below provides a summary of the proposed timelines and costs for the short term options and the evaluation of each option is discussed in more detail in the following technical memorandum.

Table 1. Interim Measures Timeline and Costs

Interim Measure	Proposed Timeline	ROM Opinion of Probable Cost
Recirculation around Lagoons	1) Purchase New Pump (early Dec 2015) 2) Develop protocol for additional monitoring (early Dec 2015) 3) Implement Lagoon 2 recirculation option (Dec 2015 – Feb 2016) 4) Implement Lagoon 1 recirculation option (Feb 2016 – April 2016) 5) Evaluate impacts of recirculation options and determine recirculation configuration for sustained operation (April-May 2016)	$25,000 (Including additional testing, analysis, and monitoring)
Covering Lagoon 3	Summer 2016	$0.8M+
Removal of Lagoon Solids	1) Remove Cover and Dredge Lagoon 1 (May 2016)	2 weeks of operator time

	2) Remove Cover and Dredge Lagoon 2 (May-June 2016)	
Alkalinity feed	1) Purchase small lime feed system (Jan – April 2016) 2) Relocate existing 12'x16' Storage building and construct 3-sided Lime Storage Shed (May-June 2016)	$106,000
Adding Attached Growth Media	Also an alternative for long term WWTP upgrade	$7M
Meat Processing Pre-treatment	Based on sampling of pre-treated discharge (May 2016)	-

Interim Measures

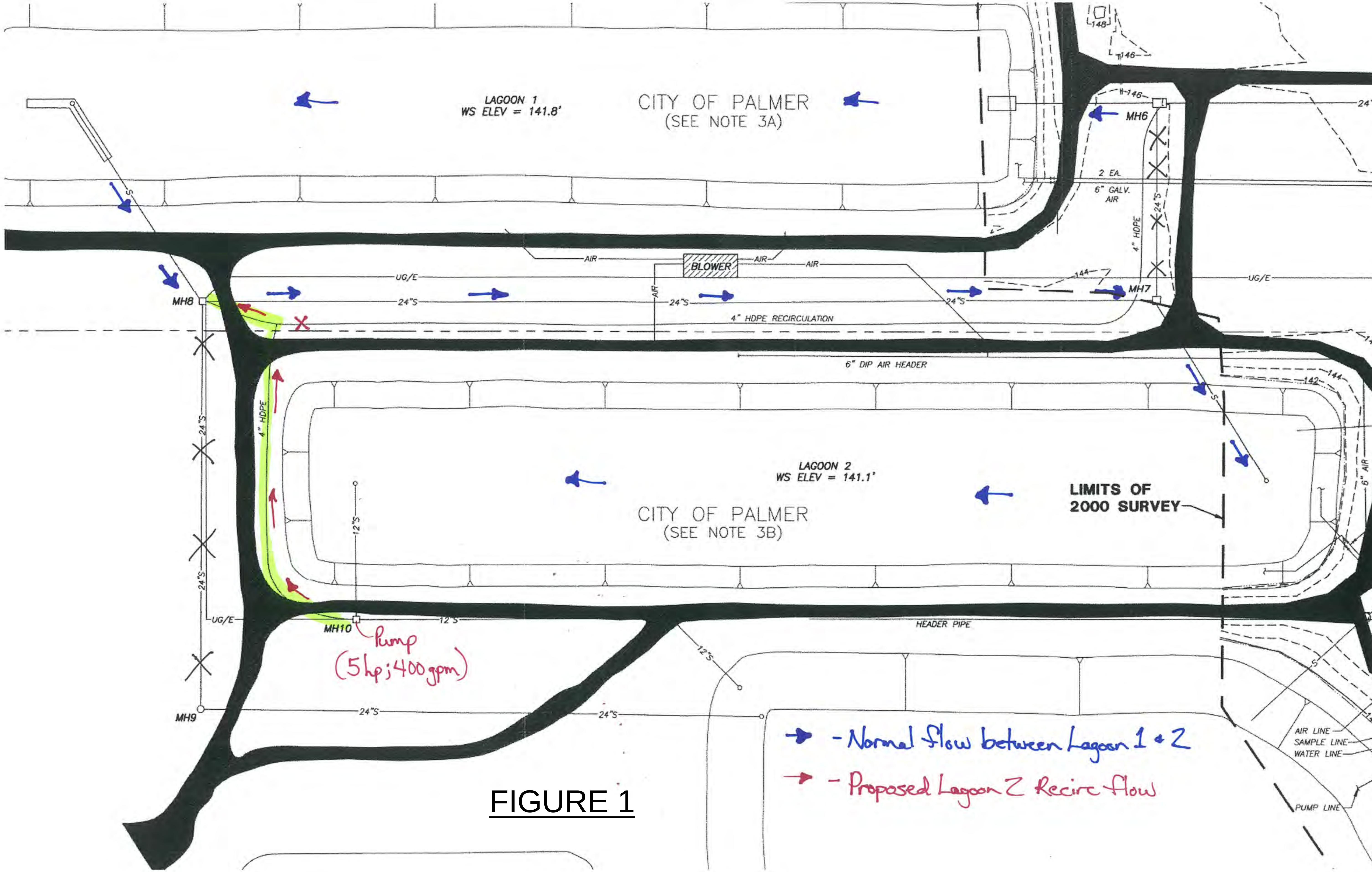
Recirculation Lagoons 1 and 2

This alternative's effectiveness may be determined using existing pipe installed at the WWTP site. The City of Palmer WWTP operations staff has experimented with recycling flow briefly in the past with minimal measured impacts to the treatment performance. The City of Palmer operations staff began recirculating flows between Lagoons 1 and 2 in mid-October 2015. However, monitoring and sampling were not documented in order to measure any impacts the recirculation may have had on the treatment process. Without having much of a biomass to recycle (ie from a secondary clarifier, etc.), the benefits of the recirculation will likely be minimal but may provide some additional mixing and BOD reduction.

The Palmer WWTP operations staff are currently recycling flow from the effluent side of Lagoon 2 to the influent side of Lagoon 1. In order to reduce loading to Lagoon 1, it is recommended that this configuration be switched to recycle flow from the effluent side of Lagoon 2 to the influent side of Lagoon 2. This may reduce the waste loading to Lagoon 1 to allow better BOD removal in Lagoon 1. Figure 1 provides an illustration of the proposed flow path. For the figure, the original design drawing provided shows a 4" HDPE recirculation line running between Lagoons 1 and 2. For the first recirculation option, flow will be pumped from the effluent of Lagoon 2 (MH10) to the effluent of Lagoon 1 (MH8) where it will flow by gravity to the influent of Lagoon 2.

Figure 2 illustrates a second recirculation option that will be implemented after the first option is operated and monitored for several months. The second recirculation option provides an internal recycle flow from the effluent of Lagoon 1 to the influent of Lagoon 1. For this option, flow will be pumped from the effluent of Lagoon 1 (MH8) to the influent of Lagoon 1 (MH6).

Using the existing 4" HDPE recirculation line for the two recycle options is advantageous for several reasons: 1) reusing the existing line minimizes project costs; 2) minimizes disruption to the WWTP site; and 3) allows for the flow to be recirculated in underground piping. This last point is critical during the winter months as any temporary piping above ground would result in significant cooling of the wastewater and potential freezing of the lines.



LAGOON 1
WS ELEV = 141.8'
CITY OF PALMER
(SEE NOTE 3A)
MH6
2 EA.
6" GALV. AIR
4" HDPE
24"S
AIR
BLOWER
UG/E
MH8
MH7
4" HDPE RECIRCULATION
6" DIP AIR HEADER
LAGOON 2
WS ELEV = 141.1'
CITY OF PALMER
(SEE NOTE 3B)
LIMITS OF
2000 SURVEY
12"S
MH10
Pump
(5 hp; 400 gpm)
HEADER PIPE
MH9
AIR LINE
SAMPLE LINE
WATER LINE
PUMP LINE
- Normal flow between Lagoon 1 + 2
- Proposed Lagoon 2 Recirc flow

FIGURE 1

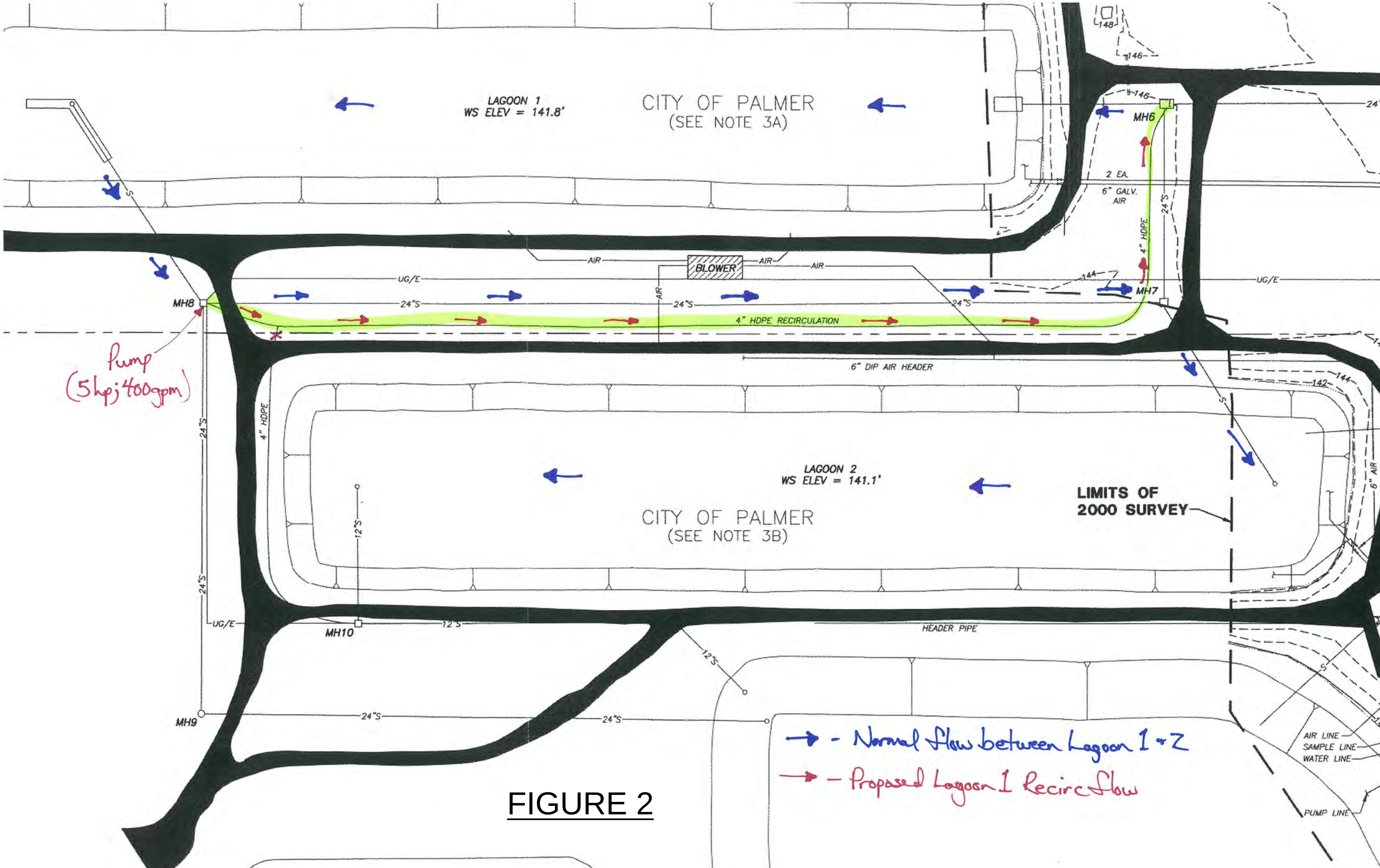

LAGOON 1
WS ELEV = 141.8'
CITY OF PALMER
(SEE NOTE 3A)
MH6
2 EA.
6" GALV.
AIR
4" HDPE
24"S
BLOWER
AIR
UG/E
MH7
MH8
24"S
4" HDPE RECIRCULATION
Pump
(5hp; 400gpm)
6" DIP AIR HEADER
4" HDPE
LAGOON 2
WS ELEV = 141.1'
CITY OF PALMER
(SEE NOTE 3B)
LIMITS OF
2000 SURVEY
12"S
6" AIR
MH10
UG/E
HEADER PIPE
MH9
AIR LINE
SAMPLE LINE
WATER LINE
PUMP LINE
– Normal flow between Lagoon 1 + 2
– Proposed Lagoon 1 Recirc flow

FIGURE 2

The following recommendations are made for recirculating flows around Lagoons 1 and 2:

- **Purchase and install a new, larger recirculation pump:** The existing recirculation pump is a 2 hp, 2” discharge pump with a capacity of approximately 200 gpm (288,000 gpd). The average influent flows to the WWTP are approximately 542,000 gpd so the current pump in use is only capable of recycling approximately half of the average daily flow. For this improvement, it is desirable to have a minimum of 1Q recycle rate (or 542,000 gpd) and it is therefore recommended that the City purchase a new pump capable of pumping 380 gpm or greater. The pump vendor’s information for the larger submersible pump has been attached to this memo. The pump is available from an on-line equipment provider (Grainger) for a relatively low capital investment and would provide the required flows for this short term measure.
- **Increase monitoring/sampling to evaluate the impacts of the recirculation:** HDR will work with the City operators to develop a protocol for increased monitoring and sampling. HDR will evaluate the data gathered and work with the operators to modify the system as needed to test different aspects of the recirculation or improve system performance.
- **Operate and Monitor the Recirculation Option in warm weather and cold weather conditions:** It is recommended that the first recirculation option (Lagoon 2 internal recycle) be operated from December 2015 into February 2016 and that the second recirculation option (Lagoon 1 internal recycle) be operated from February 2016 through April 2016. It is recommended to try each option separately at first to be able to determine which, if either, has the most impact on the system. At the end of the test for each option, HDR will work with the City to evaluate if more pumping configurations should be tried or if a more long term recirculation configuration should be implemented for sustained operation.
- **Complete installation of the new on-line DO monitoring system:** This is a related short term measure that will provide additional data for monitoring and improving the system operation. DO monitors are scheduled to be installed in Lagoons 1 and 2 and the operators have noted that the installation contractor has pulled the wires to the blower building but has not completed the commissioning of the system. We recommend completing this work as soon as possible. It will be advantageous to have the additional DO data available as we begin evaluating the recirculation options. In general, it is recommended that the City boost the oxygen levels in Lagoon 2 – the operators report they currently try to maintain a minimum 2 mg/l DO level, this could be boosted to around 4 or 5 mg/l to help the nitrifiers. Having the on-line meters available will help with system control.

COST

1. Purchase and Installation of a new submersible recirculation pump.
2. Collect and analyze additional monitoring data.
3. Approximately **$25,000**.

Covering Lagoon 3

This is not a viable short term option at the Palmer WWTP. An evaluation of costs indicates that this option would require an investment of over $800,000 to implement and it is unlikely that the expenditure would have significant impact on the treatment performance at the plant. Lagoons 1 and 2 were covered in 2010 at a cost of $662,000 (material cost alone). The total surface area covered in 2010 was approximately 7.6 acres and the surface area of Lagoon 3 is approximately 4.8 acres. Additional costs will be incurred for freight, surveying the pond for design and construction, and assembly and installation of the cover.

Covering Lagoon 3 will continue to be evaluated as part of a more long term solution. If, based on additional geotechnical investigation, the on-site subsurface discharge option is identified as the preferred design alternative, the covering of Lagoon 3 may have more significant long term impacts. However, if either the SAGR or MBBR processes are the preferred design alternative it is likely that Lagoon 3 will be abandoned. A large investment to cover the lagoon at this point could result in a sunk cost when the WWTP is upgraded.

COST

1. Purchase and Installation of a cover for Lagoon 3: **$0.8M+**

Item #	Item	Unit	Unit Price	Quantity	Total
1	Lagoon 3 Cover (material)	LS	$550,000	1	$550,000
2	Assemble and Install Lagoon 3 Cover	LS	$25,000	1	$25,000
3	Lagoon Survey	LS	$5,000	1	$5,000
4	Mobilization & Misc. Site/Civil (5%)	LS	$28,750	1	$28,750
5	Freight (6%)	LS	$33,000	1	$33,000
6	Engineering & Construction Management (5%)	LS	$32,000	1	$32,000
7	Contingency (25%)	LS	$160,000	1	$160,000
	Subtotal:				**$834,000**

Removal of Lagoon Solids

It is recommended that the City remove the sludge/solids that have accumulated on the bottom of Lagoons 1 and 2. Sludge has not been removed from Lagoons 1 and 2 since 2010, when the covers were installed. Operators tested the sludge depth in each lagoon in June 2015 (see attached 2015 Sludge Judge Report) and the sludge depth was found to be several feet in some areas of the lagoons (deepest near the baffle curtains and effluent in each lagoon). Removing the solids will increase the available lagoon volume, the overall treatment capacity, minimize the amount of sludge digesting at the bottom of the ponds, and improve overall mixing conditions in the lagoons.

HDR originally suggested dredging the ponds this year before winter but unfortunately winter has arrived and the possibility of getting the covers removed and not being able to reinstall them is very real during the winter months. The operators have had experience dealing with the covers during the cold months and have encountered significant challenges due to freezing conditions. Several years ago during a winter snow/wind storm the cover blew off of Lagoon 2. The operators found it was very dangerous to be on the covers and that any amount of snow or frost makes the installation of the covers very dangerous. For this reason, it is recommended that the ponds be dredged as early as possible next spring when the snow/ice has melted and it is safe to remove the covers. It is estimated that this work could be accomplished in the May-June 2016 time frame.

COST

1. No significant capital investment will be required for this short term measure; however a significant time investment will be required from the City operators to uncover and dredge the ponds, while performing normal operation and maintenance duties at the facility (approximately 2 weeks or operator time).

Raising pH Value (Alkalinity feed)

Per the EPA/DOJ request, HDR evaluated the effluent data for Lagoon 2 and it appears there could be some benefit to alkalinity feed. Based on 2013-2014 data, for the months of January thru June the pH range is approximately 7.3 to 7.6. For the months of July thru Nov/Dec the pH range is approx. 5.8 to 7.0. A higher pH is beneficial for nitrification and it would be best to be in the 7.5 to 8.0 range.

HDR has evaluated the use of a small lime feed system to raise the pH in the Palmer plant. Small feed systems, as manufactured by Merrick or similar, are relatively cost effective and reliable units. Figure 3 below illustrates a typical volumetric screw feeder with a day bin for lime storage (also a cutsheet for the Merrick Series 100 Volumerik unit has been attached to this memo).

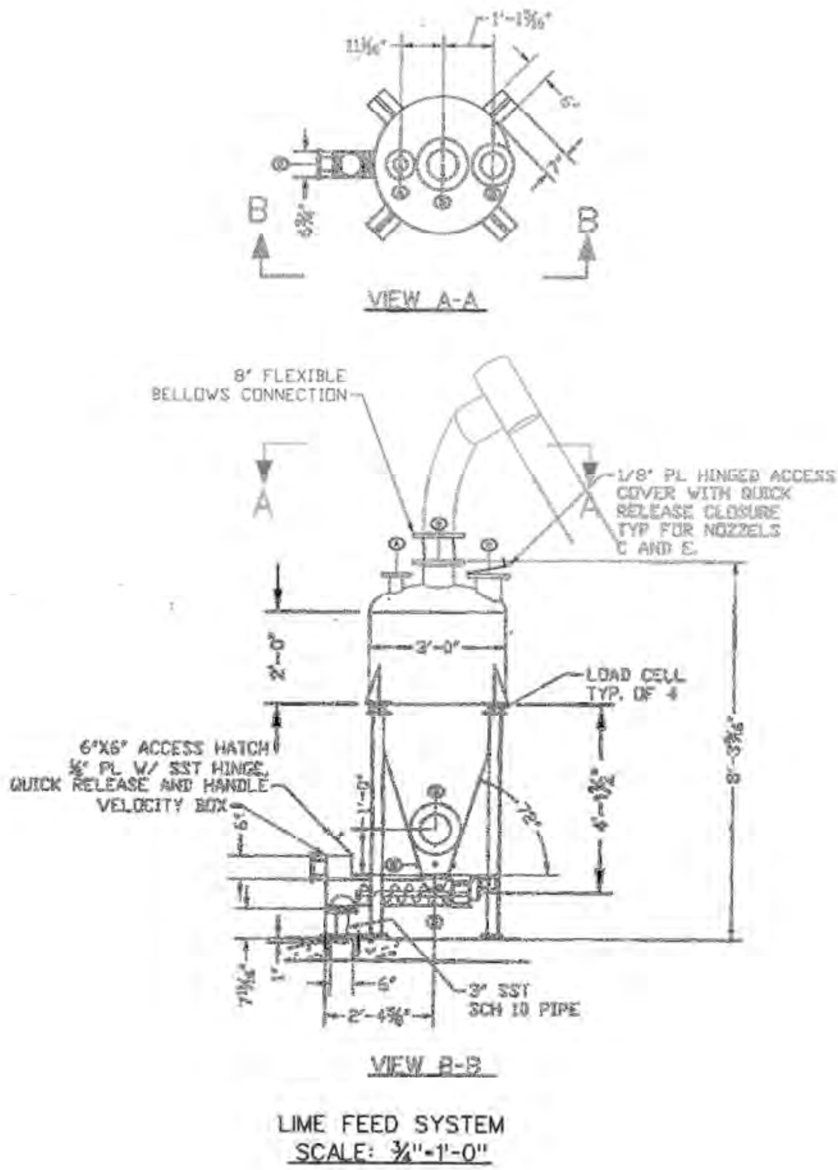


Figure 3: Example of small lime feed system

The small lime feed system could be installed in the existing 12'x16' metal storage building currently located north- east of the lab building on the WWTP site. The small metal building is currently used as storage space and could be repurposed and relocated to a spot near a lagoon influent manhole.

Lime is readily available (free) from Air Liquide – an acetylene gas manufacturing company located in Palmer and the operators have been using the lime that is a byproduct of the acetylene manufacturing process for solids handling since 2010. The lime from Air Liquide comes as a slurry – although mostly dry according to the City operators. This poses somewhat of a challenge as the lime feed system requires the use of dry lime. In order to take advantage of the available lime from Air Liquide, it is recommended that a small 3-sided shed be constructed near the 12'x16' metal building to provide a storage/drying area for the lime with protection from the elements. Operators will need to pulverize the dry lime for feeding into the day bin and lime feed system either by hand or with a piece of equipment (ball mill). If the process of drying the lime and preparing it for the feed system becomes too labor intensive, the operators could start using bags of quicklime. Mixing of the lime in the lagoons will be very important.

A lime feed system installed now as a short term option will be able to be incorporated into the long term treatment upgrade. Purchase of the lime feed system could occur over the winter months after funds have been secured and the installation of the building, equipment, etc. could take place in the spring of 2016 after the snow/ice has broken up on the site.

It is important to note that use of the lime feed system will require close monitoring of the effluent pH. While the higher pH will be beneficial for nitrification, if it results in a higher overall pH in the plant effluent this could actually increase the toxic effects of the effluent in the receiving stream.

COST

1. Purchase and Install small lime feed system in relocated 12'x16' metal building.
2. Construct 3-sided shed near the lime feed system for lime drying/storage.
3. Flow pace lime feed with plant influent flows to insure lime is not overfed.
4. Approximately **$106,000** (capital costs) – assuming the City purchases and installs the equipment (excluding electrical).

Item #	Item	Unit	Unit Price	Quantity	Total
1	Lime Feed System	LS	$78,000	1	$78,000
2	Relocate Existing Storage Building	LS	$1,500	1	$1,500
3	Shed Foundation and Floor Slab	LS	$7,500	1	$7,500
4	3-Sided Shed	SF	$50	144	$7,200
5	Misc. Site/Civil (2%)	LS	$2,000	1	$2,000
6	Misc. Electrical Systems (5%)	LS	$5,000	1	$5,000
7	Freight (6%)	LS	$5,000	1	$5,000
	Subtotal:				**$106,000**

Additional Media Install

As with the covering of Lagoon 3, the installation of additional attached growth media in the lagoons is not a viable short term option at the Palmer plant. While the operators have experimented with constructing and installing attached growth reactors in the past, the amount of media that would be required to have an impact on nitrification makes this option more of a long term alternative. We are evaluating in-situ attached growth options (Entex, etc.) and preliminary design calculations indicate that a large volume of media is required in most of Lagoons 1 and 2 to achieve significant nitrification – at a significant capital cost (approx. $7M).

Attached growth media will continue to be evaluated as part of a more long term solution. If it is determined that additional treatment (partial nitrification, etc.) is required prior to discharging to one of the long term solutions (subsurface disposal, SAGR), then a reduced amount of attached growth media may be applicable as part of the long term design.

COST

1. Purchase and Installation of Attached Growth Media: **$6,970,000 (capital cost only) –** Estimate from Draft Facility Plan (September 4, 2015) assuming Entex Webitat process in Lagoons 1 and 2.

Item #	Item	Unit	Unit Price	Quantity	Total
1	Webitat SFF Process	LS	$3,352,000	1	$3,352,000
2	Blower and Panel Prefab. Building	SF	$150	500	$75,000
3	Blower Piping	LF	$200	500	$100,000
4	Mobilization (5%)	LS	$176,000	1	$176,000
5	Ancillary Equipment (15%)	LS	$212,000	1	$212,000
6	Misc. Site/Civil (10%)	LS	$353,000	1	$353,000
7	Misc. Electrical Systems (15%)	LS	$529,000	1	$529,000
8	Freight (6%)	LS	$10,500	1	$10,500
	Subtotal:				**$4,808,000**

Summary of Costs

Total Construction Costs		**$4,808,000**
Engineering (10%)	0.10	$480,800
Construction Management (10%)	0.10	$480,800
Contingency (25%)	0.25	$1,202,000
Total Project Costs:		**$6,972,000**

Meat Processing Plant Pre-treatment

The Mt. McKinley meat packing plant in Palmer is subsidized by State funds, employs three full- time state workers, and is staffed with thirteen inmates from Goose Creek Correctional Facility. Given the state funding cuts and budgetary issues, it is unknown if the meat processing plant will be closed in the near future. The state legislature approved funding for the facility for one more year at which point the future of the plant is unknown.

City of Palmer WWTP operators conducted a site visit/inspection of the meat processing plant on November 19, 2015 and provided the following notes:

- The plant butchers approximately 800 total animals per year. Of those, 500 are pigs and 300 are cows.

- The plant has an area where they bleed out the animals before slaughter. There are two drains in the floor, one goes to the City sewer and one goes to a pit (approximately 1000 gallons) where they collect the blood. They have a truck on site that pumps out and stores the blood until a tanker truck from Shamrock Septic Pumping comes and picks it up and hauls it to Anchorage for disposal.
- Wash water from washing down the equipment, the butcher room, and anywhere else they might have blood residue or any meat particles goes into an aerated tank (approximately 10,000 gallons) outside the building. This tank is aerated 24/7 until it is discharged into the city sewer system. The aerated tank is discharged at a very slow rate, usually over a 24 hour period, after being aerated for up to 18 months.

The City operators made arrangements to be contacted before the next discharge in May 2016 to pull samples and to check the BOD before allowing the plant to discharge. Also of note, the ADEC is in the process of conducting an Industrial User Survey as part of their Pretreatment Program. DEC will be analyzing the industrial users to determine if ‘Pretreatment Program type requirements’ will be necessary in Palmer’s APDES permit.

COST

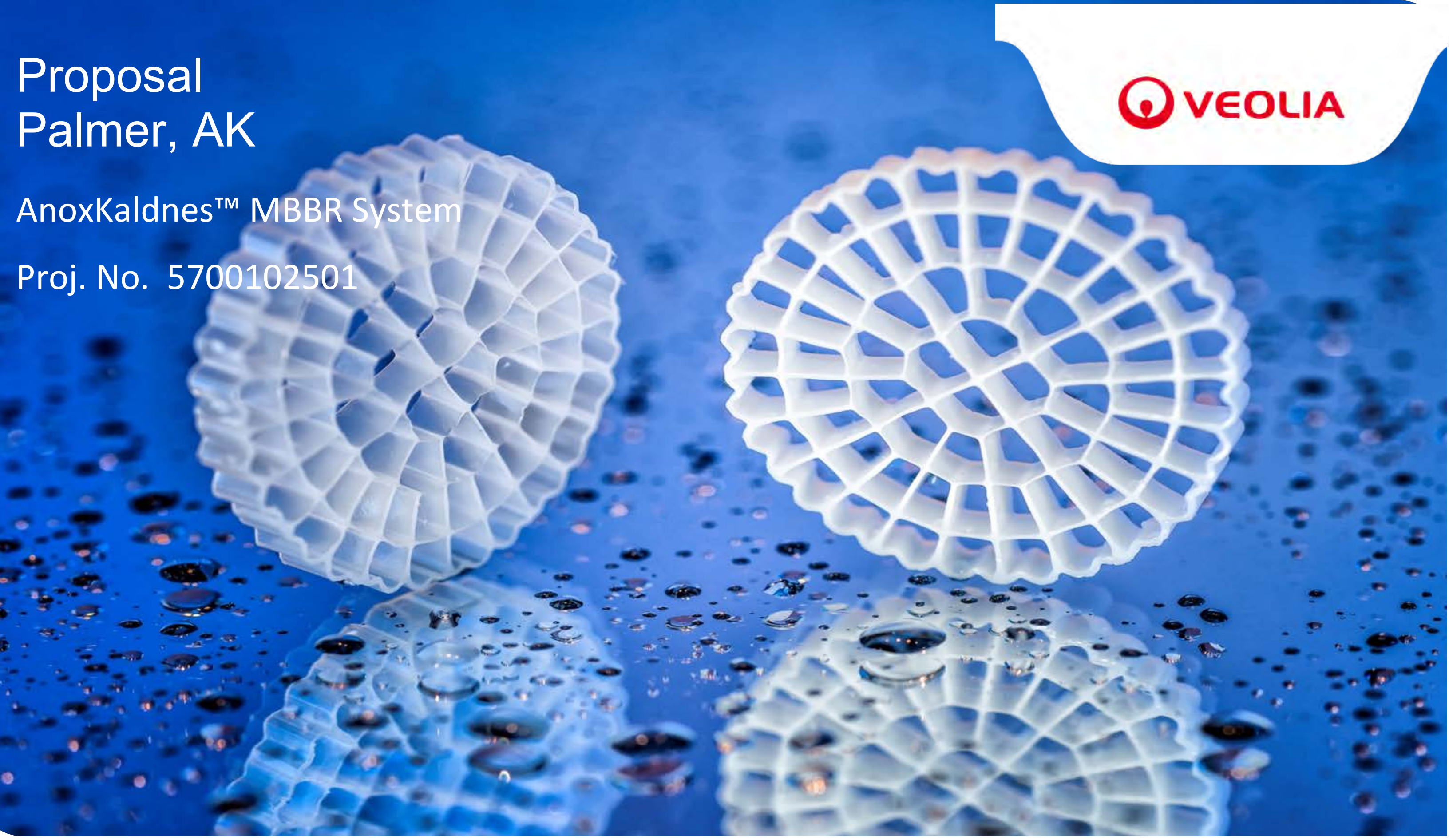
No significant capital investment will be required for this short term measure; sampling will occur in May 2016 and additional pre-treatment may be required at the meat processing facility.

APPENDIX C: EQUIPMENT INFORMATION

Proposal
Palmer, AK

AnoxKaldnes™ MBBR System

Proj. No. 5700102501



Submitted to: Jim Wodrich, P.E.
HDR

Submitted by: Daniel Hurt
Application Engineer

Date: 1/20/2016

Kruger Inc.
4001 Weston Parkway
Cary, NC 27513
tel. +1 919-677-8310 • fax +1 919-677-0082
www.krugerusa.com

Water Technologies

Introduction

I. Kruger Inc is pleased to present this proposal for our AnoxKaldnes MBBR System for Palmer, AK. Kruger proposes a phased construction approach for the Palmer, AK project:

Phase I: Kruger proposes the construction of two (2) process trains consisting of one (1) carbon removal reactor followed by two (2) nitrification reactors. Each reactor will include 30% K5 media, cylindrical screens, airgrids, and instrumentation.

Phase II: To increase the plants max month capacity from 0.65 MGD to 1.22 MGD, assuming the same influent/effluent concentrations, simply add K5 media to each reactor increasing the fill to 55%. The airgrids and screens were designed in Phase I to accommodate Phase II airflows and hydraulic demands.

Phase III: To increase plants max month capacity by another 50% (1.22 MGD to 1.83 MGD), a third process train identical to the Phase II process trains shall be constructed.

Please refer to the general layout drawing within the proposal for approximate reactor dimensions and proposed phasing. Table 3 will provide you with the necessary process design information.

We appreciate the opportunity to provide this proposal to you. If you have any questions or need further information, please contact our local Representative, Bill Reilly of W.H. Reilly & Company or our Regional Sales Manager, Brad Mrdjenovich, at (412)-352-0975 (brad.mrdjenovich@veolia.com).

cc: CT, BWM, LFO, CS, project file (Kruger)
Bill Reilly (W.H. Reilly & Company)

Revision	Date	Process Eng.	Comments
0	9/24/2015	CS, LFO	Initial, budgetary proposal (Lagoon Guard Proposal).
1	11/02/2015	CS, LFO	Revised, budgetary proposal (Pure MBBR Proposal).
2	1/19/2016	LFO, CS	Phased approach, two trains to three trains

We Know Water

I. Kruger Inc. (Kruger) is a water and wastewater solutions provider specializing in advanced and differentiating technologies. Kruger provides complete processes and systems ranging from biological nutrient removal to mobile surface water treatment. The ACTIFLO® Microsand Ballasted Clarifier, BioCon® Dryer, BIOSTYR® Biological Aerated Filter (BAF) and NEOSEP™ MBR are just a few of the innovative technologies offered by Kruger.

Kruger Inc. is a Veolia Water Solutions & Technologies' (VWS) company providing innovative water and wastewater treatment solutions for the U.S. municipal market. As a global company with 135 Business Units in 57 countries, **Veolia Water** with nearly 10,000 employees worldwide and with over 250 proprietary technologies is the world leader in water and wastewater treatment.

Kruger delivers unequalled **S**ervice to our customers delivering and creating **V**alue while being environmentally **R**esponsible with a focus on safety. Since 1986, Kruger has been providing leading edge technologies for biological wastewater treatment, High Rate Clarification for phosphorus removal and water treatment, filtration for TSS removal, water reuse and drinking water and Biosolids processing. Based in Cary, North Carolina, Kruger's 120 plus professionals are dedicated to providing the most technically sound solution to meet our customers' needs while following our principles of **SVR.**

Energy Focus

Kruger, along with Veolia Water Solutions & Technologies (VWS) is dedicated to delivering sustainable and innovative technologies and solutions.

We offer our customers integrated solutions which include resource-efficient technology to improve operations, reduce costs, achieve sustainability goals, decrease dependency on limited resources, and comply with current and anticipated regulations.

Veolia's investments in R&D outpace that of our competition. Our focus is on delivering

- neutral or positive energy solutions
- migration towards green chemicals or zero chemical consumption
- water-footprint-efficient technologies with high recovery rates

Our carbon footprint reduction program drives innovation, accelerates adoption and development of clean technologies, and offers our customers sustainable solutions.

Kruger is benchmarking its technologies and solutions by working with our customers and performing total carbon cost analysis over the lifetime of the installation.

By committing to the innovative development of clean and sustainable technologies and solutions worldwide, Kruger and VWS will continue to maximize the financial benefits for every customer.

Process Description

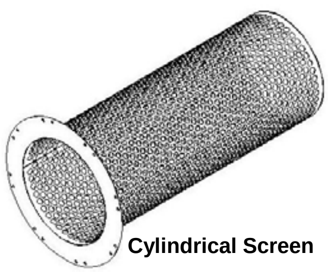
AnoxKaldnes MBBR and IFAS


K5 Media

Kruger's AnoxKaldnes process design is based on more than 20 years of experience with Moving Bed Biological Reactors (MBBR) and Integrated Fixed Film Activated Sludge (IFAS) systems. Our knowledge is supported by lab and pilot scale studies and data from more than 475 AnoxKaldnes operating systems for BOD, nitrification, and TN removal.

The MBBR and IFAS (or Hybas™ – Hybrid Biofilm Activated Sludge) processes are continuous flow through, non-clogging bio-film reactors containing "carrier elements" or media with a high specific surface. The media does not require backwashing or cleaning.

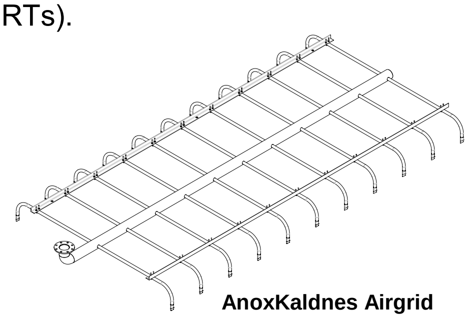
The biomass that treats the wastewater is attached to the surfaces of the media. The media is designed to provide a large protected surface area for the biofilm and optimal conditions for biological activity when suspended in water. Media of different shapes and sizes provide flexibility to use the most suitable type depending on wastewater characteristics, discharge standards and available volumes. AnoxKaldnes media is made from polyethylene and has a density slightly less than water.


Cylindrical Screen

In the MBBR process, all of the biomass is attached to the media and retained in the reactor, with no returned sludge. In the Hybas process, the reactor contains both free-floating biomass (activated sludge) and biomass attached to the media. The free-floating biomass passes through the reactor, is settled and recycled back to the reactor. The media and attached biofilm remain in the reactor as in a MBBR.

The Hybas process is often considered for upgrading existing conventional activated sludge systems within the existing tankage for either maintaining nitrification at new higher flow rates or loads or upgrading a plant to meet new nitrification requirements. It is accomplished by adding the media directly into the activated sludge reactors to enhance the growth of the autotrophic bacteria. The Hybas system is capable of meeting these new effluent requirements at low solids retention times (SRTs) and short hydraulic retention times (HRTs).

The mixing of the media within MBBR and Hybas reactors is provided by AnoxKaldnes' medium bubble aeration system in aerobic application, whereas specially designed submersible mixers are used in anoxic environments for denitrification.


AnoxKaldnes Airgrid

Kruger's minimum scope of supply for MBBR and Hybas systems includes the AnoxKaldnes media, screen assemblies (to keep media in each reactor), medium bubble aeration grid assemblies and submersible mixers for the anoxic zones. In cases where they are needed, Kruger also provides the blowers, instrumentation and controls, SCADA, and field instruments (dissolved oxygen, nitrate, ammonia, etc.) for single source responsibility.

Design Summary

The proposed design is based on the following influent wastewater characteristics and incorporating peak flow conditions for screen design purposes only. The design assumes that the raw influent wastewater is biodegradable, no toxic compounds are present, sufficient alkalinity is available to avoid pH depressions, that the COD/BOD ratio is between 1.7 and 2.3, and that none of the equipment provided would be used in a classified area (e.g. Class 1, Division 1 or Class 1, Division 2).

Facilities with primary clarification will require screening with a maximum of 6 mm (1/4 inch) openings for removal of particulate matter (rags, debris, etc.) prior to entering the AnoxKaldnes MBBR System treatment reactors. Facilities that lack primary clarification will require screening with a maximum of 3 mm (1/8 inch) openings.

Table 1: Influent Design Basis

Parameter	Units	Phase I	Phase II	Phase III
Flow, Max Month Design	MGD	0.65	1.22	1.83
Flow, Peak Hourly	MGD	0.98*	1.83*	2.75*
BOD_5, Design	mg/L	280	280	280
TSS, Design	mg/L	299	299	299
TKN, Design	mg/L	48	48	48
NH_3-N, Design	mg/L	32	32	32
Elevation	ft	243*	243*	243*
Min/Max Temperature	°C	6 / 16	6 / 16	6 / 16

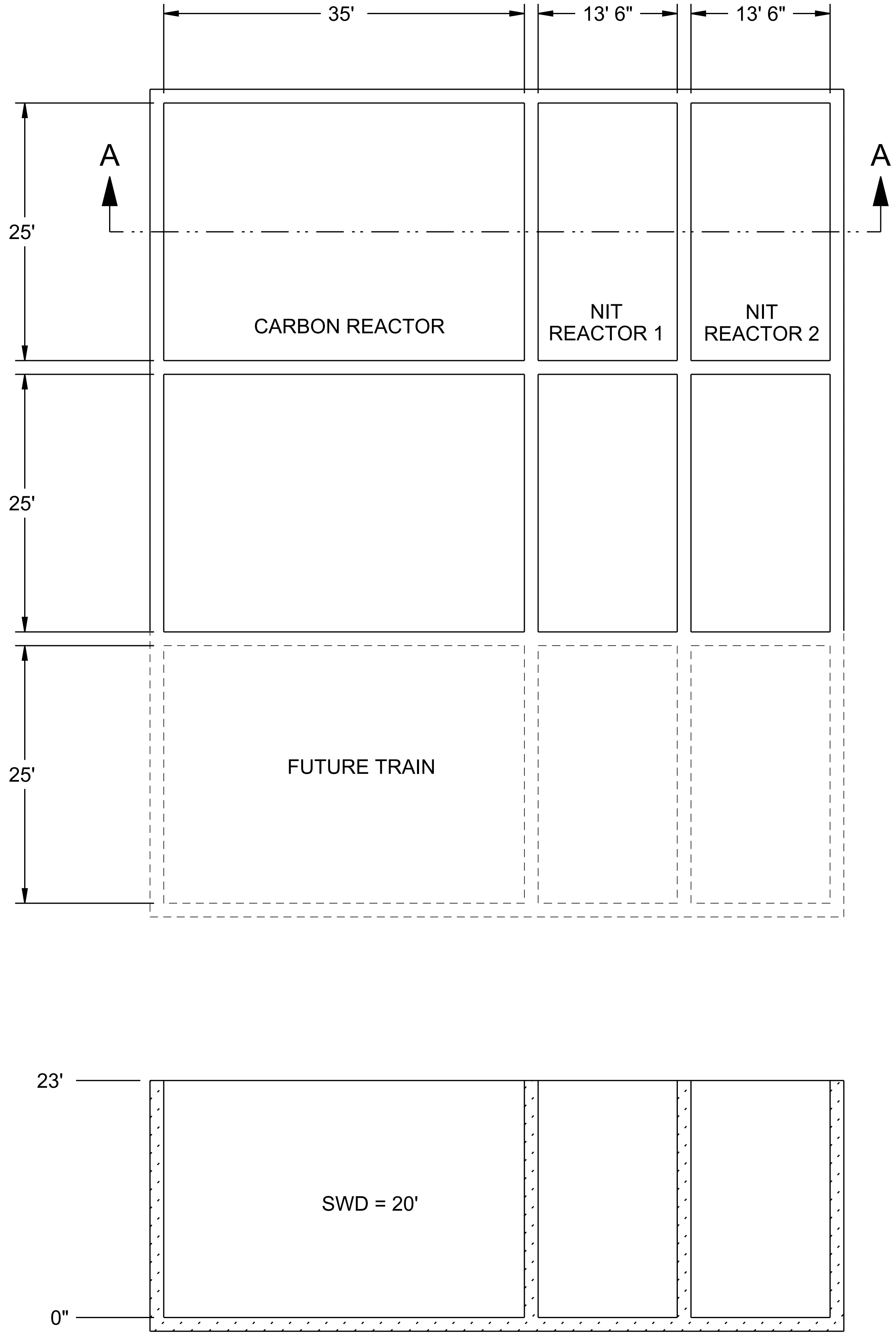
* Assumed values.

Table 2: Effluent Objectives (30 Day Average)

Parameter	Units	Value
Soluble $cBOD_5$	mg/L	≤ 10.0
NH_3-N (Summer)	mg/L	≤ 1.7
NH_3-N (Winter)	mg/L	≤ 8.7

Table 3: Process Design Summary

-Parameter	Units	Phase I	Phase II	Phase III
Process Trains	-	2	2	3
Aerobic Carbon Removal Reactors per Train	-	1	1	1
Aerobic Nitrification Reactors per Train	-	2	2	2
C-Stage Reactors				
Dimensions (Each)	ft	35 L x 25 W x 20 SWD	35 L x 25 W x 20 SWD	35 L x 25 W x 20 SWD
Volume (Each)	ft^3	17,500	17,500	17,500
Volume (Total)	ft^3	35,000	35,000	52,500
Media Type:	-	K5	K5	K5
Fill of Biofilm Carriers	%	29	55	55
Nitrification Reactors				
Dimensions (Each)	ft	13.5 L x 25 W x 20 SWD	13.5 L x 25 W x 20 SWD	13.5 L x 25 W x 20 SWD
Volume (Each)	ft^3	6,750	6,750	6,750
Volume (Total)	ft^3	27,000	27,000	40,500
Media Type:	-	K5	K5	K5
Fill of Biofilm Carriers	%	29	54	54
Aeration System Type	-	Medium Bubble	Medium Bubble	Medium Bubble
Min. Anticipated Residual DO, Max. Month	mg/L	4 - 5	4 - 5	4 - 5
Total Media Volume	ft^3	18,008	33,756	50,635
Total Media Protected Surface Area	ft^2	4,391,675	8,232,239	12,348,358
Total Process Air Requirement (All Trains)	SCFM	800	1,530	2,168
Total Mixing Air Requirement (All Trains)	SCFM	2,170	2,170	3,255
Discharge Pressure (Top of Drop Pipe)	psi	~ 9	~ 9	~ 9
Effluent TSS, Max Month	mg/L	305	305	305
Recommended Freeboard	ft	2-3	2-3	2-3



SECTION A-A

Phase I: Construct two trains with three reactors. Outfit each reactor with 30% media, cylindrical screens, airgrids, and I&C.
Phase II: Add K5 media to increase reactor fill to 55%
Phase III: Construct new identical 3rd treatment train.

1503217	A.0	Released	1503217	A.0	Released

REV	DESCRIPTION	DRAWN	APPR	DATE
A	PRELIMINARY RELEASE	JCC	.	01.20.16

VEOLIA
krugerusa.com

ANOXKALDNES
CONCRETE, PLAN AND SECTIONS

5700102501
PALMER, AK

SCALE	DRAWING NO	SHEET	REV
1:180	1503217	1 of 1	A

Scope of Supply

Kruger is pleased to present our scope of supply which includes process engineering design, equipment procurement, and field services required for the proposed treatment system, as related to the equipment specified. The work will be performed to Kruger's high standards under the direction of a Project Manager. All matters related to the design, installation, or performance of the system shall be communicated through the Kruger representative giving the Engineer and Owner ready access to Kruger's extensive capabilities.

Process and Design Engineering

Kruger will provide process engineering and design support for the system as follows:

- Process Engineering consisting of aeration system sizing and configuration, sieve and outlet design.
- Review and approval of P&I Diagram for the AnoxKaldnes MBBR System portion of the process. Preliminary General Arrangement Drawings and review and approval of final General Arrangement Drawings for the process. Review of reactor drawings with respect to penetrations and dimensions, excluding structural design.
- Equipment installation instructions for all equipment supplied by Kruger.

Field Services

Kruger will furnish a Service Engineer to perform the following tasks:

- Inspect installation of key pieces of equipment during construction.
- Inspect the completed system prior to startup.
- Assist the Contractor with initial startup of the system.
- Train the Owner’s staff in the proper operation and maintenance of the AnoxKaldnes MBBR System.
- Test and start any Kruger-supplied control equipment, including PLC programming and SCADA systems.

AnoxKaldnes MBBR System Equipment – Phase I

Process and Mechanical Equipment Items	Qty	Description
AnoxKaldnes K5 Media, (ft^3)	18,008	High density polyethylene carrier elements.
Cylindrical Screen Assemblies	12	One (1) per reactor. 304L SS. 23" ø perforated plate pipes terminated in ANSI flanges for mounting directly to the tank wall.
Medium Bubble Aeration system	6	One (1) aeration system per reactor. 304L SS including header, lateral piping, and hardware (excluding anchor bolts).
Instrumentation and Controls Equipment Items	**Qty**	**Description**
High Level Float Switch	2	One (1) for each process train.
Dissolved Oxygen Probes	6	One (1) for each aerobic reactor
PLC Control Panel	1	NEMA 12 Freestanding or Wall Mount Control Panel (For Indoor Use). ControlLogix PLC; Panelview HMI; 120V Feed.

AnoxKaldnes MBBR System Equipment – Phase II Additional

Process and Mechanical Equipment Items	Qty	Description
AnoxKaldnes K5 Media, (ft^3)	15,748	High density polyethylene carrier elements.

AnoxKaldnes MBBR System Equipment – Phase III Additional

Process and Mechanical Equipment Items	Qty	Description
AnoxKaldnes K5 Media, (ft^3)	16,879	High density polyethylene carrier elements.
Cylindrical Screen Assemblies	6	One (1) per reactor. 304L SS. 23" ø perforated plate pipes terminated in ANSI flanges for mounting directly to the tank wall.
Medium Bubble Aeration system	3	One (1) aeration system per reactor. 304L SS including header, lateral piping, and hardware (excluding anchor bolts).
Instrumentation and Controls Equipment Items	**Qty**	**Description**
High Level Float Switch	1	One (1) for each process train.
Dissolved Oxygen Probes	3	One (1) for each aerobic reactor
PLC Control Panel	1	NEMA 12 Freestanding or Wall Mount Control Panel (For Indoor Use). ControlLogix PLC; Panelview HMI; 120V Feed.

Notes Regarding System Design and Installation

- For any MBBR or IFAS system, regardless of manufacturer, the quality and finish of reactor surfaces is important for the long-term longevity of the system. AnoxKaldnes has years of experience in the design and manufacture of MBBR and IFAS systems, with the quality and texture of the finished reactor walls is important. It is particularly important to prevent chipping, holidays, or rough areas that would leave open any annular spaces around media retention screens.

Scope of Supply BY INSTALLER/PURCHASER

The contractor's scope of supply for the AnoxKaldnes MBBR System system should include, but is not limited to, the following items:

- All civil/site and electrical work.
- A concrete foundation for the tanks.
- Reactors to house the MBBR treatment equipment.
- All provisions for interconnecting piping.
- Unloading, storage and installation of equipment.
- Centrate equalization tanks
- Cover for reactor tanks

Design Options

In addition to the proposed system as detailed herein, Kruger is able to further incorporate our process and controls expertise into wastewater treatment plants, allowing municipalities to meet stringent effluent requirements and future plant upgrades. Kruger is also able to offer our instrumentation and controls expertise to build upon the proposed system by providing a **customized plant-wide SCADA system** or designing a **Motor Control Center (MCC)**, providing clients a single source responsibility for plant controls. Please contact Kruger if the options above are of interest or to be included in the current proposed system or future upgrades. ***Please note that the design options listed above are not included in the pricing noted herein.*

Schedule

- Shop drawings will be submitted within 6-8 weeks of receipt of an executed contract by all parties.
- All equipment will be delivered within 18-20 weeks after receipt of written approval of the shop drawings.
- Installation manuals will be furnished upon delivery of equipment.
- Operation and Maintenance Manuals will be submitted within 90 days after receipt of approved shop drawings.

Pricing

The price for the AnoxKaldnes MBBR System, as defined herein, including process and design engineering, field services, and equipment supply is:

Phase I $885,000.

Pricing is FOB shipping point, with freight allowed to the job site. This pricing does not include any sales or use taxes. In addition, pricing is valid for ninety (90) days from the date of issue and is subject to negotiation of a mutually acceptable contract.

Please note that the above pricing is expressly contingent upon the items in this proposal and are subject to I. Kruger Inc. Standard Terms of Sale detailed herein.

Kruger Standard Terms of Payment

The terms of payment are as follows:

- 10% on receipt of fully executed contract
- 15% on submittal of shop drawings
- 75% on the delivery of equipment to the site

Payment shall not be contingent upon receipt of funds by the Contractor from the Owner. There shall be no retention in payments due to I. Kruger Inc. All other terms per our Standard Terms of Sale are attached.

All payment terms are net 30 days from the date of invoice. Final payment not to exceed 120 days from delivery of equipment.

I. Kruger Inc. Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of the equipment and related services, if any (collectively, "Equipment"), referred to in Seller's purchase order, quotation, proposal or acknowledgment, as the case may be ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation provides otherwise, freight, storage, insurance and all taxes, duties or other governmental charges relating to the Equipment shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval.

3. Delivery. Delivery of the Equipment shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, Delivery terms are F.O.B. Seller's facility.

4. Ownership of Materials. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Equipment. Buyer shall not disclose any such material to third parties without Seller's prior written consent.

5. Changes. Seller shall not implement any changes in the scope of work described in Seller's Documentation unless Buyer and Seller agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. This includes any changes necessitated by a change in applicable law occurring after the effective date of any contract including these terms.

6. Warranty. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from beneficial use, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO SECTION 10 BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

7. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

8. Force Majeure. Neither Seller nor Buyer shall have any liability for any breach (except for breach of payment obligations) caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, delay of carriers, failure of normal sources of supply, act of government or any other cause beyond such party's reasonable control.

9. Cancellation. If Buyer cancels or suspends its order for any reason other than Seller's breach, Buyer shall promptly pay Seller for work performed prior to cancellation or suspension and any other direct costs incurred by Seller as a result of such cancellation or suspension.

10. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

Miscellaneous. If these terms are issued in connection with a government contract, they shall be deemed to include those federal acquisition regulations that are required by law to be included. These terms, together with any quotation, purchase order or acknowledgement issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. Buyer may not assign or permit any other transfer of the Agreement without Seller's prior written consent. The Agreement shall be governed by the laws of the State of North Carolina without regard to its conflict of laws provisions.

World water works
Clean Water and Energy from Wastewater

DATE: June 16, 2015
TO: Ryan Moyers, HDR
FROM: Chandler Johnson, World Water Works, Inc. (WWW)
RE: WWW PROPOSAL – Palmer, K

Dear Ryan Moyers,

Thank you for the opportunity to allow World Water Works' to provide the following proposal. WWW's products are designed to achieve long term, highly efficient and economical performance.

Founded in 1998, WWW is headquartered in Oklahoma City, OK with offices throughout the US and India. Our core competency continues to be designing, manufacturing, integrating and delivering the highest quality water, process and wastewater technology in the field. Our passion for and dedication to our customers' success has fueled our global growth and has led to numerous awards. We continue to successfully deliver products and projects on every major continent.

We ask that you respect the confidentiality of this information within your organization. Please do not hesitate to call me with any questions you may have and/or to begin the process of procuring the items quoted. Thank you for your time and consideration.

Best Regards,

Chandler Johnson

Chandler Johnson
World Water Works, Inc.

4000 SW 113th St. ~ Oklahoma City, OK 73173 ~ 1(405)-ANAMMOX

CONFIDENTIAL

World water works

Clean Water and Energy from Wastewater

PROPOSAL

1. DESIGN ASIS

Project Goals:		Discharge Compliance	
Facility Information:			
Type of Industry		Municipal: Municipal POTW	
Elevation at Site (ft)		250	
Flow Information:			
Initial Avg. Month Flowrate (GPD)		1,000,000	
Initial Avg. Month Flowrate (GPM)		694	
Future Avg. Month Flowrate (GPD)		1,500,000	
Future Avg. Month Flowrate (GPM)		1,041.7	
Max. Month Flowrate (GPD)		1,875,000	
Max. Month Flowrate (GPM)		1,302	
Design Parameters:	**Units**	**INFLUENT**	**EFFLUENT**
Biochemical Oxygen Demand (BOD)	mg/L	296	30
Total Suspended Solids (TSS)	mg/L	296	30
TKN	mg/L	47	
Ammonia Nitrogen (NH3 N)	mg/L	32	1
pH		7.5	
Maximum Temperature	°F	52	
Average Temperature	°F	48	
Minimum Temperature	°F	42	

2. SCOPE DOCUMENT

Project Mgt, Eng & Design

Quantity	Model	Equipment Description	Description	Provided By
1.0	DRAW AP	Process Engineering, Design & Project Management		WWW

Transfer System 1				
Quantity	**Model**	**Equipment Description**	**Description**	**Provided By**
2.0	*PUMP-TR-1500*	*Transfer Pump*		*Others*
2.0	*VFD-0300*	*Variable Frequency Drive*		*Others*
1.0	*LC-LT-Submersible-20*	*Level Control*		*Others*

Prescreen				
Quantity	**Model**	**Equipment Description**	**Description**	**Provided By**
1.0	*SCREEN-*	*Screen*		*Others*

World water works
Clean Water and Energy from Wastewater

Biological Process				
Quantity	**Model**	**Equipment Description**	**Description**	**Provided By**
1764.0	MBBR MEDIA ABC 5R	MBBR Media	Cubic meters of media for all reactors at 1.5 MGD Design Flow Rate	WWW
4.0	MANI LT06	MBBR Manifolds	Two (2) Aeration grids each 27 ft long x 7 ft wide in each reactor	WWW
2.0	MANI LT06	MBBR Manifolds	Two (2) Aeration grids each 27 ft long x 7 ft wide	WWW
2.0	MANI LT06	MBBR Manifolds	Two (2) Aeration grids each 27 ft long x 7 ft wide	WWW
8.0	MBBR SIEV 1150K	MBBR Sieve	One (1) Media retention sieve in each reactor	WWW
2.0	*TANK-MBBR-*	*MBBR Reactor Tank*	BOD reactors 30 ft x 30 ft x 18 ft SWD (each)	*Others*
1.0	*TANK-MBBR-*	*MBBR Reactor Tank*	Nit 1 reactor 40 ft x 30 ft x 18 ft SWD	*Others*
1.0	*TANK-MBBR-*	*MBBR Reactor Tank*	Nit 2 reactor 30 ft x 30 ft x 18 ft SWD	*Others*
3.0	Blow 2000 L	Blower	Total Air Flow required – 3510 SCFM at 8.2 psig at 1.5 MGD Design Flow Rate	WWW
3.0	VFD 1500	Variable Frequency Drive		WWW

Biological Process				
2.0	PM	DO robe(s) Controller		WWW
2.0	CHEM CS1 CS	Antifoam Feed System		WWW

Secondary Separation				
Quantity	**Model**	**Equipment Description**	**Description**	**Provided By**
2.0	*DAF-RSP-17S*	*Dissolved Air Flotation*		*Optional*
2.0	*BUB-NIK-M50SP-2-S-V-B*	*Microbubble Generation System*		*Optional*
1.0	*BUB-*	*Microbubble Generation System*		*Optional*
2.0	*PLAT-PB-S*	*Platform*		*Optional*
1.0	*PLAT-PE-17S*	*Extended Platform*		*Optional*
2.0	*PUMP-AOD-300-Al*	*Sludge Pump*		*Optional*
1.0	*CHEM-CS1-EP-66*	*Auto Polymer Dilution & Feed System*		*Optional*

Controls & Electrical				
Quantity	**Model**	**Equipment Description**	**Description**	**Provided By**
1.0	*CTRLS-*	*Low Voltage Electrical Cabinet*		*Optional*
1.0	*CTRLS-HV*	*High Voltage Electrical Cabinet*		*Optional*

Miscellaneous				
Quantity	**Model**	**Equipment Description**	**Description**	**Provided By**
1.0	*AIRCOMP-20*	*Air Compressor*		*Optional*

QC & Shipping				
Quantity	**Model**	**Equipment Description**	**Description**	**Provided By**
1.0	QCSH	Quality Control		WWW
1.0	QCSH	Shipping & Handling		WWW

Startup and Training

Quantity	Model	Equipment Description	Description	Provided By
1.0	SERV FS 20	Startup and Training Services		WWW

Warranty

Quantity	Model	Equipment Description	Description	Provided By
1.0	WTY 1/10	Warranty		WWW

3. SHIPPING

FOB Point	FOB Origin
Shipping & Handling Terms	Prepay & Add

4. PAYMENT TERMS

20% Upon approval of Shop Drawings
70% Upon Delivery of Equipment (Net 30 Days)
10% Upon Startup (Net 90 Days From Shipping)

5. PRICE

TOTAL:	For Treating 1.0 MGD	$ 1,400,000 USD
TOTAL:	For Treating 1.5 MGD	$ 2,000,000 USD

Shipping (Estimate): $ TBD

Optional AF's or SS emoval $550,000 USD

This includes the specified equipment and ervices n he cope ection abeled WWW", but are not inclusive of any of the items labeled "BY OTHERS", "OPTIONAL", "EXISTING", or the responsibilities under the attached "TERMS and CONDITIONS". This pricing also does not include any pplicable local, state, and federal sales and use taxes, tariffs, duties, import taxes, bonding, system stallation costs and equipment shipping osts beyond what is stated.

6. DRAFTING ENGINEERING SERVICES

World Water Works offers a variety of drafting and engineering package options from basic packages to complete process design solutions. Please let us know if anything more than a general product layout drawing would be requested for this purchase and we can add the applicable costs to the quote.

7. FIELD STARTUP, TRAINING SERVICES

World Water Works offers a variety of field startup and training services. Please inquire if you would like to add a ackage. o ield ervice as equested t his ime. ny nsite upport requirements will be billed at $1,000/day plus expenses and will be billed at a minimum of 2 days.

8. MECHANICAL WARRANTY

Equipment ill e arranted rom efects aterials, orkmanship and design for a period of 12 months from the date upon which the goods are used or put into operation or 18 months from shipment, whichever ccurs irst. ny olypropylene vessel will be warranted from defects in materials, workmanship and design for a period of 10 years from the date of shipment. Warranty is contingent upon the system being stored, installed, operated and maintained in accordance with World Water Works' instructions. Extended warranties are available for an additional cost.

9. TERMS & CONDITIONS

1. Offer Validity. This ffer nd rice alid or 0 ays.
2. Acceptance. he erms nd onditions f his ffer hall pply nd ecome art f he contract between Seller and Buyer. Any conflicting terms and conditions in any purchase order, acknowledgement or other document utilized by Buyer in this transaction, are expressly rejected by Seller.
3. Seller's Limited Warranty. Seller warrants the goods against defects in workmanship and materials under normal and proper use and operating conditions for a period of twelve (12) months from ate f hipment Seller's imited arranty).
4. Limitation of Remedies. In the event of any failure of goods to perform as warranted, Seller will, at eller's ole ption, eplace r epair goods, or refund the purchase price of defective portion of goods supplied to Buyer, all other costs, including shipping costs, excluded. In o event hall eller e responsible for any INCIDENTAL, PUNITIVE OR CONSEQUENTIAL damages, or damages from tort arising out of or in connection with the use of goods, including without limitation the loss of contents.
5. Force Majeure. Shipping and delivery dates are approximate and are based upon Seller's ability to btain ll ecessary bor, aterials nd arts nd, where applicable, the receipt of all necessary information, plans or specifications from Buyer.
6. Taxes. eller's rices o ot clude ales, xcise r imilar axes vied y overnment authority, ither oreign r omestic.
7. Cancellation, etc. Buyer's cancellation of any order is required to be in writing, and Buyer is subject o ay ancellation ee qual o 5% f he otal urchase rice lus ll on recoverable costs and expenses.
8. Law. he ights nd bligations f he arties hall be governed by the domestic laws of the State of Oklahoma without regard to its conflict of law rules or the United Nations Convention for the International Sale of Goods.
9. Arbitration. ny ispute, ontroversy r laim rising nder his greement hall be settled by arbitration in Oklahoma City, Oklahoma, pursuant to the American Arbitration Association rules.
10. Entire Agreement. This Offer contains the entire agreement between Seller and Buyer, and no modification of this Offer shall be binding upon Seller unless evidenced by an agreement in writing signed y n xecutive fficer f eller fter he ate ereof. o ral r ritten tatements y eller's sales epresentatives, r ther gents, ade fter he ate ereof hall odify r ary he xpress terms hereof unless evidenced by an agreement in writing signed by an executive officer of Seller after the date hereof. To the extent any advertising or promotional material of Seller contradicts or disagrees with the terms hereof, Seller and Buyer agree that the terms hereof shall control and that such advertising and/or promotional materials are not part of the agreement between Seller and Buyer.
11. Confidentiality of Proposal. All terms and conditions of this Offer shall be held in strict confidentiality by the Buyer and shall not be divulged by the Buyer to any other person or entity without the express prior written approval of Seller.

Meteor®

MBBR System

BUDGET PROPOSAL

Project : Palmer, AK WWTP

Engineer : HDR

Proposal No : 50167905.01

Date : August 23, 2016

REGIONAL BUSINESS MGR.

PAUL RAVELLI
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treatment solutions | North America

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August 23, 2016

Mr. J. Ryan Moyers, P.E.
HDR, Inc.

Re: Palmer, AK WWTP
Proposal # 50167905.01

Dear Mr. Moyers;

Thank you for considering SUEZ Treatment Solutions, Inc. (SUEZ) for the Palmer, AK WWTP. With regard to your recent request, SUEZ is pleased to submit its proposal for a **METEOR® MOVING BED BIOLOGICAL REACTOR (MBBR)** system.

The MBBR process has been designed for a design average flow of 1.2 MGD initially with the ability to add media to achieve 1.8 MGD and a max hydraulic flow of 2.20 MGD by implementing a METEOR® system.

We have endeavored to provide complete information in this proposal. However, if you have any questions or need additional information, please feel free to contact Paul Ravelli, our Regional Business Manager, Joe Buckman, our local representative, or me directly.

Sincerely,

Brian McGovern
Senior Process Engineer - Biological Systems Group

TABLE OF CONTENTS

PROCESS DESCRIPTION

The proposed biological process is a **METEOR® MBBR FOR COD AND AMMONIA NITROGEN REMOVAL**, which is a **MOVING BED BIOLOGICAL REACTOR (MBBR)**. This design consists of NUTRICELL™DTı biofilm carriers, carrier retaining screens and an aeration system. This process employs proprietary mobile biomass carriers (**NUTRICELL™DTı**) to support a very high concentration of attached biomass. The neutrally buoyant HDPE NUTRICELL™DTı biofilm carriers within the bioreactor tank provide a stable base for the growth of a diverse community of micro-organisms.

The attached growth biofilm carriers have a very high surface-to-volume ratio, allowing for a high concentration of biological organisms to thrive within the internally protected areas. The detached biomass from the biofilm carriers will remain suspended within the Fluidized Fixed Film reactor, and is continuously removed from the process by the existing flow stream, resulting in an operator free biological system.

METEOR® PROCESS ADVANTAGES:

- ✓ **INCREASED NITRIFICATION** – Total biofilm retention in basin. Micro-organisms on the biofilm carriers have extended retention time and proliferate resulting in consistently low effluent Total Nitrogen
- ✓ **IMPROVED PROCESS STABILITY** – during peak flow conditions resulting from retention of biomass in treatment basin
- ✓ **NUTRICELL™DTı** - biofilm carriers were specifically designed for hybrid applications allowing large screen openings and biofilm carrier apertures. Local production in the US minimizes shipping, duties and installation time.
- ✓ **FIELD PROVEN AT FULL SCALE** – These systems have recently been selected for similar plants such as Falling Creek WWTP, VA, Proctor's Creek WWTP, VA, East Providence WWTP, RI, Martinsburg WWTP, WV.
- ✓ **UPGRADE WITHIN EXISTING BASIN** – Enables the upgrade of conventional activated sludge plants without additional real estate.

Conventional activated sludge processes may experience inconsistent Nitrification and denitrification at low Solids Retention Times (SRT) due to fluctuations in flow and operation. The biomass retention offered by biofilm carriers maintains a stable population of autotrophic bacteria, despite flow variation that would otherwise cause washout. The fixed film nature of NUTRICELL™DTı prevents washout, and provides a larger biomass population, resulting in a consistent effluent at lower suspended solids SRTs.

Biomass retention on the carriers enables a much lower solids load downstream, as the biofilm is retained in the aeration basin. The biofilm thickness and mass is self-regulating, responding to both high and low influent mass loadings.

FIGURE 1. NUTRICELL™DT3 Biomass carrier with biofilm growth, as an example

DESIGN SUMMARY

The proposed system is based on the following design conditions:

INFLUENT WATER QUALITY†		
	PHASE 1	PHASE 2
DESIGN MAX MONTH FLOW	1.2 MGD	1.8 MGD
DESIGN PEAK HYDRAULIC FLOW	1.5 MGD	2.20 MGD
cBOD5	≤ 282 mg/L	≤ 282 mg/L
TSS	≤ 310 mg/L	≤ 301 mg/L
TKN	≤ 47.9 mg/L	≤ 47.9 mg/L
AMMONIA	≤ 32.1 mg/L	≤ 32.1 mg/L
TEMPERATURE	> 5 ˚C	> 5 ˚C
† The proposed design is preliminary and based on the above water quality information. Final influent water quality range must be defined for SUEZ to confirm the proposed design. Please advise SUEZ with any changes to the influent water quality		

EFFLUENT WATER QUALITY†	
	PHASE 1 & PHASE 2
cBOD5	≤ 10 mg/L
TSS	≤ 20 mg/L
AMMONIA	≤ 1.0 mg/L
† The proposed design is preliminary and based on the above water quality information. Final effluent water quality range must be defined for SUEZ to confirm the proposed design. Please advise SUEZ with any changes to the effluent water quality	

DESIGN SUMMARY

SUEZ has designed and proposes a METEOR® MBBR system with an aerobic reactor, a design that effectively meets all the specified design requirements and achieves the desired effluent quality.

1. **DESIGN** - The METEOR® process will be implemented in two new concrete tanks provided by others with the addition of biofilm carriers and installation of screens and an aeration system. System setup is based on the increased ability of the modified system to bring about BOD and ammonia nitrogen reduction due to the addition of biofilm carriers. This process is ideal for achieving low effluent levels required. The tank volume is based on treating the future Phase 2 design flow of 1.8 MGD.

2. **CHEMICAL FEEDS** – Based upon the influent water quality provided a supplemental phosphorous feed system in the form of phosphoric acid may be required for the bacteria population. If required, SUEZ is willing to include this feed system in its scope if requested by the Client. In addition to phosphoric acid, a supplemental alkalinity feed system in the form of caustic soda may be required to be added to the aeration tank to maintain the proper operating pH in the reactor due to the high level of ammonia concentrations that need to be removed in the system. If required, SUEZ is willing to include this feed system in its scope if requested by the Client.

3. **MEDIA** - NUTRICELL™DTI3 biofilm carriers will be added to the tanks, resulting in increased biomass concentrations due to the active biomass growth on the biofilm carriers. The media fill fraction to meet the Phase 1 design flow of 1.2 MGD is equal to 35% while the media fill fraction to meet the future design flow of 1.8 MGD is equal to 50%. The initial amount of media provided for the current condition is equal to 1,140 m^3. The additional quantity of media required to meet the future design condition of 1.8 MGD is equal to 488 m^3 for a total amount of media equal to 1,628 m^3.

4. **AERATION SYSTEM** – Our proposal includes the cost of providing a complete new coarse bubble diffused aeration system. Air will be supplied to the aeration and reaeration tanks by means of new blowers supplied by SUEZ. Three blowers with a rated capacity of 1,985 scfm will be provided. Two duty and one standby blower will be supplied.

5. **MEDIA RETAINING SCREENS** – Our proposal includes the cost of providing cylindrical retaining screens in each zone of the two trains. The number of screens provided will be able to treat the future maximum hydraulic flow of 2.20 MGD.

6. **SOLIDS SEPARATION** – The anticipated effluent TSS concentration exiting the proposed MBBR system will be approximately 300 mg/L. An additional solids separation step will be required to meet effluent TSS < 20 mg/L. The SUEZ/Poseïdon PPM Model 550-E can be provided if requested by the Client. The dissolved air flotation clarifier provided will be able to treat the future maximum hydraulic flow of 2.20 MGD if requested by the Client. An additional solids separation step will be required after the DAF to meet effluent TSS < 10 mg/L. Suez can provide an additional filtration step to meet < 10 mg/L.

DESIGN SUMMARY

SYSTEM DESIGN		
	PHASE 1	PHASE 2
Design Flow	1.2	1.8
Peak Hydraulic Flow	1.5	2.20
Number of MBBR Trains	2	2
Aeration Zone Volume Per Train	430,000	430,000
Aeration Zone Volume Total	860,000	860,000
Media Type	NUTRICELL™ DTi3	NUTRICELL™ DTi3
Media Surface Area	630	630
Media Fill – Aerobic Zone	35	50
Media Volume Aerobic Zone Per Train	570	814
Media Volume Aerobic Zone Total	1,140	1,628
Cylindrical Screens (12” dia. X 72” L) Per Train	2	2
Cylindrical Screens (12” dia. X 72” L) Total	4	4
Process Air Required (11 deg C) Per Train	1,515	1,985
Process Air Required (11 deg C) Total	3,030	3.970
Approx. Inside Length Dimension Per Train	89	89
Approx. Inside Width Dimension Per Train	36	36
Approx. Inside Height Dimension Per Train	20	20
Side Water Depth	18	18
Number of Dissolved Air Flotation Units	1	1
Model Number	PPM 550-E	PPM 550-E
Approx. Length Dimension	32.75	32.75
Approx. Width Dimension	15	15
Approx. Height Dimension	13.83	13.83

DESIGN SUMMARY

AERATION SYSTEM

The air requirement is based on the estimated amount of oxygen required and the amount of air needed to thoroughly mix the bioreactor. The total air requirement for the proposed design is indicated in the table above. Note that this air requirement is based on a coarse bubble air diffusion system at **20 ^{O}C**.

The aeration system will consist of a 304L stainless steel vertical drop leg including elbow and vertical flange for connection to the air main. Upstream piping of the flanged elbow will be provided by others. The drop leg will be connected to a 304L stainless steel manifold which will have further connections to each air distributor header. The manifold pipes will be provided with stainless steel supports, hold down straps, cradle, and adjusting/locking mechanism. The 304L stainless distribution headers will consist of factory installed diffuser holders, positive locking anti-rotational joint connections, support stands with hold down clamps, locating plates, and anchor bolts. The aeration system for each grid will be complete with a purge system with eductor piping and isolation valve.

The **COARSE** bubble aeration system is provided due to its primary advantage of high oxygen transfer efficiency and consequent lower maintenance requirements as compared to fine air bubble aeration system. The aeration system and process air blower system has been included in the scope of supply.

CARRIER RETAINING SCREENS

The system will consist of **12” DIAMETER X 72” LONG** cylindrical media carrier retaining screens. The cylindrical screens can be flange or slide-in mounted. The screens are manufactured from 304L stainless steel wedge wire. Each screen has abundant open area, with slot widths of 3/8” (10 mm) to provide excellent flow capacity. The biomass carriers constantly scour the screen surfaces and keep it free from debris. The large size of biomass carriers enables large screen openings, resulting in significantly reduced head loss across the screens, and less of a tendency to foul. The head loss through the screens is expected to be less than 0.5 inch. The total number of screens is based on hydraulically handling the maximum flow of 2.20 MGD through both trains.

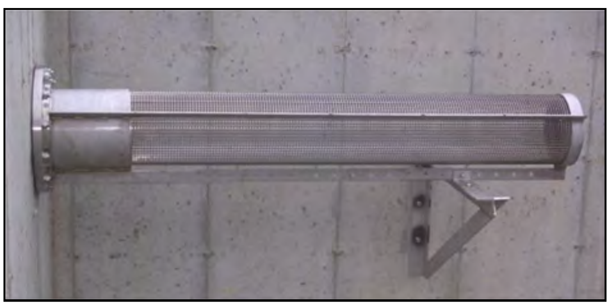


FIGURE 2 Typical Cylindrical Screen

AIR SCOUR SYSTEM

One duty and one standby blower dedicated for the air scour associated with the carrier retaining screens rated for 250 scfm will be provided. Scour air will be introduced at set time intervals throughout each day in order to ensure that the carrier retentions screens do not build unnecessary headloss. A separate dedicated blower system is provided in order that the aeration control in the oxic zones is unaffected when the scour air is introduced into the system. This allows for better aeration controls in the oxic zones and leads to less dramatic fluctuations in the operation of the dedicated blowers associated with the aeration introduced into the oxic zones.

DESIGN SUMMARY

SUPPLEMENTAL PHOSPHOROUS FEED SYSTEM

Supplemental phosphorous may be needed for the METEOR® process. Phosphoric acid feed pumps can be provided if requested by the Client. One duty and one standby pump will be provided in order to introduce phosphorous prior to entering each of the METEOR® process trains.

SUPPLEMENTAL PH/ALKALINITY FEED SYSTEM

A supplemental pH/alkalinity source may be required to maintain the proper pH and alkalinity levels in the aerobic zones for the MBBR process. Caustic feed pumps can be provided if requested by the Client. The estimated caustic dosage required to maintain the influent pH is equivalent to approximately 95 mg/L of 50% commercially available caustic soda.

SUEZ/POSEÏDON PPM DISSOLVED AIR FLOTATION UNIT

If requested by the Client, the SUEZ/Poseidon PPM® 550-E DAF unit will be provided that uses dissolved air flotation technology to remove suspended solid particles from the water. The DAF unit will be a 304 stainless steel tank package unit equipped with a Poseipump recirculation pump and sludge scraper and sludge thickener system. Clean and dry compressed air capacity of 5.5 scfm supplied by the Client at a minimum pressure of 70 psi is required for the recirculation system.

Chemical feed pumps for the introduction of coagulant (ferric chloride) will be provided. Ferric chloride feed pumps will be provided with one duty pump, and one standby pump rated for 10 gph. Sizing of pumps based upon pumping commercially available 40% ferric chloride at a dosage of 50 mg/L.

Chemical feed pumps for the introduction of flocculant polymer will be provided. Two emulsion polymer feed pumps will be provided with one duty pump, and one standby pump rated for 0.5 gph. Sizing of pumps based upon pumping neat emulsion polymer at a dosage of 5 mg/L. Potable water may be required for assistance in delivery of neat polymer.

SCOPE OF SUPPLY – BY SUEZ

SUEZ proposes to furnish the following equipment and services for Phase 1:

QTY	ITEM	DESCRIPTION
1,140 m^3	Media	NUTRICELL™ DTI 3 Biofilm carriers delivered in supersacks
4	Media Retaining Screens	304L SS Cylindrical Biofilm Carriers Retaining Screens; 12" dia x 72" long Horizontal Cylindrical Screen Assemblies
2	Drain Screen	Drain Screen
2	Air diffusers	Coarse Bubble aeration system with diffusers, basin piping for c/w drop legs, flanged diffuser pipes, mounting brackets and connection fasteners.
3	Process Air Blower package	Process air blowers, two duty and one standby blower rated for 1,985 scfm.
1+1	Scour Air Blower package	Scour air blowers, one duty and one standby blower rated for 250 scfm.
2	MBBR Air Knife Equipment	Air knife assemblies with droplegs, flanged diffuser pipes, mounting brackets and connection fasteners
LOT	MBBR Air Valves	Process air control valves
LOT	MBBR Instrumentation	Six (6) DO Analyzers Two (2) Dual pH and Temperature Analyzer Two (2) Level Transmitter for MBBR Tanks Six (6) Thermal Mass Air Flowmeter
1	Control Panel	Allen-Bradley PLC, Panelview 600 HMI, NEMA 4X, FRP enclosure
LOT	O&M Manuals	As required
LOT	Submittals	Complete SUEZ standard set of engineering submittals
10	Field Services	Days of a SUEZ field service representative for installation inspection, commissioning and training in no more than three (3) trips. Additional days of field service are available on a per diem basis at $1,500/Day, plus travel expenses

SCOPE OF SUPPLY – BY SUEZ

SUEZ proposes to furnish the following equipment and services for Phase 2:

QTY	ITEM	DESCRIPTION
488 m^3	Media	NUTRICELL™ DTI 3 Biofilm carriers delivered in supersacks

SCOPE OF SUPPLY – BY OTHERS

The following items, but not limited to, shall be provided by Others:

- Supplemental Phosphorous Feed Pumps/System
- Supplemental pH/Alkalinity Feed Pumps/System
- Installation of any kind, unloading & placement of equipment from delivering carrier
- All concrete and civil works of any kind
- All blast, prime and finish painting of any mild components
- All access stairs
- All interconnecting piping from aeration grid manifold back to blower
- All interconnecting piping of any kind
- All required buildings and civil structures
- All other process systems
- All sludge sumps , sludge handling equipment and related equipment
- All inlet flow control and metering
- Any additional monitoring instruments (ph, turbidity, etc)
- All chemicals, bulk storage, containment and interconnecting piping
- All other field valves not specified herein
- Supply and installation of all electrical power and control wiring and conduit to the equipment served plus interconnections between the SUEZ equipment as required, including wire, cable, VFDs, MCCs, junction boxes, fittings, conduit, cable trays, safety disconnect switches, circuit breakers, etc.
- Install and provide all field wiring, wireways and supports
- All compressed air systems (if required)
- All taxes, tariffs, duties
- All embedded pipe sleeves
- All other necessary equipment and services not otherwise listed as specifically supplied by SUEZ

BUDGET PRICING

BUDGET PRICING	
Base Design Scope of Supply – By SUEZ	ADVISED BY REP
Adder Option 1 – Supplemental Phosphorous Feed Pumps/System	TBD
Adder Option 2 – Supplemental Alkalinity/pH Feed Pumps/System	TBD
Adder Option 3 – Dissolved Air Flotation System	TBD
Adder Option 4 – Filtration System	TBD
Adder Option 5 – Phase 2 Media Quantity	TBD

TERMS & CONDITIONS OF SALE

All budget pricing is based on SUEZ's standard terms & conditions, which can be provided upon request. This proposal is being provided for preliminary estimating purposes and is a non-binding offer. SUEZ reserves the right to update our scope of supply and cost due to market escalation, changes in the process approach or updated information regarding the design influent/effluent characteristics. SUEZ will not be responsible or liable in any manner for these costs until such time of our mutual execution of a definitive written agreement.

FREIGHT TERMS	
FOB	Jobsite

PAYMENT TERMS	
15%	Net Cash, Payable in thirty (30) days from date of submittal of initial drawings for approval
80%	Net Cash, Payable in progress payments thirty (30) days from dates of respective shipments of the Products
5%	Net Cash, Payable in thirty (30) days from Product installation and acceptance or sixty (60) days after date of final Product delivery, whichever occurs first

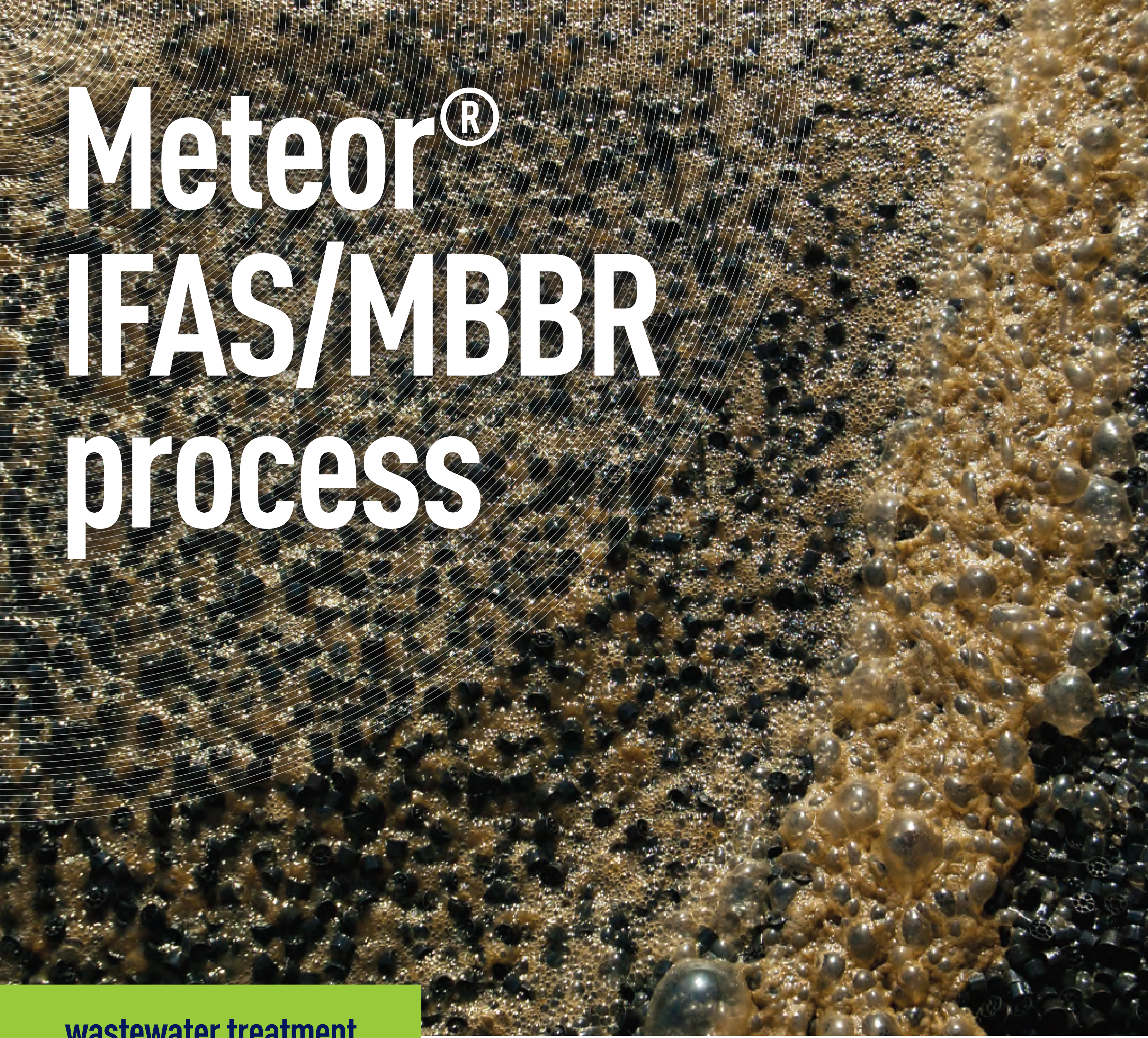
BUDGET PRICING

PRELIMINARY SCHEDULE	
Submittals	6-10 weeks following a fully executed agreement
Delivery	18-22 weeks following submittal approval

BROCHURE

Attached you will find product literature of the proposed system.

Meteor® IFAS/MBBR process



wastewater treatment

Meteor® IFAS/MBBR technology is based on proprietary polyethylene biofilm carriers, which, when added to a treatment basin, provide a large internal surface area for the growth of micro-organisms.

The Meteor® IFAS/MBBR technology offers flexible solutions to a multitude of biological process upgrade applications such as nitrogen removal, treatment capacity increase and wastewater reuse.

Carrier size, geometry and specific internal surface area are critical features. Our unique carriers have been designed with optimal performance in mind.

ready for the resource revolution

suez

how it works

IFAS, the integrated fixed film activated sludge (Meteor®) process incorporates the positive traits of two fundamental biological treatment processes, namely fixed-film technology and suspended growth technology (conventional activated sludge), together into one hybrid system.

By combining high biomass quantities typical of IFAS fixed-film technologies with fluidization typical of a conventional activated sludge (CAS), the Meteor® technology achieves high removal rates in a small volume.

Conventional activated sludge bioreactors are generally retrofitted with the addition of IFAS carrier retaining screens and modifications to the aeration grid to accommodate the addition of IFAS biofilm carriers. The media facilitates the growth of attached biomass and due to its size, is fluidized throughout the bioreactor.

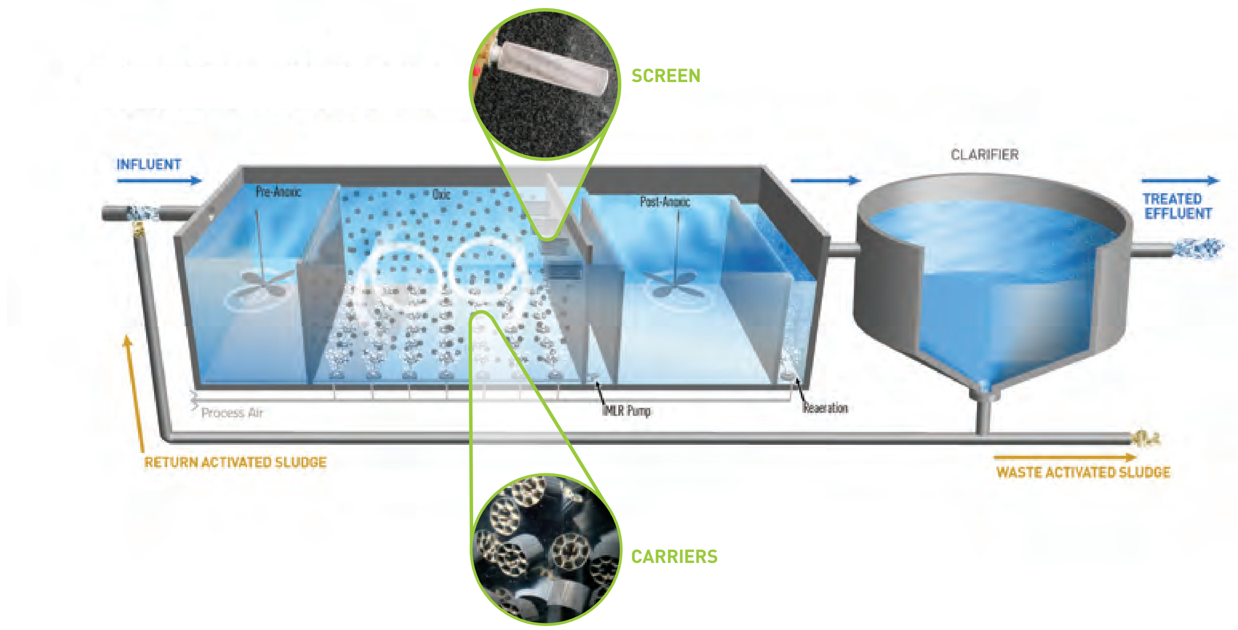
In MBBR systems all the biomass is supported on the biofilm carrier with no recycled activated sludge.

This attached growth significantly increases the microbial population within the tank, thereby increasing the SRT of the system without increasing the suspended growth population.

Such conditions are conducive to the proliferation of nitrifying autotrophic bacteria and can be designed to ensure that a sufficient population exists to maintain nitrification through cold water conditions when process kinetics slow down. The biofilm carriers can also be added to anoxic tanks to improve denitrification, if necessary.

These characteristics make Meteor® technology an attractive option for upgrading existing BOD removal facilities for nitrogen removal in response to new regulatory requirements without costly physical expansion. Since addition of biofilm carriers reduces/eliminates dependence on the suspended growth phase, this technology is also advantageous after secondary treatment where virtually no mixed liquor suspended solids (MLSS) are available.

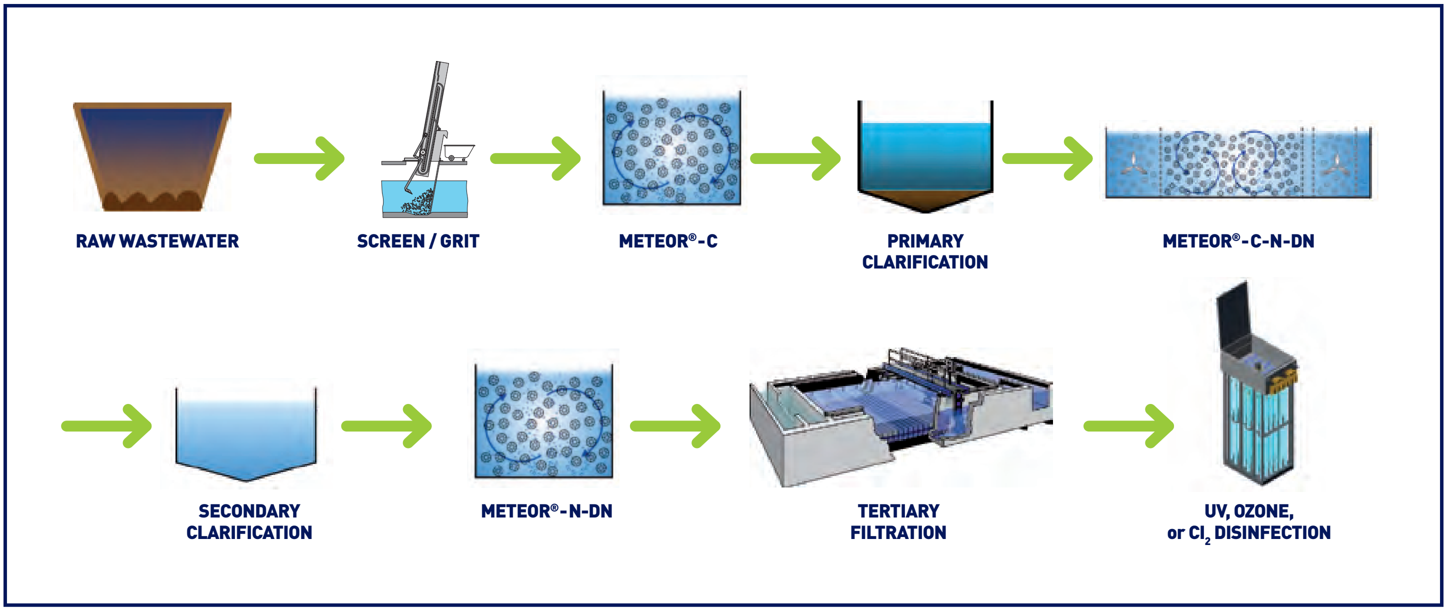
METEOR® : An easy-to-implement and cost effective way to upgrade WWTPs



main features

- **IFAS/MBBR systems were designed to optimize mass transfer, biomass density and contaminant removal rates through intensive research.**
- **The combination of large aperture area, high specific biomass and UV resistance makes Meteor® well suited for IFAS/MBBR applications.**
- **A 22mm diameter carrier offers the ability to utilize a larger screen mesh size, thereby minimizing headloss across the screen and the tendency to foul**
- **Highly resilient process for flow and contaminant loading variations**

Meteor® treatment line



technical advantages

biofilm carrier advantages

Multiple basin configurations are possible depending on existing installations and effluent objectives (i.e. roughing reactor before CAS for enhanced BOD removal, separate stage nitrification and/or denitrification following CAS, MLE process or 4-stage process for total nitrogen removal, or a 5-stage process for TN and TP removal).

- Unique biofilm carriers were developed specifically for IFAS/MBBR operation with high MLSS values – other media were designed for operation with no return sludge. The geometry of the carrier prevents overgrowth and provides excellent mass transfer.
- The biofilm carriers have larger apertures (internal openings) to prevent and resist clogging tendencies. The large apertures are designed to allow high mass transfer rates to promote active treatment productivity.
- The biofilm carriers are significantly larger than other free-floating media types. The larger media size allows installation of screens that have much larger openings. This mitigates the impact on overall plant headloss that can be a problem for processes employing smaller media.

biofilm carrier options

- Surface area - 450 m^2/m^3
- Surface area - 515 m^2/m^3
- Surface area - 630 m^2/m^3
- Surface area - 750 m^2/m^3

mechanical advantages

- The biofilm carriers are made from high quality High Density Polyethylene (HDPE), and unlike other media, are formulated with UV inhibitors for a long service life (twenty years or more) even in open basins exposed to constant sunlight.
- Meteor® process is compatible with both coarse and fine bubble aeration. Some competing media are not compatible with fine bubble due to reduced scour of small apertures in the media.

technical features

- **increased capacity of activated sludge basins by 100% to 200% with an in-basin retrofit**
- **Upgrade of existing BOD removal facilities to full nitrification and total nitrogen removal in response to new regulatory requirements:**
  - **Ammonia removal to < 1 mg/L NH3-N**
  - **Nitrate removal to < 1 mg/L NO3-N**
  - **Total Nitrogen removal to < 3 mg/L TN**
- **Suspended solids with better settling characteristics than that from conventional activated sludge**
- **Reduced suspended growth MLSS after a retrofit, resulting in reduced solids loading on the clarifiers**

» **Increase in oxygen transfer efficiency due to the presence of the media**

Meteor®
IFAS/MBBR process

integrated treatment solutions

As a full treatment line specialist, SUEZ draws upon a broad portfolio of proven technologies to assist industries and municipalities meet their water and waste water treatment challenges. We provide integrated equipment solutions and services for a wide range of applications:

- **industrial water and wastewater**
- **municipal drinking water**
- **municipal wastewater**
- **biosolids management**

We also offer global expertise in the design, build, operation and maintenance of water treatment plants and systems, all delivered to your specific demands.

piloting

SUEZ in North America offers pilot systems and services for this and many other of our product offerings. Pilot studies are a practical means of optimizing physical-chemical and biological process designs and offer the client several benefits, such as:

- **proof of system reliability**
- **optimal design conditions for the full-scale system**
- **raw water lab analysis**
- **regulatory approval**

Please contact us if you would like to learn more about pilot studies for this system.

services

Aftermarket
SUEZ in North America sells parts and components for most SUEZ brand equipment as well as parts for demineralizers, thickeners, nozzles, pressure filters, and valves. We offer reliable spare parts at competitive prices. We maintain records of previous installations to quickly identify your requirements. Many items are shipped directly from stock for quick delivery.

Rebuilds, Retrofits and Upgrades
SUEZ in North America offers cost-effective rebuilds and upgrades for SUEZ provided systems, no matter what year they were built. If you are interested in an economical alternative to installing a whole new system, contact us for a proposal.

If interested in this product, check out some of our complementary products:

- **Biofor®**
- **Ferazur®/Mangazur®**
- **Climber Screen®**
- **Helico®**
- **Vortex**
- **ABW®**
- **Cannon Mixer®**
- **2PAD**
- **Thermylis®**
- **Densadeg®**
- **AquaDAF®**

contact

SUEZ
8007 Discovery Drive
Richmond, VA 23229 USA
Tel. : +1 804 756 7600
Fax : +1 804 756 7643
sales.usa@suez-na.com

042016

poseidon® PPM® dissolved air flotation units

industrial water treatment

The poseidon® PPM® DAF unit uses dissolved air flotation technology to separate particles from water. The unique design of the poseidon® PPM® unit provides for cost-effective water treatment and allows for the achievement of a high solids capture rate with maximum operational flexibility.

The SUEZ poseidon® PPM® units are modular, pre-mounted, rectangular-shaped units which are space-efficient and require small footprints and minimal field erection.

Different stainless steel grades, such as 304L, 316L and Duplex 2205 and other corrosion-resistant materials used for construction are used to fit to process needs.

ready for the resource revolution

SUEZ

feeding the unit

The raw water to be treated is collected in a feed chest and pumped into the inlet manifold of the flotation unit. The poseidon® PPM® unit can be fed with either a constant or variable flow, and tolerates variations in feed concentration, which allows for operational flexibility. A dual chemical system or a single chemical system may be required for optimum suspended solids removal. In a dual chemical system, a coagulant is mixed with the influent at the suction of the feed pump or at the inlet of a flocculator in order to coagulate the finely dispersed material. Downstream, in the manifold area, a polyelectrolyte is mixed into the stream, initiating floc formation. In a single chemical system, the flocculant is also mixed with the stream prior to the inlet compartment. If the feed flow rate varies, a proportional flow regulator for the chemical dosage pumps will allow for the right chemical addition rates.

proprietary recirculation system

The micro-bubbles required for flotation are produced with a recirculation system. This system, designed to operate on a continuous basis, meets the essential conditions for proper air dissolution and micro-bubbles generation. It also ensures a high solids capture rate by allowing the combining of flocs and microscopic air bubbles, forming air-floc conglomerates.

The recirculation system is composed of a pneumatic box, a patented poseipump™ recirculation pump (U.S. Patent 5.385.443) and a pressure release system. The efficiency of the recirculation system is mainly attributed to the poseipump™, which ensures fine air dispersion into the recirculated water and builds a proper pressure to allow for air dissolution. The poseipump™ is fed from the clarified water outlet, the recirculation water ratio being about 15% of the total flow. The micro-bubbles are formed when the recirculated water is released to atmospheric pressure prior to entering the inlet compartment of the unit.

The poseidon® air dissolving system generates very small air bubbles (30-40 m) and ensures the combination of the micro-bubbles with the flocculated particles, increasing their buoyancy. The floatable air-floc conglomerates, along with the rest of the wastewater stream, enter into the flotation unit inlet compartment and then into the separation cell. The floatable material then rises to the surface, and any heavy settleable particles (sand, grit, etc.) settle into sludge cones at the bottom of the machine.

benefits

- **HIGH PERFORMANCE AND OPERATIONAL FLEXIBILITY:**
  - + High capture rate
  - + High sludge / float consistency
  - + Easily handles upstream variations in flow rate and contaminant concentration
- **LOW OPERATING COSTS:**
  - + Efficient polymer consumption
  - + Minimal operator monitoring required
  - + Minimal maintenance required
  - + Stainless steel and complete corrosion-resistant construction
- **LOW INSTALLATION COSTS:**
  - + Modular pre-mounted units
  - + Space-efficient small footprint
  - + Minimal field erection time: unload, position and connect

intermediate capture surface zone

The poseidon® PPM® unit is equipped with poseidon® poseipack® which constitutes an intermediate solids capture surface zone that maintains a low overflow rate and ensures a high capture rate. The poseipack® also allows for low polymer consumption.

Particles having different densities will rise and form the sludge / float layer at different rates. Fast rising particles will rise in the upper part of the separation cell and smaller, slow rising particles, will be separated with the poseipack®, located prior to the outlet of the flotation unit. The poseipack® uses corrugations to favor the contact between smaller flocs and micro-bubbles, increasing their size and buoyancy, thus allowing them to rise to the sludge / float. The clarified water flows down the poseipack® where it is collected into outlet pipes and directed to a clarified water chest.

sludge/float removal system

The poseidon® PPM® unit is equipped with a scraping system which allows for continuous proper removal of the sludge / float. This system includes a sludge / float scraper and one or more rotary thickeners which are all equipped with a motor-reducer with variable speed adjustment capability. This provides for flexibility on the sludge / float consistency and removal.will be separated with the poseipack®, located prior to the outlet of the flotation unit. The poseipack® uses corrugations to favor the contact between smaller flocs and micro-bubbles, increasing their size and buoyancy, thus allowing them to rise to the sludge / float. The clarified water flows down the poseipack® where it is collected into outlet pipes and directed to a clarified water chest.

water level adjustment

The unit is also operated with a level adjustment system by means of adjustable weirs or an automatic level control system. The poseidon® PPM® unit Model B is designed with adjustable weirs for level adjustment. The poseidon® PPM® unit Model E is operated with an automatic level control system consisting of a level control valve and a level transmitter. Both types of level adjustments allow for flexibility on sludge / float consistency and removal and, in addition, increase the stability of the treatment by maintaining a constant level in the unit.

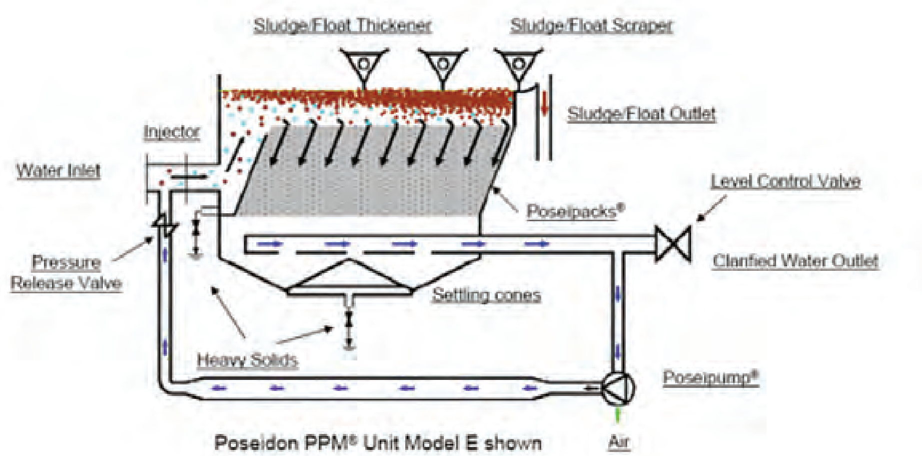
Pre-mounted, modular, space-saving design

sediment removal system

In order to avoid any build up of heavy solids in the bottom of the unit, sludge cones and automatic drain valves are installed. The sequence of drainage is set relative to the particular application requirements.

Small installed footprint saves space and new building cost

poseidon® PPM® Model E unit shown



poseidon® PPM®

dissolved air flotation units

integrated treatment solutions

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If interested in this product, check out some of our complementary products:

- **poseidon® DAF Saturn**
- **poseidon® DNF PPM**
- **poseidon® Oil-Water Separators**
- **Accelator®**
- **Aquadaf®**
- **Densadeg®**
- **Densadeg XRC®**
- **Superpulsator®**
- **Ferazur®/Mangazur®**
- **Greenleaf®**
- **Smartrack™**

contact

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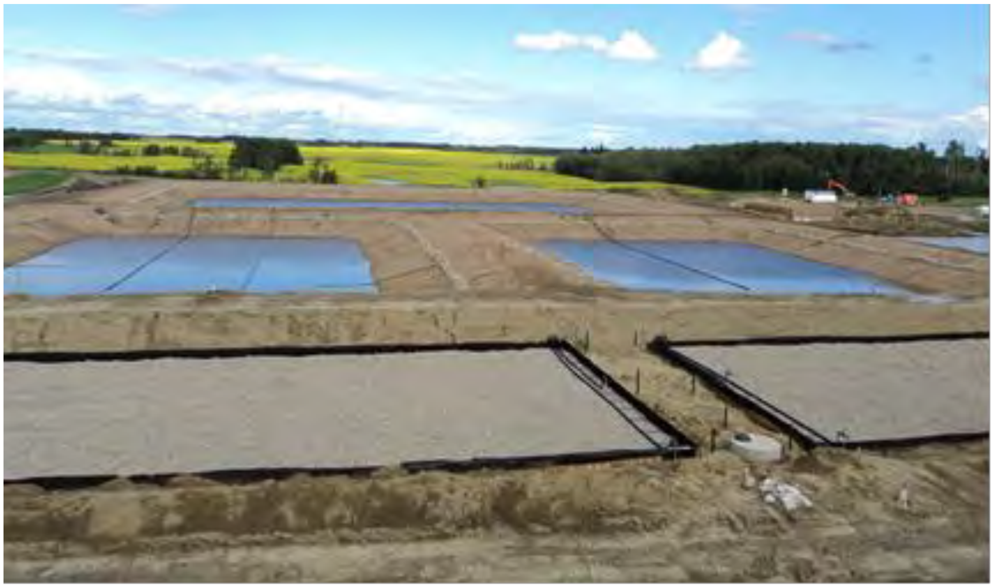
sales.usa@suez-na.com

042016

Nelson Environmental Inc

OPTAER™

WASTEWATER TREATMENT SYSTEM



Preliminary Proposal for:

Design, Supply, and Installation Inspection of

OPTAER Wastewater Treatment System

City of Palmer, AK

Design Flow: 1.22 MGD

November 13, 2015

NE reference: cd2149.04 Proposal

5 Burks Way, Winnipeg, Manitoba R2J 3R8
Toll Free: (888) 426-8180 • Tel: (204) 949-7500 • Fax: (204) 237-0660

1.0 Project Overview

An OPTAER SAGR Wastewater Treatment system is proposed for the City of Palmer, AK as an upgrade to the existing wastewater treatment facility to meet ammonia discharge requirements. The proposed system would utilize the existing lagoon infrastructure and consist of the following upgrades, processes, and technologies:

- Retain the existing lagoon aeration for primary and secondary treatment (suitability and condition to be confirmed by others).
- Remove existing lagoon covers (by others).
- Construct a **3-cell** aerated SAGR® (Horizontal Flow Submerged Attached Growth Reactor) for nitrification (ammonia removal), BOD, and TSS polishing following the existing treatment system.
- UV Disinfection system prior to discharge if required (by others).

2.0 System Design Parameters

Preliminary design loads and flows as well as effluent requirements are summarized in the following tables:

		Influent	SAGR Influent	Effluent
Design Flow (Max Month)	gpd	1,220,000		
Design Flow (Average)	gpd	1,000,000		
cBOD	lbs/day	2,818		
cBOD	mg/L		42	<20
TSS	lbs/day	3,012		
TSS	mg/L		40	<20
TKN	mg/L	47	47	
Total Ammonia (TAN)	mg/L			<1.7

SAGR aeration design parameters are summarized in the following table:

SAGR Aeration System	
	SAGR
Alpha	0.70
Beta	0.95
Theta	1.024
Site elevation (ft)	145
Minimum Influent Water temperature (^oC)	1.0
Min. Dissolved Oxygen (mg/l)	3.0
Max SAGR Loading Rate (lbs BOD/100ft^2/day)	2.8
Max SAGR Loading Rate (lbs NH_3/1000 ft^3)	0.479
Total SCFM (design)	**2,527**

3.0 OPTAER Treatment Process

i. Submerged Attached Growth Reactor (SAGR)

The Submerged Attached Growth Reactor (SAGR) is a patented process designed to provide nitrification (ammonia removal) in cold to moderate climates. The SAGR is essentially a clean aggregate media bed with evenly distributed wastewater flow across the width of the cell, and a horizontal collection chamber at the end of the treatment zone.

LINEAR aeration throughout the floor of the SAGR provides aerobic conditions that are required for nitrification. The gravel bed is covered with a layer of wood chips or mulch to prevent freezing.

The following variables need to be considered during nitrification design:

- *Dissolved Oxygen Levels* - Nitrifying bacteria require aerobic conditions. A minimum dissolved oxygen concentration of 3 mg/L must be present for the process to fully occur.
- *BOD concentration* – Nitrifying bacteria require low BOD concentrations to be effective. Primary BOD removal occurs in the upstream lagoon system. The SAGR provides additional BOD polishing if necessary to reduce BOD concentrations below 25 mg/l.
- *Surface area* - Bacteria require a medium of some form to grow on. High surface area medium allows for higher-density nitrifying bacteria population.
- *Bacteria* - In order to convert ammonia (NH_3) to nitrite (NO_2^-) and ultimately nitrate (NO_3^-) (nitrification) sufficient quantities of two bacteria are required, *Nitrosomonas* and *Nitrobacter*.
- *Alkalinity* - The nitrification process reduces pH levels and consumes alkalinity. In order for nitrification to occur, 7.1 mg of alkalinity must be available for each mg/L of ammonia removed
- *Temperature* - Nitrification in a SAGR occurs at water temperatures as low as 0.5^{o}C. The long sludge age inherent in an attached growth system allows for full nitrification at temperatures where bacteria reproduction is greatly inhibited.
- *pH* - Nitrification is enhanced at higher pH levels. pH levels of 7.5 to 8.5 are ideal, although nitrifying bacteria can adapt outside of this range.

Three (3) SAGR cells are operated in parallel. Piping allows any cell to be isolated and bypassed.

4.0 Aeration Process Equipment

i. Submerged Attached Growth Reactor (SAGR) LINEAR Aeration System

LINEAR coarse bubble diffusers are used to provide oxygen to the wastewater. Diffuser lines are manufactured from LDPE (Low Density Polyethylene) with reinforced air releases along the tubing. The diffuser tubing is designed for direct burial in the SAGR bed.

The diffuser locations have been spaced according to the projected oxygen demand in the SAGR. The design diffuser distribution is critical to ensure that nitrification occurs. In addition to providing oxygen for nitrification the proposed aeration system brings numerous other long-term performance benefits to this sub-surface flow system.

- Full aeration grid ensures that wastewater channeling cannot occur in the gravel layer (maximize retention time and media contact).
- Sludge digestion in gravel layer is enhanced due to aerobic conditions.

ii. Positive Displacement Blowers

Positive displacement blowers are used to provide air supply for the OPTAER treatment system. Blowers are designed to provide the required airflow at normal system operating pressure, and have the capability of operating at the maximum required pressure intermittently for diffuser purging. The blowers are equipped with sound attenuating enclosures. VFDs are recommended on the lagoon blowers to conserve energy. Blower requirements are summarized in the following table:

		SAGR Blowers
Number of blowers total		3
Number of blowers on duty		2
Number of blowers on standby		1
Motor nameplate horsepower	hp	75
Design airflow per blower	SCFM	1264
Normal operating pressure	psi	5.9
Maximum required pressure	psi	8.9
Actual Power Consumption (per blower)	bhp	50.1
Actual Sound level	dB(A)	74

5.0 Operation and Maintenance

The following table presents anticipated operation and maintenance costs for the OPTAER system:

			*Electrical Rate:		**0.128**	$/kW-h
		Motor Power		**Monthly**	**Unit**	**Annual**
	Quantity	**bhp**	**kW**	**cost**	**cost**	**Cost**
SAGR Blowers	**3**					
Normal Operating Conditions	2	50.1	37.4	$6,985	-	$83,815
Filters (6 months)	**-**	-	-	-	$80	$320
Oil (12 months)	**-**	-	-	-	$90	$180
Belts (24 months)	**-**	-	-	-	$250	$250
Total Operation & Materials						$84,565
* Electrical rate estimated by Nelson Environmental Inc						

The aeration system will require one operator for approximately 0.5 - 1 hour per day for routine inspection & maintenance. Maintenance requirements may include:

- Blower maintenance –oil changes, intake filters
- SAGR dual feed operation

6.0 Budgetary Capital Cost

Budgetary Capital cost for the OPTAER wastewater treatment system is as follows:

Submerged Attached Growth Reactor (SAGR)

- Process design including
  - Process CAD drawings and specifications

- Aeration lateral piping, feeder piping, diffusers, valves, and fittings as required
- SAGR Influent flow distribution piping/chambers and effluent collection chambers
- Three (3) 75 hp positive displacement blowers with full sound attenuating enclosure
- ***SAGR installation inspection /start-up /commissioning /training***
- Operation and maintenance manuals
- As-built Drawings

Budgetary cost for the design, supply, and installation inspection as above:

$1,529,000 USD plus Taxes, FOB Jobsite

Items specifically NOT included in the above pricing:

- Material offloading and on-site storage
- SAGR System Installation
- Civil works including SAGR and lagoon basin design and construction, liner, transport piping, inter-cell piping, discharge piping, manholes, valves, access roads to site, site roads and landscaping, lagoon desludging etc. if required
- Galvanized metal blower header and connection pipe (heat dissipation)
- Blower control panel
- Electrical / control wiring for all supplied components
- Process piping including influent piping and effluent piping.
- Materials and construction required for the SAGR:
  - granular material
  - insulating wood chips
- Building to house blowers if required, including concrete, electrical, and HVAC.
- Site preparation and restoration

All budgets are subject to final design review.
All budgetary prices include shipping to jobsite but do not include taxes.
Budget prices are valid for 90 days.

7.0 Civil Works Required for OPTAER Implementation (by others)

The intent of this proposal is not to provide details regarding civil works required but rather to provide a general overview as to the anticipated scope of work. The following quantities are not included in the Nelson Environmental scope of work, but are provided below for cost estimation purposes.

- Construct new SAGR cells
- Construct inter-cell piping
- Construct discharge control structure after SAGR
- Materials and construction required specifically for the SAGR (estimated material quantities are shown in the following table):

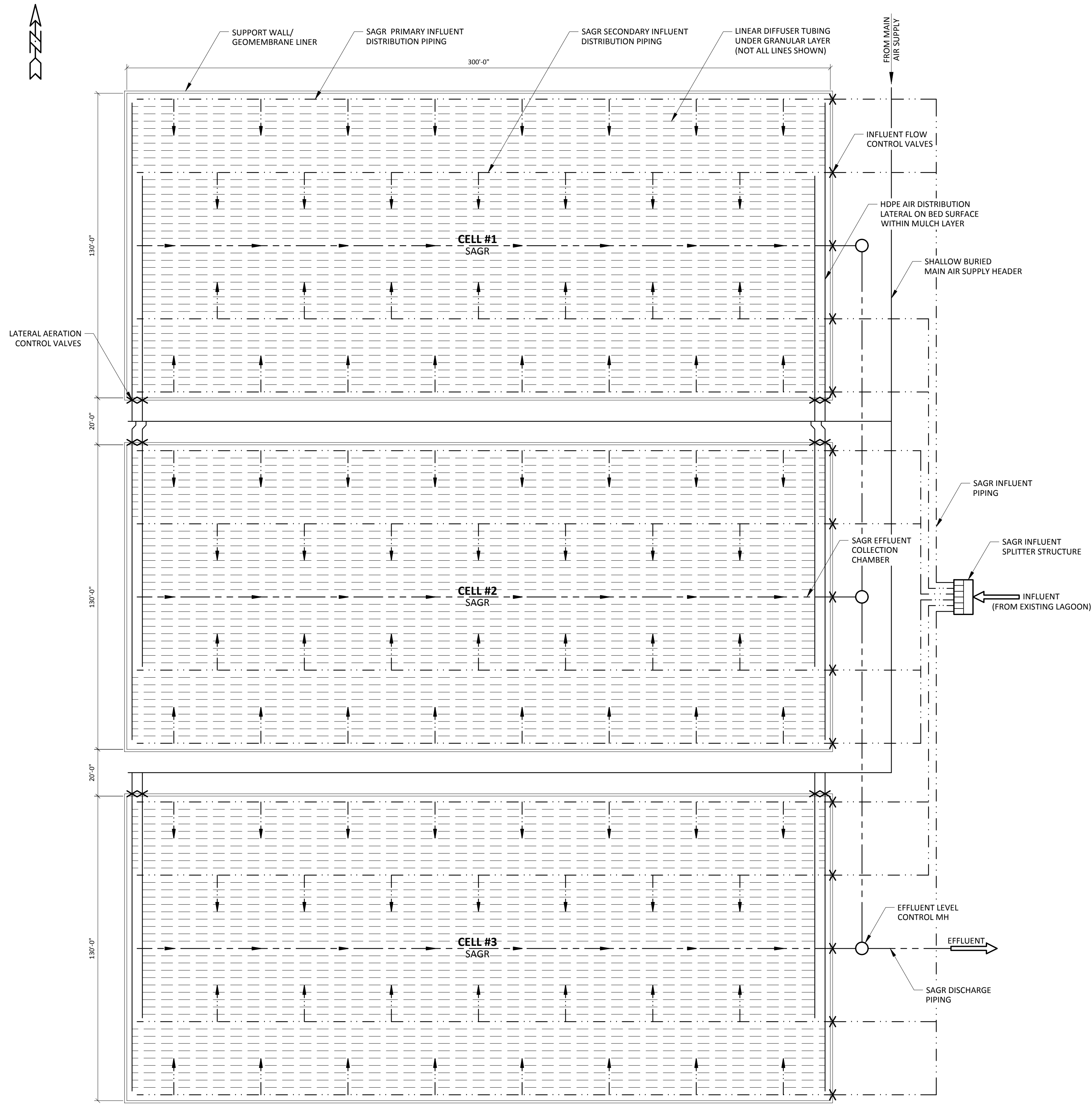
SUMMARY				
Item Description	UOM	Quantity	Unit Price	Total Cost
Uniform Graded Clean Rock	cu.yd.	**42,900**	$ 35.00	$ 1,501,500.00
Insulating Wood Chips	cu.yd.	**3,740**	$ 10.00	$ 37,400.00
Non-Woven Geotextile (8oz)	sq.ft.	**288,620**	$ 0.15	$ 43,293.00
HDPE Liner (60mil)	sq.ft.	**159,920**	$ 1.50	$ 239,880.00
Wall Framing & Sheathing	lineal ft.	**2,710**	$ 25.00	$ 67,750.00
Influent Flow Splitter Structure	ea	**1**	$ 20,000.00	$ 20,000.00
Piping, fittings, valves from splitter to SAGR	LS	**1**	$ 72,400.00	$ 72,400.00
Effluent Level Control MH	ea	**3**	$ 5,000.00	$ 15,000.00
Install NEI supplied process equipment	LS	**1**	$ 180,000.00	$ 180,000.00
Additional Civil Works (As Required)				
Common Excavation - Backfill	cu.yd.	**TBD**	$ -	$ -
New Berm Construction	cu.yd.	**TBD**	$ -	$ -
Piping from Lagoon to Splitter	LS	**TBD**	$ -	$ -
Piping from SAGR to discharge	LS	**TBD**	$ -	$ -
TOTAL				**$ 2,177,223.00**
*Construction Unit Prices based on typical installed values. Pricing to be updated to reflect local construction costs				

Any questions or comments can be directed to:

Nelson Environmental Inc.
5 Burks Way
Winnipeg, MB R2J 3R8
Tel: 204-949-7500
Fax: 204-237-0660

PLOT SIZE: 610mm x 914mm (24" x 36")

REDUCED SIZE PLOT - DO NOT SCALE



INFLUENT/EFFLUENT PIPING TO SAGR SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. EXACT PIPING ROUTING TO BE DETERMINED BASED ON FINAL LOCATION OF SAGR.

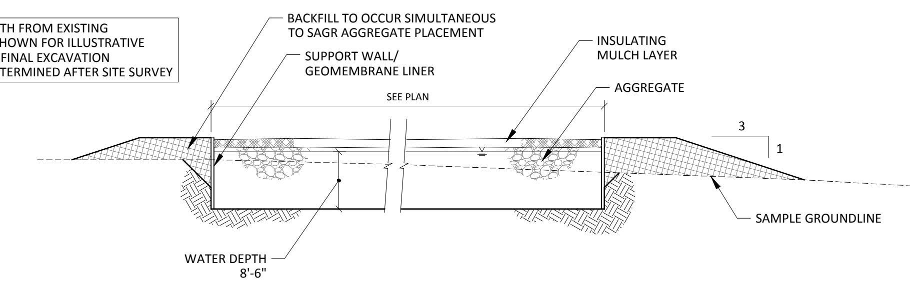
PROPOSED SAGR LAYOUT

SCALE: 1:300

LOCATION PLAN

SCALE: N.T.S.

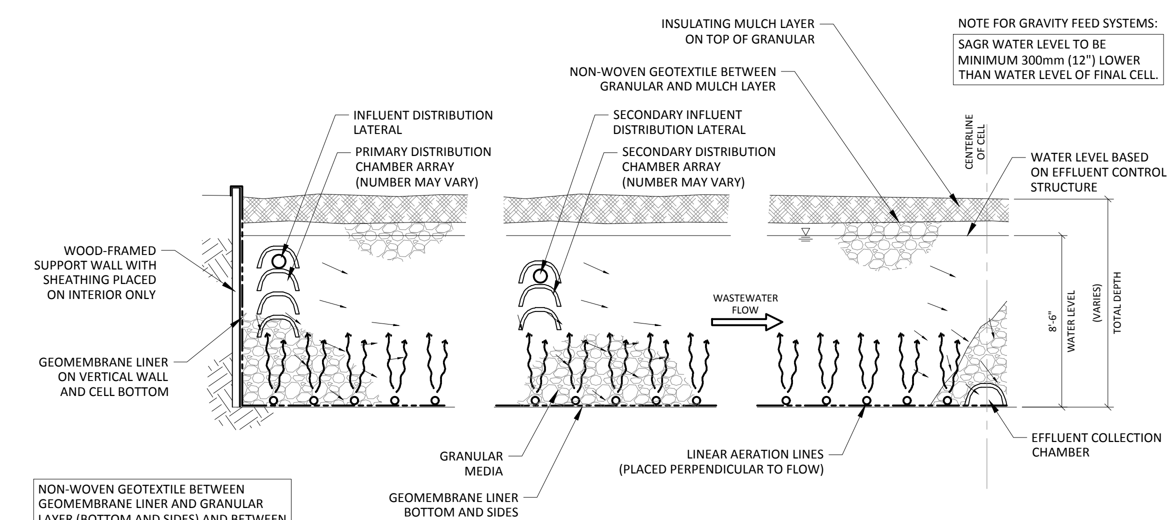
NOTE:
EXCAVATION DEPTH FROM EXISTING GROUND LEVEL SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. FINAL EXCAVATION DEPTHS TO BE DETERMINED AFTER SITE SURVEY



TYPICAL SAGR CONSTRUCTION

SCALE: N.T.S.

NOTE FOR GRAVITY FEED SYSTEMS:
SAGR WATER LEVEL TO BE MINIMUM 300mm (12") LOWER THAN WATER LEVEL OF FINAL CELL.



NON-WOVEN GEOTEXTILE BETWEEN GEOMEMBRANE LINER AND GRANULAR LAYER (BOTTOM AND SIDES) AND BETWEEN MULCH LAYER AND GRANULAR LAYER (TOP)

HORIZONTAL FLOW SAGR - SECTION

SCALE: N.T.S.

NELSON ENVIRONMENTAL INC.
5 BURKS WAY
WINNIPEG, MANITOBA
CANADA R2J 3R8
Ph: (204) 949-7500
Fax: (204) 237-0660
www.nelsonenvironmental.com

PROJECT:	PALMER, AK PROPOSED WASTEWATER TREATMENT SYSTEM
TITLE:	PROPOSED OPTAER SAGR SYSTEM PROPOSED SAGR LAYOUT, TYPICAL SECTION, LOCATION PLAN
DRAWN BY:	AM
APPROVED BY:	LE
SCALE:	AS NOTED
DRAWING NO.	NE01
SHT.	1 of 1
REV.	0
DATE:	2015/11/10
FILE #	CD2149.04

Parkson
Treating Water Right

biolac®

Palmer, AK

Preliminary Design Proposal

January 29, 2016

To:	**Jim Wodrich, PE**	**Date:**	**1/29/2016**
Company:	**HDR Inc.**	**From:**	**Rakesh Desai**
Tel.:	**(208) 387-7117**	**Tel.:**	**(954) 917-1818**
cc:	**Mark Rasor, Steve Young, Bill Reilly (WH Reilly)**		
Subject:	**Parkson Biolac® Treatment System, Preliminary Design Proposal for Palmer, AK**		

Dear Mr. Wodrich,

Thank you for your interest in Parkson's Biolac® Treatment System. Based upon the data provided for this project, we developed the Biolac® design described in this proposal. We believe that this Biolac® design not only meets effluent quality requirements, but also provides the most cost effective solution for this municipality.

We look forward to working with you on this project. Should you have any questions or need clarifications, please do not hesitate to contact me at (954) 917-1818. Thanks.

Sincerely,

PARKSON CORPORATION

An Axel Johnson, Inc. Company

Rakesh Desai
Sr. Applications Engineeer
RDesai@Parkson.com

Table of Content

1. Design Basis

1.1. Influent and Effluent Specifications

The proposed system design is based on wastewater influent with the following characteristics:

Table 1.1 – Design Influent flow requirements

PARAMETER	UNITS	AVERAGE
Start-Up Flow (Phase 1)	MGD	0.65
Phase 2 flow	MGD	1.22
Phase 3 Max Month (Design) Flow	MGD	1.83
Peak Hourly Flow	MGD	2.5 x design flow

Note: Customer must confirm these final design flows to assure accuracy of the hydraulic calculations.

Table 1.2 - Influent Water Quality

PARAMETER	UNITS	AVERAGE
Design Temperature	Deg C	11
Minimum Temperature	Deg C	5.5
BOD_5	mg/L	297
Total Suspended Solids	mg/L	296
TKN	mg/L	47
NH_3-N	mg/L	32
Total Phosphorous (TP)	mg/L	6
pH	-	6 to 8
Alkalinity	mg/L as $CaCO_3$	400

Note: Customer must confirm Influent loading conditions for any associated process warranty.

In order to offer this proposal, Parkson Corporation must make the following assumptions. Deviations from these assumptions should be brought to the attention of the designer of this system as modifications maybe required:

a. The wastewater will be pretreated to remove debris and grit using a fine influent screen.

b. Sufficient alkalinity is present or will be added to allow nitrification to proceed uninhibited.

c. The incoming oil, grease, chemical and metals concentrations are within biologically treatable levels.

d. Sufficient nutrients (P, N, etc.) are present in the influent for biomass growth or will be added by the plant operating staff.

e. A qualified operator will supervise plant activities and performance.

Based on the specified influent water quality, Parkson anticipates that the proposed Biolac® system will provide the following effluent quality:

Table 1.3 - Effluent Water Quality

PARAMETER	UNITS	QUALITY
BOD_5	mg/L	10
Total Suspended Solids	mg/L	15
NH_3-N	mg/L	1

1.2. Selected Design Parameters

Based on the design loading information described above, the proposed Biolac® System will be derived as follows:

F/M Ratio	**0.06**	**MLSS**	3,000 mg/l
HRT	1.54 days	**SRT**	25-50 days

2. System Description

The Biolac® Biological Nutrient Removal System is an innovative complete mix activated sludge process using extended retention of biological solids to create an extremely stable and easily operated system. The Biolac® process can be applied to a wide range of wastewater treatment applications, whether for municipal application or industrial application. Biolac® has over 800 installations in North American and over 1000 installations globally.

Some of the advantages of the Biolac® BNR process include:

a. Economical construction: Most Biolac® systems are installed in earthen basins which reduces construction cost tremendously by eliminating the need for sophisticated concrete structures and complex piping systems for recycling.

b. Biolac® BNR systems are typically designed with a sludge age greater than 30 days. The extended sludge age provides stable operation, low sludge production, low production of well stabilized biosolids, and high effluent quality.

c. Economical process in terms of operation and maintenance cost.

d. Comprehensive electrical control system to optimize air delivery and provide peace of mind to plant operator.

e. Utilization of fine bubble aeration using extremely high mixing efficiency of 4 CFM per 1000 ft^3 which is over 50% improvement in comparison to the mixing efficiency achieved by stationary fine bubble diffusers.

f. Ease of aeration expansion capability simply by adding additional Biofuser® tubes to modules.

g. Biological nutrient removal is implemented using the Wave-Ox™ design by Parkson's process experts. The Wave-Ox™ process is designed to achieve sequential nitrification / denitrification which results in oxygen and alkalinity recovery and translates into an energy efficient and stable operation.

h. Integral clarifier design using common walls with the Biolac® basin, designed to make the most efficient use of the available footprint.

i. Elimination of the need to drain the aeration basin(s) with the Biolac® system since all components can be cleaned and maintained from the surface.

The Biolac® process is characterized by excellent BOD removal, complete nitrification, enhanced denitrification, and biosolids stabilization. It uses fine bubble membrane diffusers attached to floating aeration chains, which are moved across the basin propelled by the air release from the diffusers. The moving aeration chains equipped with the Biofuser® diffuser assemblies provide efficient mixing of the basin contents as well as high oxygen transfer at low energy usage.

The Biofuser® system does not have submerged aeration piping or any other components to be installed, leveled, or secured on the basin floor. The BioFlex® chains with BioFusers do not contact or harm the basin liner. Each BioFlex® chain can be individually controlled by independent air valve providing excellent flexibility in fine-tuning the system to meet the oxygen demand. The individual control capability of the BioFlex chains is used to create alternating oxic and anoxic zones (Wave-Ox™) to allow denitrification in a single basin without internal mixed liquor recycle or complex controls. The moving aeration chain design is not mixing limited so the horsepower required for mixing is typically half of that required for aeration. A turndown capability of 50-70% during low loaded periods is typical without sacrificing mixing due to the movement of the BioFlex aeration chains. Inspection and service of the BioFusers is done quickly and easily without dewatering the basin, keeping maintenance costs low and eliminating the need for redundant aeration basins. In case of cold climates, the fine bubble diffusion beneath the water surface eliminates icing and minimizes wastewater cooling.

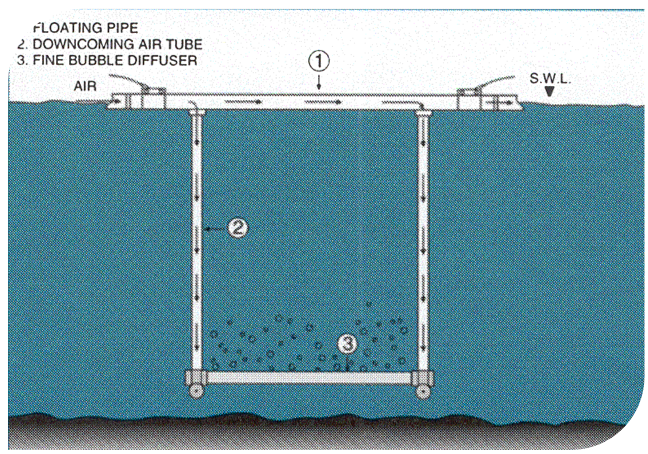
Earthen basins can be used rather than expensive concrete tanks making this extended aeration/activated sludge design the lowest cost alternative available on the market. Integral clarifier(s) are installed using common-wall construction with the extended aeration basin to settle and recycle the stable extended aeration solids.

3. System Components

The Biolac® aeration system consists mainly of suspended aeration chains, fine bubble diffusers, motorized and controlled air valves, clarification equipment, blowers and automatic electrical control system.

3.1. Moving Aeration Chain System

The moving aeration chain suspends fine bubble diffusers near the bottom of the basin. The aeration system is designed so that there are no points of attachment to the bottom of the basin. The aeration system is completely suspended above the basin bottom and is not supported or rested on the bottom. This arrangement allows for ease of access for service and maintenance without dewatering the basin or having a complete aeration system shut down.



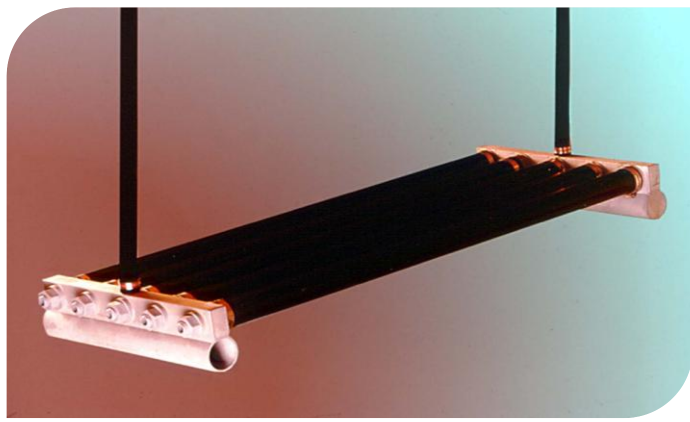
The aeration chain system is designed to be self-propelled and to move back and forth systematically in the wastewater to provide high mixing efficiency of the basin's content. This capability is critical to allow turndown flexibility in the aeration system while maintaining a completely mixed environment.

Air is delivered to each aeration chain from one side and connects to the air main through individual branches with butterfly valves. The butterfly valve provides individual control or isolation of the airflow to each chain.

The moving aeration chain is constructed of a single continuous polyethylene header. The moving aeration chain is connected to the Biofuser® by EPDM hose.

3.2. Diffuser Frame

The diffuser frame is formed from an extruded polypropylene compound with sufficient strength to prevent warping or deflection. The end connections of each frame shall be sealed using mechanical welding procedures providing a connection stronger than the unwelded tube.



The suspended air diffuser assembly consists of a fully functioning unit capable of housing up to five (5) diffuser tubes total.

3.3. System Integral Clarifier

The Biolac® system includes an integral clarifier basin(s) with a V-bottom zone. The integral clarifier is located downstream of the Biolac® system. All metal components of the clarifier are generally fabricated using 304SS. The clarifier is

typically designed using conventional solids and hydraulic loading rates.

Each clarifier has a flocculating rake mechanism which consists of a drive assembly and non-drive / pulley assembly.

The sludge removal system includes an airlift pump and a sludge suction pipe and the Return Sludge will flow by gravity upstream of the Biolac® basin. The sludge suction piping for removing the settled solids from the clarifier is located along the length of the clarifier hopper bottom. Holes are placed along the length of the suction pipe for uniformal removal of the sludge.

Each integral clarifier includes a fixed overflow weir to control the liquid level in the clarifier and Biolac® basin as well as control the flow to the effluent pipe.

A scum baffle is included in the integral clarifier as well to prevent floating objects from passing over the overflow weir.

3.4. Aeration Design

a. The aeration requirements for the Biolac® System are summarized in Table 1.

b. The estimated air and energy requirements and the number of BioFlex© moving aeration headers and Biofuser® units estimated are given in Table 1. A typical BioFlex aeration header and Biofuser® assembly is shown in Drawing SD-37.

c. The required air for Biolac® basin will be supplied by four (4), 50 Hp positive displacement blowers. One (1) additional blower is provided as an installed spare. Only one (1) blower is necessary for mixing. Therefore, it is possible to operate one blower and cut energy usage substantially during periods of low load, such as nighttime operation. The blowers are expected to be located on a concrete pad next to the aeration basins or in a blower building as dictated by local requirements. Only two (2) blowers are required for phase 1 loadings.

3.5. Clarifier Design

a. The biomass is separated from the mixed liquor in the clarifiers. A floating flocculating rake mechanism travels back and forth through the length of the clarifier(s) to aid in solids settling and distribution. Settled biomass is collected in the V-bottom of the clarifier by a stationary suction pipe and pumped through the RAS system. The biomass may be returned to the influent zone of the activated sludge aeration basin via RAS pumps. Biomass is wasted using an automated valve as dictated by the wasting method. The effluent leaves through a fixed v-notch overflow weir. Floating materials and debris are removed using a scum trough removal system.

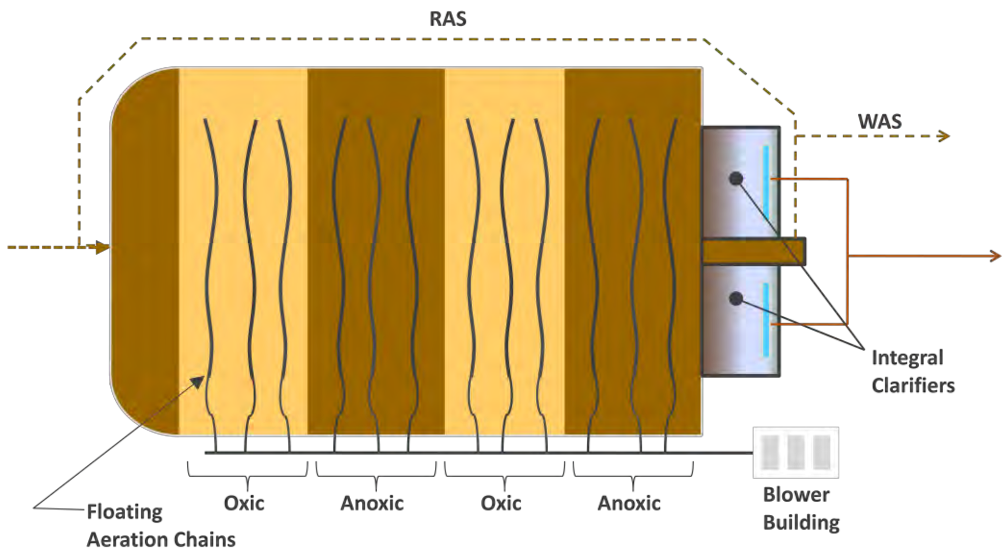
b. The clarifier dimensions and design criteria can be found in Table 1.

c. Some advantages to the Parkson's clarifier design:

- More efficient concrete design. Common wall design between clarifiers reduces concrete cost
- Capability to isolate each clarifier individually (for multiple clarifier design)
- Smaller overall plant footprint compared to plants using conventional clarifiers
- Common wall design with the aeration basin removes the need for:
    - Separate Pump(s) Station(s) to feed clarifier(s)
    - Clarifier Distribution Boxes (required for external clarifiers)
- Low maintenance
- Simple Sludge Rake Mechanism
- Low velocity inside the clarifier resulting from uniform feed distribution from the inlet channel
- Automatic flow equalization capability in the treatment basin (clarifier inlet channel increases liquid level during peak flows)
- Individual control of RAS.
- Easy to add additional process equipment(s)/design(s) such as Phosphorous removal system and sand filtration system.

4. Wave-Ox™ Plus Biological Nutrient Removal

Biological Nutrient Removal (BNR) is simplified and affordable with the Biolac® Wave Ox™ Plus process. Simple control of the air flow distribution to the Biolac's moving aeration chains varies the basin dissolved oxygen content by creating a unique moving wave of multiple oxic and anoxic zones. This repeated cycling of environments nitrifies and denitrifies the wastewater without recycle pumping or additional external basins. The Wave-OX™ Plus process with MixMode™ energy reduction technology optimizes total nitrogen removal with the lowest possible energy usage.



Biological phosphorus removal can also be accomplished by incorporating an upstream anaerobic zone.

The Biolac Wave-Ox™ Plus process not only produces BNR effluent quality with low effluent total nitrogen and total phosphorus, but also includes main features such as

- Single basin BNR process resulting in major construction costs savings by eliminating the need for baffle walls to create independent zones.
- Reduced energy consumption by eliminating the need for internal recycle pumps and mixers for anoxic zones
- Optimized process operation by using simple and smart electrical controls achieving up to 80% denitrification .

5. Biolac® Treatment System Preliminary Design Information

Biolac Extended Aeration Basin	
Number of Biolac® Basin(s)	1
Approximate Dimensions at Grade (ft)	320 x 146
Approximate Bottom Dimensions (ft)	300 x 107
Side Slope	1.5 : 1
Side Water Depth (ft)	10
Basin Volume (MG)	2.82
Basin Freeboard (ft)	**3**
Number of Clarifiers	2▪
EzClear Clarifier Size (ft)	100 x 23 ea.
Clarifier Freeboard (ft)	**2**
Clarifier Design Hydraulic Loading Rate (gpd/ft^2)	397 (Design Flow)
Estimated SOR (lbs/hr)	
Oxidation-only	832
Wave Ox™ (including denite credit)	602
Estimated SCFM (excluding airlift requirements)	
Oxidation-only	4,592
Wave Ox™ (including denite credit)	3,491
Estimated Brake HP (excluding airlift requirements)	
Oxidation-only	162
Wave Ox™ (including denite credit)	123
# Diffusers	880*
# Biofuser® Assemblies	220
# Diffusers / Biofuser® Assemblies	4*
# BioFlex© Headers	20

▪ *Phase 1 will require one (1) clarifier.*

* *Phase 1 will require 2 diffusers per assembly. Additional tube(s) can be added as loadings increases.*

6. Equipment and Services Supplied

Parkson will supply the following equipment and services for the Biolac® treatment system described above:

- Complete BioFlex® moving chains with BioFuser® aeration units including, reinforced hi-temperature connecting hose, HDPE piping, restraining cable system and required hardware.
- Electric motor actuated butterfly valves for individual control of each BioFlex aeration chain.
- Qty five (5) complete, 50 Hp, blower assemblies (PD blowers) including motor and required backflow prevention valves, pressure gauges and accessories (includes one installed spare blower for redundancy).
- Two (2) integral clarifier equipment including biosolids removal piping, RAS pumps (4 duty, 1 standby), flocculating mechanism, scum removal pipe and overflow weir.
- One dissolved oxygen probe and analyzer per basin.
- Remote-mounted control system for operation of the Biolac® Wave-Ox™ System including control enclosure, VFDs, timers, relays and control switches for all motors, and components in the system. Dissolved oxygen monitoring and blower control are also provided.
- Final installation inspection, start-up supervision and operator training.

7. Cost Estimate and Term

a. The budget price for the equipment and services supplied is ..... $ 1,200,000

FOB Factory, Freight Allowed.

Deduct for equipment not required for Phase 1 (one clarifier, two blowers, two RAS pumps and diffuser tubes) is.. $ 175,000

b. Terms are 90% net 30, 10% upon startup.

c. Approval drawings-typically 8-12 weeks after receipt of written order.

d. Equipment Shipment - typically 16-20 weeks after complete release for manufacture.

8. Supplemental Information and References

a. Biolac® System Oxygen Requirements

b. Typical Drawings

- SD-37 "BioFlex Moving Aeration Chain with Biofuser® Series 3104"
- SD-12 "Wave-Ox Valves"
- SD-7 "Anchor Post with Hook Detail"
- SD-8 "Positive Displacement Aeration Blower Assembly"
- SD-23 "Waste Valve Assembly"

BIOLAC® SYSTEM
OXYGEN REQUIREMENTS

Parkson — Treating Water Right

Project: Palmer, AK **Date:** January 29, 2016

Data

Basins: 1

MxMn (Ph 3)

Influent Flow	Per Basin	Q	1.83	MGD	6.93	MLD
Basin Volume	Per Basin	V	376794	ft3		
	Total	V_{Total}	376794	ft3		

Influent		Effluent			% Removal
BOD_{in}	296	BOD_{out}	0	mg/l	100.00%
TKN_{in}	47	$NO3_{out}$	0	mg/l	100.00%
$NH3_{in}$	32	$NH3_{out}$	0	mg/l	

BOD	1.5	Lbs of O2/Lb BOD
TKN-N	4.6	Lbs of O2/Lb NH3-N
NO3	2.9	Lbs of O2/Lb NO3-N
% denitrification	75%	

Loading Rates

Hydraulic Residence Time, HRT

$$HRT = \frac{V \ \text{(ft3)}}{Q \ \text{(ft3/day)}}$$

1.54 days

BOD Loading Rate** (per Basin)**, BOD** **Load

$$BOD_{Load} = BOD_{in}(mg/L) * \%Removal * Q \ \text{(MGD)} * 8.34 \text{ (lbs/gal)}$$

4521.52 lb/d

BOD Volumetric Loading Rate** (per Basin)**, BOD** **Vol Load

$$BOD_{Vol\,Load} = \frac{BOD_{Load}}{V}$$

12.00 Lb/1000 ft3

TKN Loading Rate** (per Basin)**, TKN** **Load

$$TKN_{Load} = TKN_{in}(mg/L) * \%Removal * Q \ \text{(MGD)} * 8.34 \text{ (lbs/gal)}$$

717.94 lb/d

AOR

Actual Oxygen Requirement, AOR

AOR_{BOD}	1.5 Lbs of O2/Lb BOD	*	4521.5	lb/d	=	6782.3	lb/d
AOR_{TKN}	4.6 Lbs of O2/Lb NH3-N	*	717.9	lb/d	=	3302.5	lb/d
Denite Credit	2.9 Lbs of O2/Lb NO3-N	*	539.6	lb/d	=	1564.8	lb/d

Total AOR: 10084.83 lb/d Non-WaveOx; 8520.07 lb/d w/ Denite Credit

SOR

Standard Oxygen Demand, SOR

$$\frac{SOR}{AOR} = \frac{C_{S,20}}{\alpha * (\beta * C_{\bar{S},T,H} - C_L) * (\theta^{T_d - 20}) * F}$$

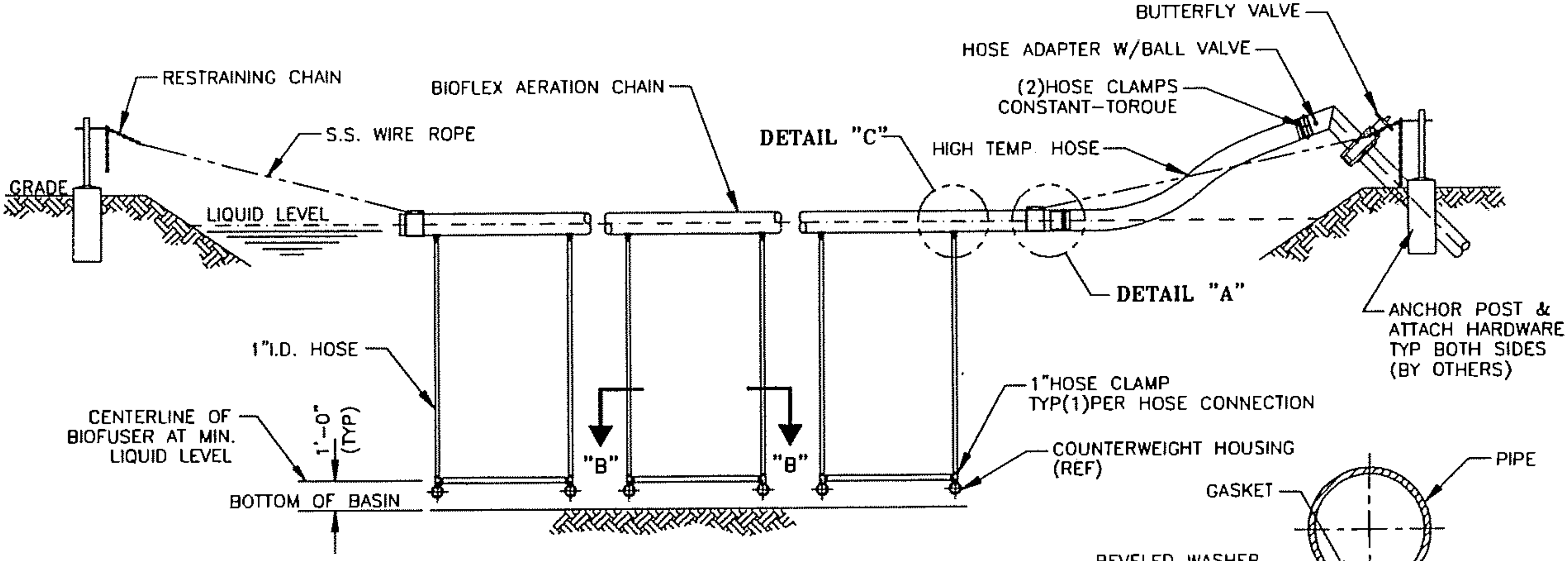
Where

$C_{S,20}$	DO Saturation Concentration in Clean Water @ 20C & 1 atm	9.092426	mg/L
$C_{\bar{S},T,H}$	Avg DO Sat. Conc.in Clean Water in Aeration Tank @ T °C & altitude H	11.58309	mg/L
C_L	Operating Oxygen Concentration (Non-WaveOx)	2	mg/L
	Operating Oxygen Concentration (WaveOx)	0.5	mg/L
α	Oxygen Transfer Correction Factor for Waste	0.7	
β	Salinity-surface tention correction factor	0.95	
θ		1.024	
T	Operating Temperature	11.1	°C
F	Fouling Factor	0.9	
SOR	Standard Oxygen Req. in tap water @ 20C & 0 [lb O2/day		

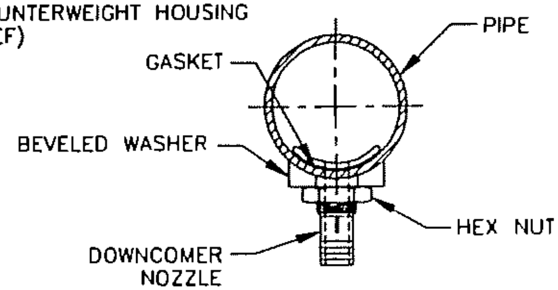
SOR/AOR		
	1.98	Non-WaveOx
	1.70	WaveOx

$$SOR = AOR * \left(\frac{SOR}{AOR}\right) Ratio$$

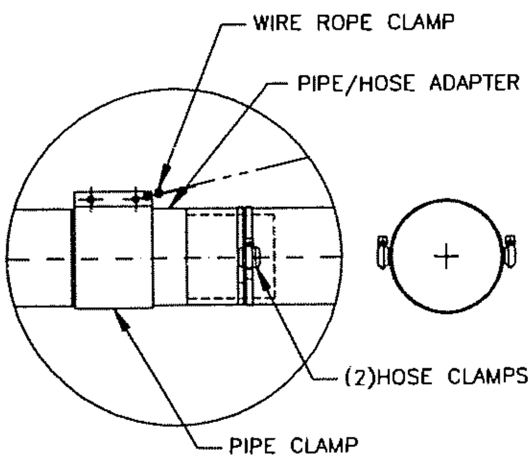
	Non-WaveOx	w/denit Credit	
SOR	19963.9	14457.7	lb O2/day
	831.8	602.4	lb O2/hr



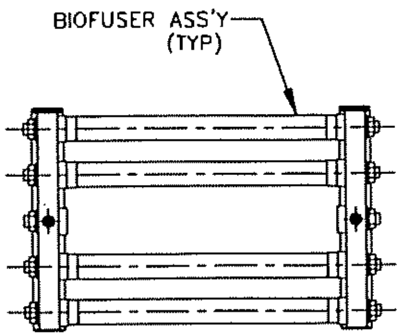
ELEVATION (BIOFLEX/BIOFUSER ASS'Y)



DETAIL "C"



DETAIL "A"



VIEW "B-B"

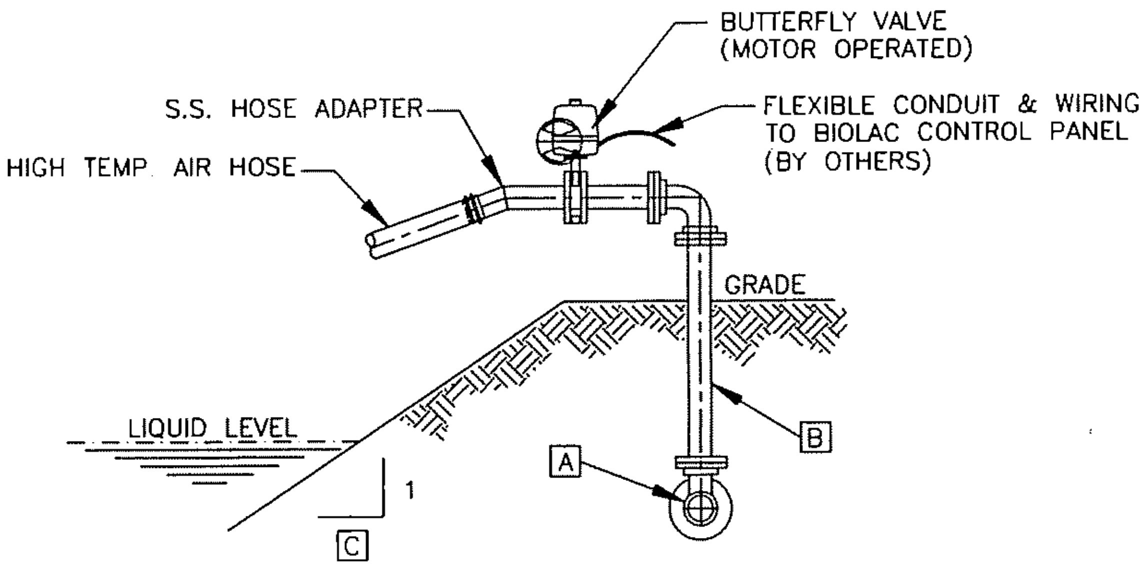
NOTES:

1. CIVIL & CONCRETE DESIGN NOT BY PARKSON CORP.
2. TWO(2)HOSE CLAMPS TO BE INSTALLED AT EACH HOSE CONNECTION. WHEN TIGHTENED, WORM GEARS SHOULD BE 180° FROM EACH OTHER.
3. BIOFLEX WILL BE PROVIDED IN STANDARD LENGTHS. FUSION WELDING & DRILLING DOWNCOMER HOLE IN FIELD WILL BE REQUIRED BY CONTRACTOR.

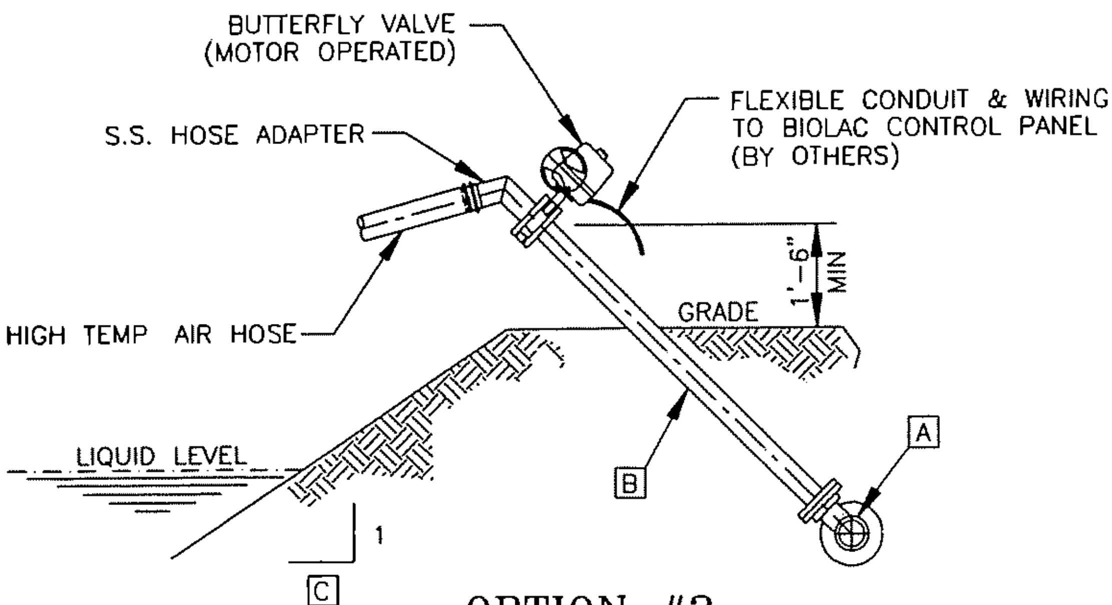
PARKSON CORPORATION

BIOLAC LONG SLUDGE AGE SYSTEM
BIOFLEX MOVING AERATION CHAIN
WITH BIOFUSER SERIES 2004

Drawn By G.C.	Checked By	Approved By	Micro Rev.	CAD No. SD-33	Loc. status LS
Date 2/1/96	Date	Date	Date	DWG Scale NONE	CAD init scale 64
Location			Dwg. No. SD-37		Rev A



OPTION #1



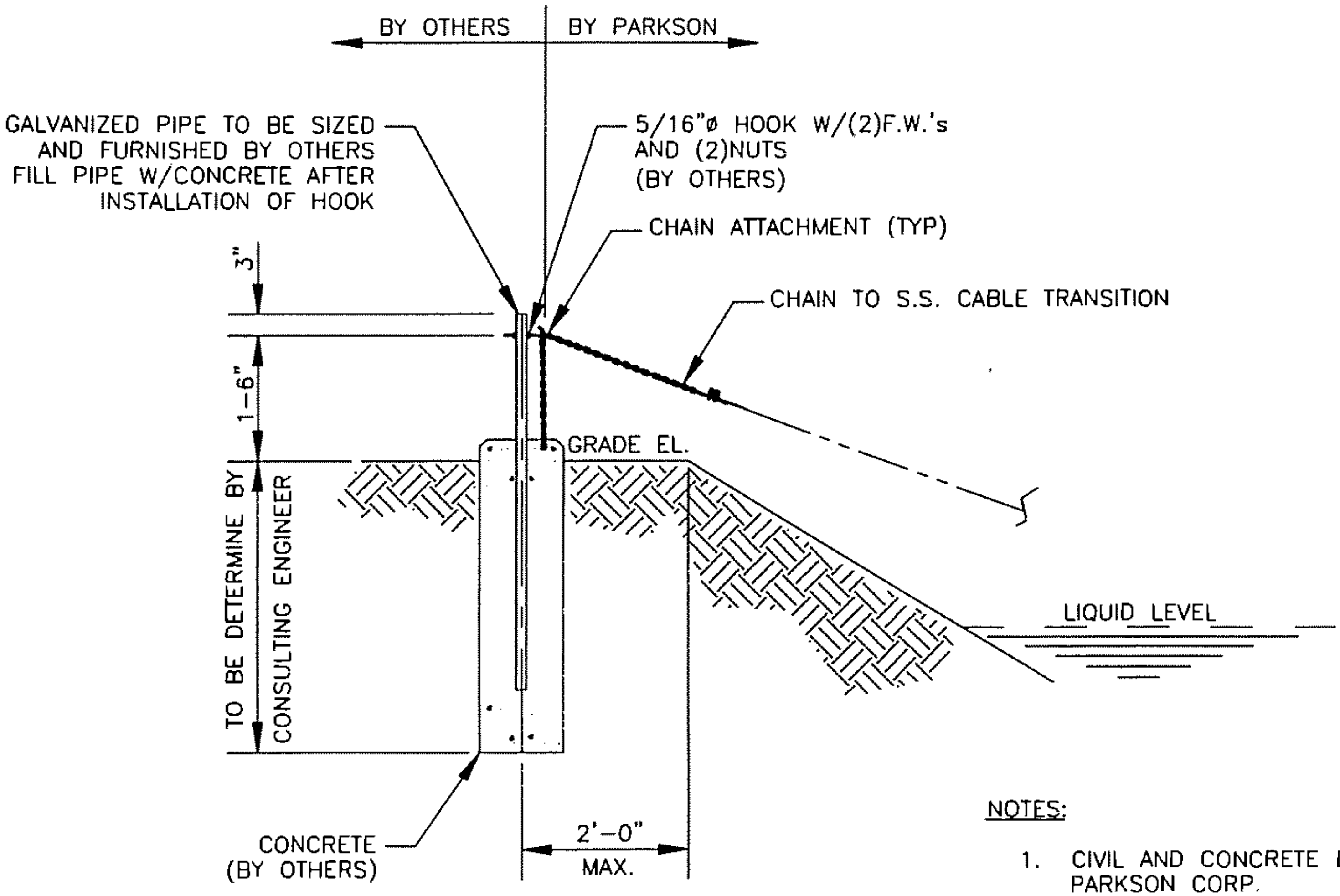
OPTION #2

ITEM	DESCRIPTION	DIM
A	AIR HEADER DIAMETER	
B	AIR FEED PIPE DIAMETER	
C	WALL SLOPE	

PARKSON CORPORATION

BIOLAC LONG SLUDGE AGE SYSTEM
WAVE-OX VALVES

Drawn By G.C.	Checked By	Approved By	Micro Rev.	CAD No. SD12	Loc status LS
Date 2/1/96	Date	Date	Date	DWG Scale NONE	CAD ini scale 37
Location			Dwg. No. SD-12		Rev A



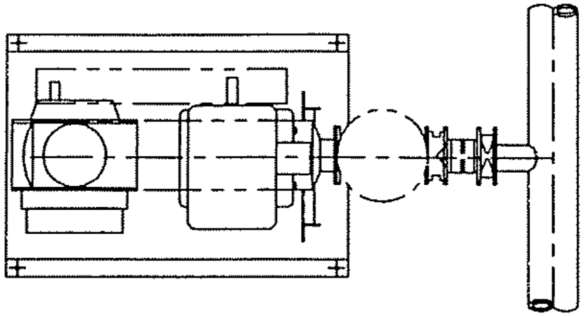
NOTES:

1. CIVIL AND CONCRETE DESIGN NOT BY PARKSON CORP.
2. PRELIMINARY DWG., NOT FOR CONSTRUCTION.

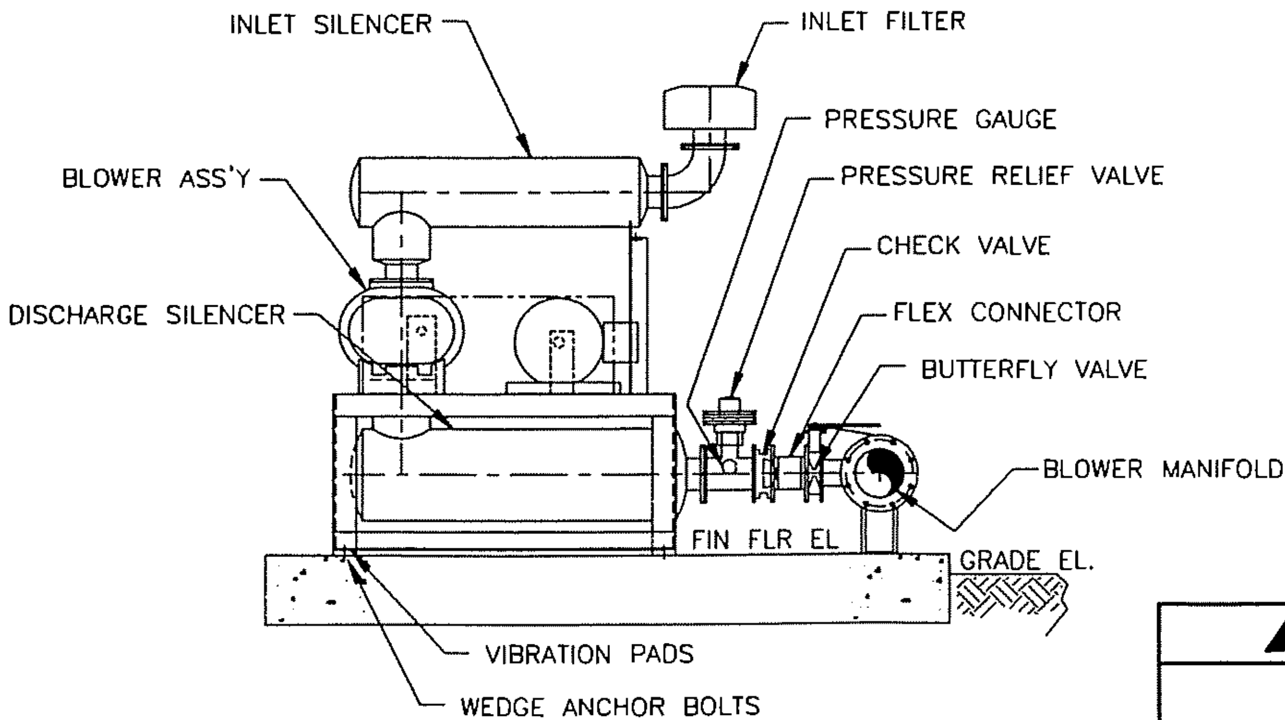
PARKSON CORPORATION

BIOLAC LONG SLUDGE AGE SYSTEM
ANCHOR POST W/HOOK DETAIL

Drawn By G.C.	Checked By	Approved By	Micro Rev.	CAD No SD7	Loc. status LS
Date 2/1/96	Date	Date	Date	DWG Scale NONE	CAD ini scale 24
Location			Dwg No. SD-7		Rev A



PLAN

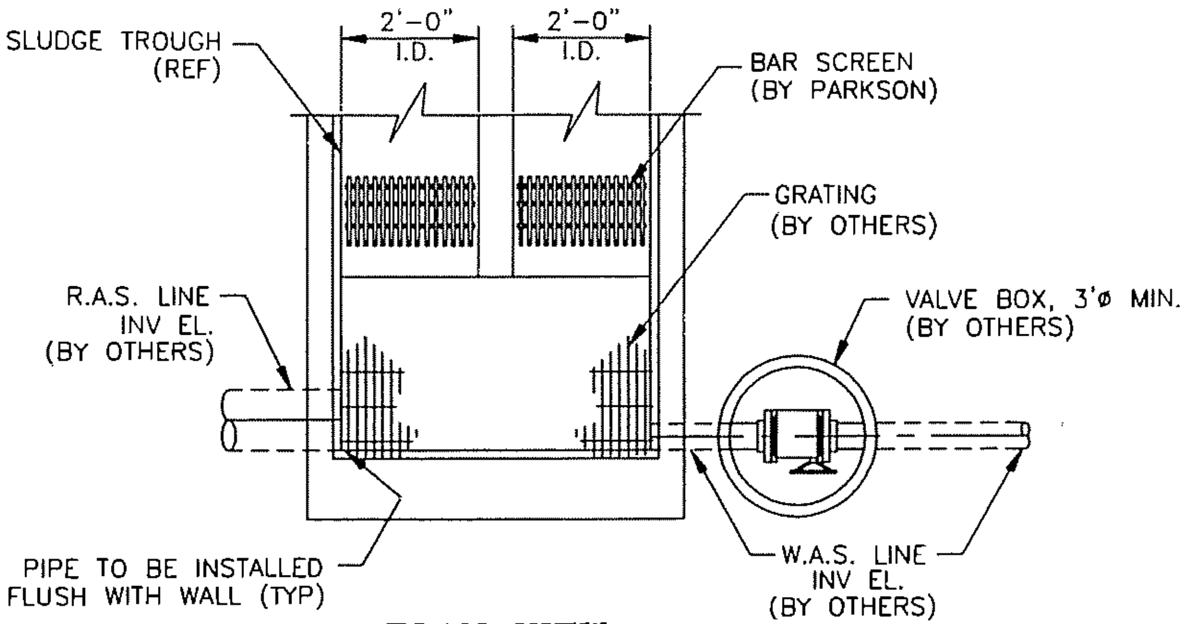


ELEVATION

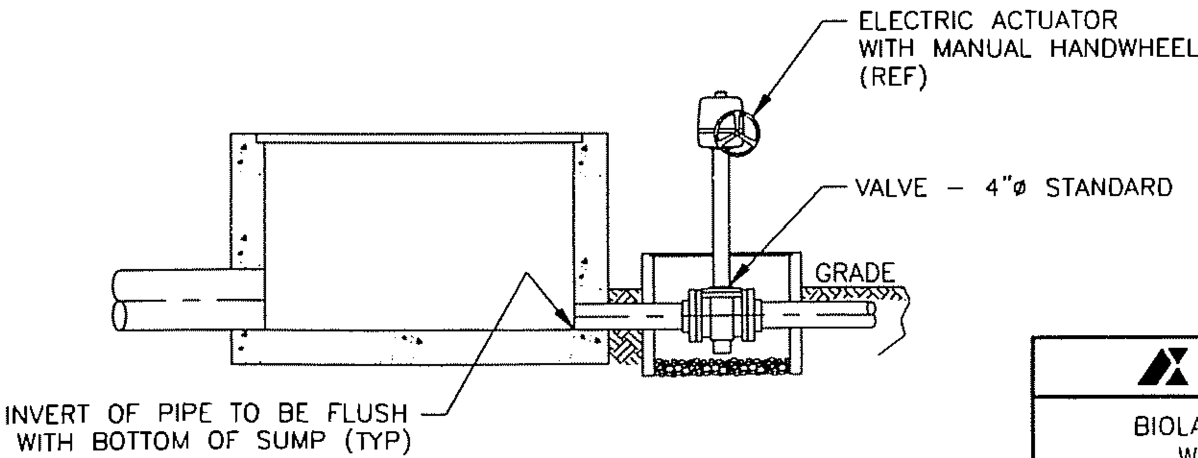
PARKSON CORPORATION

BIOLAC LONG SLUDGE AGE SYSTEM
POSITIVE DISPLACEMENT
AERATION BLOWER ASS'Y

Drawn By G.C.	Checked By	Approved By	Micro Rev.	CAD No. SD8	Loc. status
Date 2/1/96	Date	Date	Date	DWG Scale NONE	CAD int scale 32
Location			Dwg. No. SD-8		Rev A



PLAN VIEW



ELEVATION
(WALL OMITTED FOR CLARITY)

PARKSON CORPORATION

BIOLAC LONG SLUDGE AGE SYSTEM
WASTE SLUDGE VALVE ASS'Y

Drawn By	Checked By	Approved By	Micro Rev.	CAD No	Loc status
G.C.				5023	
Date 2/1/96	Date	Date	Date	DWG Scale	CAD ini scale 32
Location			Dwg. No SD-23		Rev A