City of Wasilla
Wastewater Outfall Feasibility Study

Prepared for:
City of Wasilla
290 E. Herning Avenue
Wasilla, AK 99654

Prepared by:
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725 East Fireweed Lane, #200
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Project No. 204700415

April 3, 2017

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Executive Summary

The City of Wasilla wastewater treatment plant was constructed in approximately 1989 to provide treatment for septic tank effluent pumped to the plant by a septic tank effluent pumping system. Effluent is treated in an aerated lagoon system, and disposed of in subsurface infiltration beds. While lagoon capacity is adequate, the capacity of the disposal beds at to the plant has been exceeded.

There are two primary capacity and treatment concerns:

1. Disposal beds have an effective capacity as low as *"100,000 gpd or possibly less.*[1]", much less than the originally expected design capacity. At higher flows, the beds flood, and effluent leaks from the ground surface on the slope surrounding the plant. Actual treatment flows averaged to 340,000 gpd in 2015.

2. In general, the nitrate levels in the shallow aquifer beneath the wastewater treatment plant exceed permitted values at the compliance monitoring wells. The City's permit allows for nitrate of up to 10 mg/l, but measured nitrate levels regularly exceed this value, with results averaging 12.7 mg/l. Nitrate is a "nutrient" byproduct of the wastewater treatment; high levels in groundwater present health risks.

To address the elevated levels of nitrate, and the capacity limitations of the WWTP effluent disposal system, this *Feasibility Study* examines the potential to use the 77-acre parcel adjacent to the existing wastewater treatment plant for treatment and /or disposal of effluent. This parcel, which consists primarily of wetlands, is owned by the City. The use of the wetlands for nitrate treatment of WWTP effluent to on the order of 300,000 gpd in the summer appears to be feasible, with potential to accommodate on the order of 500,000 gpd. Impacts to drinking water wells surrounding the wetlands and water treatment plant must be considered, although it appears the wetlands disposal will have less influence on existing wells that the current subsurface disposal beds, at least to the 300,000 gpd level.

Given the uncertainties inherent in wetland use, a pilot study followed by incremental development and monitoring is proposed. Initially, a pilot study should be completed to develop the necessary information to confirm the concept, the treatment capacities, and to provide information necessary for regulators to permit the project.

[1] 1986, November 14. RSE Group, Owen Ayers and Associates, Inc. Report on hydraulic impact analysis of the wastewater infiltration facility at Wasilla, AK.

Initial wastewater application to the wetlands without invasive construction in the wetlands is estimated to cost $980,000 for piping system, outfall, access, perimeter fencing and contingencies Construction of simple enhancements to wetlands retention to some extent should be anticipated and scheduled within a few years (1 to 5) of initial wetland use as channels and drainages form. Simple gravel pathways forming low (6-inch) berms would be constructed to create shallow impoundment and breakup stream flow. 4700 linear feet of pathways and berms is estimated to cost $429,000.

Abbreviations and Acronyms

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOL&WD	Alaska Department of Labor and Workforce Development
APDES	Alaska Pollutant Discharge Elimination System
AWWU	Anchorage Water and Wastewater Utility
BOD	biochemical or biological oxygen demand
cfs	cubic feet per second
City	City of Wasilla
CW	Constructed wetlands
CWA	Clean Water Act
DIP	ductile iron pipe
EAAS	Extended Aeration Activated Sludge
EPA	Environmental Protection Agency
ET	Evapotranspiration
FC/100 mL	fecal coliform per 100 milliliters
FCI	functional capacity index
FEMA	Federal Emergency Management Agency
FIPS	Federal Information Processing Standard
FOG	fats, oils, and greases
gpd	gallons per day
Gpm	gallons per minute
GPS	global positioning system
HLRs	hydraulic loading rates
JD	jurisdictional determination
L	Liter
LF	linear feet
MBR	membrane bioreactor
MCL	maximum contaminant levels
MG	million gallons
mg	milligram
mg/L	milligram per liter
mgd	million gallons per day
MSB	Matanuska –Susitna Borough
MW	monitoring wells

NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resource Conservation Service
NTL	NTL Alaska, Inc.
NWI	National Wetland Inventory
O&M	operations and maintenance
OLR	organic loading rate
PIT	pilot infiltration test
RCRA	Resource Recovery and Conservation Act
RSE	RSE Engineers
S&W	Shannon and Wilson, Inc.
SDWR	Secondary Drinking Water Regulation
sf	square foot
Stantec	Stantec Consulting Services Inc.
STEP	septic tank effluent pumping
TSS	Total suspended solids
US	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WELTS	Well Log Tracking System
WWTP	wastewater treatment plant

1.0 INTRODUCTION

The City of Wasilla (City) wastewater treatment plant (WWTP) was constructed in approximately 1989 to provide treatment for septic tank effluent pumped to the plant by a septic tank effluent pumping (STEP) system. Effluent is treated in an aerated lagoon system, and disposed of in subsurface infiltration beds. While lagoon capacity is adequate, the capacity of the currently available disposal beds at to the WWTP has been exceeded.

The City disposal system is acknowledged to exceed capacity in two primary areas:

1. WWTP treatment capacity is limited by the capacity of the existing disposal beds. The actual operating capacity is much less than the original design anticipated due to presence of low permeability soils below the WWTP. Actual capacity may only be "*on the order of 100,000 gallons per day (gpd) or possibly less*.[2]" and potentially lower (see Section 3.3.3). At higher flows, the beds flood, and effluent leaks from the ground surface on the slope surrounding the WWTP. Actual treatment flows averaged to 340,000 gpd in 2015.

2. Nitrate treatment must be improved. Nitrate is a "nutrient" byproduct of the wastewater treatment; high levels in groundwater present health risks. The nitrate levels in the shallow aquifer beneath the WWTP exceed permitted values at the compliance monitoring wells. The WWTP permit allows for nitrate of up to 10 mg/l, but measured nitrate levels regularly exceed this value, with results averaging 12.7 mg/ l, with a maximum one-time report of 77 mg/L since 1997.

1.1 REPORT PURPOSE

To address the elevated levels of nitrate, and the capacity limitations of the WWTP effluent disposal system, the City has contracted with Stantec Consulting Services Inc. (Stantec) to examine the potential to use the 77-acre parcel adjacent to the existing WWTP for treatment and /or disposal of effluent from the WWTP. This parcel, which consists primarily of wetlands, has been purchased by the City.

The City's *Wastewater Outfall Feasibility Study* (*Feasibility Study*) has two goals: first, address the nitrate compliance problems from the existing effluent percolation beds, and second, maximize the disposal capacity of the WWTP within the property limits.

The *Feasibility Study* provides the following:

- Project Planning (Section 2.0)

[2] 1986, November 14. RSE Group, Owen Ayers and Associates, Inc. Report on hydraulic impact analysis of the wastewater infiltration facility at Wasilla, AK.

- A review of the existing WWTP facilities (Section 3.0)
- Discussion of need for the proposed project (Section 4.0)
- Criteria for project development (Section 5.0)
- Potential improvement alternatives (Section 6.0)
- Alternative evaluation and comparison (Section 7.0)
- Proposed Project – Recommended Alternative (Section 8.0)
- Project Recommendations (Section 9.0)

This *Feasibility Study* is generally organized in accordance with the preliminary engineering report outline defined by US Department of Agriculture (USDA) Rural Utilities Service Bulletin 1780-2[3]. As the USDA outline is accepted by a variety of agencies, and captures environmental data required by regulatory and funding agencies, it has been used to the extent possible to create a complete project report. If this *Feasibility Study* is to be used for City funding efforts with agencies requiring the USDA format, the only major items that will need to be added are a utility financial analysis, facility audits, and lifecycle costing of alternates. The USDA outline begins with a thorough review of background and existing conditions. Alternative development, proposed work, is discussed in Section 6.0.

1.2 AGENCY AND STAKEHOLDER SCOPING

As part of the *Feasibility Study,* comments were solicited from a number of applicable federal, state, and local agencies, as well as other stakeholders using an agency scoping process. The scoping process to identify potential environmental, regulatory, and other impacts associated with the proposed alternative under consideration. Results from the scoping process are included throughout the *Feasibility Study* as appropriate with documentation and summary of scoping efforts and associated responses in Appendix A.

1.3 INVESTIGATIONS

In support of this feasibility study, the Stantec team has conducted several investigations and site visits. These studies are discussed throughout the report as appropriate and include:

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[3] 2013. US Department of Agriculture (USDA) Rural Utilities Service. Bulletin 1780-2 Preliminary Engineering Reports for the Water and Waste Disposal Program. Available at https://www.rd.usda.gov/files/UWP_Bulletin_1780-2.pdf.

Geotechnical Investigations: In 2015, Shannon and Wilson, Inc. (S&W) conducted geotechnical investigations on the new 77-acre parcel west of the existing WWTP. The investigations included borings, soil sampling and percolation testing. The results of the S&W effort are discussed in Section 3.4 with a geotechnical data report provided in Appendix B[4].

Groundwater Study: A thorough understanding of the regional groundwater gradients and flow rates was required for the development of conceptual design presented in this *Feasibility Study*. S&W developed a groundwater model to depict existing conditions and groundwater flows, and to predict the resulting groundwater flows and impacts from the alternatives considered in this report. The modeling report is presented in Appendix C with geotechnical engineering recommendations for development[5].

Wetlands Delineation: In September 2014, Stantec delineated wetlands and assessed habitat on the parcel west of the WWTP. The results of these efforts are discussed in Section 3.4 and a full wetlands delineation report is provided in Appendix D.

Survey: For this feasibility study, Matanuska-Susitna Borough (MSB) mapping and LIDAR topography is generally sufficient. To supplement the available information, Stantec performed a limited survey to determine wetland boundaries, establish control, and record locations of geotechnical borings. This information is not presented separately, but has been incorporated into the conceptual designs and figures provided.

Wetland Analysis: Development of concept designs required understanding of treatment potentials. Wetland modeling and calculation results are included in Appendix E.

Effluent Study: The WWTP does a good job of maintaining process control and regulatory compliance testing. In addition to this data, groundwater and surface waters were sampled and tested within the study area for nitrate, ammonia, and fecal coliform bacteria. Analysis reports for these tests are provided in Appendix F. Additional testing needs are discussed in Appendix G.

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4 2016, June. S&W. Revised Geotechnical Report, Water Treatment Plant Improvements, Wasilla, Alaska (Geotechnical Data Report).

5 2016, October. S&W. Revised Geotechnical Engineering and Hydrogeologic Assessment, Water Treatment Plant Improvements, Wasilla, Alaska (Hydrogeologic Assessment, Appendix C).

2.0 PROJECT PLANNING

2.1 LOCATION

Wasilla was named after the respected local Dena'ina Indian, Chief Wasilla (also known as Chief Vasili). In the Dena'ina Athabascan Indian dialect, "Wasilla" is said to mean "breath of air" or he may have taken his name from the Russian Vasili. The townsite was established in 1917 along the Alaska Railroad and was incorporated in 1974 as a second class city.

Wasilla incorporated as a First Class City within the MSB in 1984. It encompasses 11.7 square miles of land and 0.7 square miles of water as shown in Figure 1.

Wasilla is located between lakes Wasilla and Lucille, approximately 1 hour from Anchorage (about 43 miles) on the George Parks Highway. The community is situated at approximately 61.58 latitude and -149.44 longitude.

2.2 ENVIRONMENTAL RESOURCES PRESENT

The following general conditions have been determined for the project area. Many of these issues were vetted with agencies and other stakeholders in the project scoping done to date. A full scoping report is available in Appendix A.

2.2.1 Soils

The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Soil Survey provides detailed coverage of the study area. The NRCS Soil Survey (2007) map units within the study area consist of Kalmbach silt loam (loess over gravelly till), cryaquepts, depressional, 0-7 percent slopes (silty volcanic ash and/or silty loess over gravelly glacial drift and/or loamy outwash), histosols (organic material over organic material and/or gravelly alluvium and/or loamy glacial drift), Cryods and Cryochrepts (silty volcanic ash and/or silty loess over gravelly glacial drift and/or loamy outwash), and Knik silt loam (loess over sandy and gravelly outwash). Soils within the study area were formed following repeated glacial advances and retreats during the Pleistocene epoch (10,000 to 2 million years ago)[6]. Topography relief of the study area and surrounding area consists of rolling hills with scattered ponds, lakes, and wetlands in the catchment basins. A site-specific investigation was completed and is discussed in Section 3.4.2.

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[6] Jokels, J.B., J.A. Munter, and J.G. Evans. 1991. Report of Investigations 90-4. Ground-Water Resources of the Palmer-Big Lake Area, Alaska: A Conceptual Model. State of Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys.

2.2.2 Wetlands and Waters of the U.S.

A review of the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory[7] and Cook Inlet Wetland Inventory[8] show wetlands within the proposed project study area. The wetland types have been confirmed with a formal delineation (see Section 3.4). Placement of fill within wetlands or ordinary high water of Waters of the U.S., will require a United States Army Corps of Engineers Clean Water Act Section 404 permit[9].

2.2.3 Floodplains

A review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps and FEMA's National Flood Hazard Layer[10] identified only 0.2 percent or 500-year Floodway Hazard Areas within the project study area. The majority of the City and the Core Area of the MSB are located within the 0.2 percent or 500-year Floodway Hazard Areas.

2.2.4 Water Quality

A review of the Alaska Department of Environmental Conservation (ADEC) Impaired Waters List[11] did not identify impaired waters within the proposed project study area vicinity. As of September 2010, Cottonwood Creek was listed as a Category 5/Section 303(d) waterbody impaired with fecal coliform, and Lake Lucille was listed as a Category 4a waterbody impaired with low dissolved oxygen concentrations. Both of these waterbodies are in the City, but are considerably upstream of the WWTP; are 0.67 and 2 miles away, respectively; and do not communicate with the proposed project. The purpose of the proposed project is to regain compliance with the requirements of the Alaska Pollutant Discharge Elimination System (APDES) permit and no impacts beyond those resulting from non-compliance are anticipated.

2.2.1 Fish and Wildlife

2.2.1.1 Fish

The Alaska Department of Fish and Game (ADF&G) Fish Resource Monitor identifies the Palmer Slough and Wasilla Creek as the closest anadromous water bodies due to the presence of Chum, Coho, and Chinook salmon. These waters are not within the boundary of the site and no Essential Fish Habitat exists for any protected species under the Magnuson-Stevens Fishery Conservation and Management Act within the proposed project study area vicinity, thus no Fish Habitat Permits will be required[12].

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7 USFWS NWI, http://www.fws.gov/wetlands/Data/Mapper.html
8 Cook Inlet Wetland Inventory, http://cookinletwetlands.info/
9 USACE Clean Water Act Section 404 permit, http://www.poa.usace.army.mil/
10 FEMA, Map Service Center http://msc.fema.gov/portal/resources/productsandtools
11 ADEC, Impaired Waters, https://dec.alaska.gov/water/wqsar/Docs/Impairedwaters.pdf
12 ADF&G Anadromous Waters Catalog, https://www.adfg.alaska.gov/sf/SARR/AWC/

2.2.1.2 Eagles and Migratory Birds

An eagle nest survey has not been completed for the proposed project study area at this time, but geographic information system (GIS) data reviewed[13] shows no nests are within 660 feet of the proposed project area vicinity. If bald eagle nests are found within the vicinity of the project area, then monitoring and construction periods would comply with USFWS protocol under the Bald Eagle Protection Act.

Migratory birds are protected under the Migratory Bird Act and many projects in Alaska require that the USFWS time periods for avoiding vegetation clearing to protect migratory birds be followed. This is often a condition of United States Army Corps of Engineers (USACE) permit. According to the USFWS *Land Clearing Timing Guidance for Alaska*, this would exclude clearing in the project area from April 1st to July 15th of any calendar year[14], because of the potential for Canada geese and swan nesting activities. Active nests discovered outside local timing windows, must be left in place and protected until young hatch and depart[15].

2.2.1.3 Threatened and Endangered Species

A review of the USFWS Environmental Conservation Online System did not identify threatened or endangered Species within the proposed project study area vicinity[16].

2.2.2 Cultural Resources

The State Historic Preservation Office confirmed that there are no known or previously-recorded cultural resource sites in the area (Appendix A). The possibility does remain that previously unidentified resources may be located. If historic or cultural resources are identified during the course of the project, further consultation with the State Historic Preservation Office will be required and requirements of the Alaska Historic Preservation Act and/or Section 106 of the National Historic Preservation Act must be followed. Additional consultation with the State Historic Preservation Officer, MSB, tribal entities, and other consulting parties maybe required as the project progresses[17].

2.2.3 Air Quality

There are no nonattainment areas in the City or the MSB and it is not expected that the project would directly affect air quality[18].

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13 USFWS, Alaska Bald Eagle Nest Atlas—computer database http://www.fws.gov/alaska/mbsp/mbm/landbirds/alaskabaldeagles/default.htm
14 USF&WS. *Land Clearing Timing Guidance for Alaska*, available at http://www.fws.gov/alaska/fisheries/fieldoffice/anchorage/pdf/vegetation_clearing.pdf
15 USFWS Migratory Bird Treaty, http://www.fws.gov/alaska/mbsp/mbm/
16 USFWS Listed and Candidate Species, http://www.fws.gov/alaska/fisheries/endangered/species.htm
17 ADNR, Office of History & Archaeology, http://dnr.alaska.gov/parks/oha/
18 USEPA Nonattainment Areas for Criteria Pollutants (Green Book), https://www.epa.gov/green-book.

2.2.4 Contaminated Sites, Spills, Underground Storage Tanks, and Hazardous Materials

A review of the ADEC Contaminated Sites Program Database[19] found several inactive contaminated sites within the overall vicinity where cleanup has been completed. No contaminated sites are in the direct vicinity of the WWTP and the ADEC identified no actively managed sites in the project area.

2.2.5 State Refuges, Sanctuaries, Critical Habitat Areas, and Wildlife Ranges

A review of the ADF&G Refuges, Sanctuaries, Critical Habitat Areas, and Wildlife Ranges identified Palmer Hay Flats State Game Refuge, which is more than 2 km to the south, but not directly in the proposed project study area vicinity. No other protected areas or Critical Habitat were identified in the proposed project area vicinity[20].

2.2.6 National Parks, Preserves, Monuments, and Wild and Scenic Rivers

A review of the National Park Service National Parks and Wild and Scenic River listings did not identify national parks, preserves, monuments, or wild and scenic rivers within the proposed project study area vicinity.[21]

2.2.7 Land Use

A review of the MSB *Geographical Information System and Property Database* indicates multiple private land owners, as well as the Alaska Railroad, and the State of Alaska own land surrounding the proposed site. Construction alternatives would comply with all MSB permits and best management practices[22].

2.3 POPULATION TRENDS

The City is the largest community in one of Alaska's fastest growing areas, the MSB. The local economy is diverse, and residents are employed in a variety of government, retail, and professional service positions, with many residents also commuting into Anchorage. Tourism, agriculture, wood products, steel, and concrete products are all part of the local economy.

19 ADEC Contaminated Sites Program Database, https://dec.alaska.gov/spar/csp/db_search.htm
20 ADF&G Conservation Areas, http://www.adfg.alaska.gov/index.cfm?adfg=conservationareas.locator.
21 National Wild and Scenic Rivers System, http://www.rivers.gov/alaska.php.
22 Based on information from the MSB, http://www.matsugov.us/shapefiles.

Located in the MSB census area (Federal Information Processing Standard [FIPS] Code 83080), the City population record is shown in Table 1 The 2016 value is estimated by the Alaska Department of Labor and Workforce Development (ADOL&WD), Research and Analysis Section, which put the MSB growth rate at between 1.45 and 2.57 percent through 2042.[23]

Table 1: City of Wasilla Population History

Census	Estimated Population
1950	96
1960	112
1970	300
1980	1,559
1990	4,028
2000	5,469
2010	7,831
2016	8,704 [24]

2.4 COMMUNITY ENGAGEMENT

As noted previously, a scoping effort to engage applicable federal, state, and local agencies has been conducted and is summarized in Appendix A. Results from these efforts are included throughout the *Feasibility Study* as appropriate. Additional community engagement is anticipated as the project develops.

23 "Alaska Population Projections 2012 to 2042". ADOL&WD, Research and Analysis Section. Accessed January 2016. http://labor.alaska.gov/research/pop/projected/data/BCAProjections.xls

24 "Alaska Population Estimates by Borough, Census Area, City, and Census Designated Place (CDP), 2010 to 2016". ADOL&WD, Research and Analysis Section. Accessed January 2017. http://live.laborstats.alaska.gov/pop/estimates/data/TotalPopulationPlace.xls

CITY OF WASILLA
WASTEWATER OUTFALL FEASIBILITY STUDY

Project Planning
April 3, 2017

3.0 EXISTING FACILITIES

The City was incorporated as a First Class City within the MSB in 1973. It encompasses 13.4 square miles of land and 1 square mile of water as shown in Figure 1. It is the largest community in one of Alaska's fastest growing areas, the Matanuska-Susitna Borough.

3.1 WASTEWATER SYSTEM HISTORY

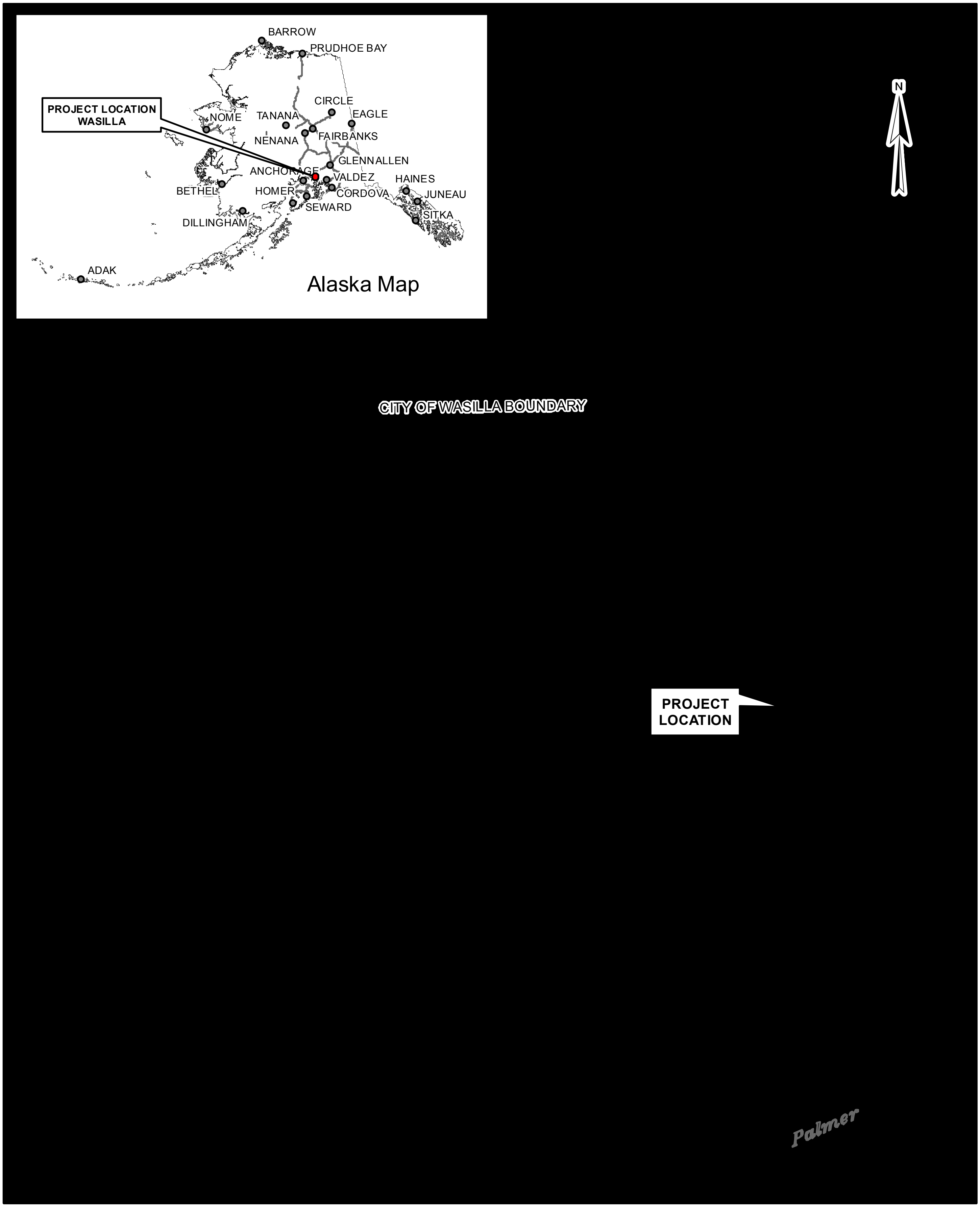
The City's water and sewer utilities are limited in service area. The wastewater system is a septic tank effluent pumping (STEP) system, collecting only settled septic effluent from customers via a force mains system. Most customers are pumped. A few areas tie into the gravity main that runs down Old Matanuska Road, but all connections have septic tanks.

The original WWTP was constructed in approximately 1989. Initially effluent from onsite private septic systems was pumped to the WWTP and treated in a circular clarifier discharging directly to nine percolation beds. Septage from the customer's septic tanks was pumped periodically and trucked for treatment in the aerobic digester. Only septage from the STEP system customers is accepted at the WWTP because of capacity issues. Other septage is trucked by commercial haulers to Anchorage.

Several system upgrades have occurred since the WWTP began operations. The current four-cell aerated lagoons system was added to improve treatment quality and remove biochemical oxygen demand (BOD) and total suspended solids (TSS), in theory allowing the percolation beds to be loaded at a higher rate. A pump house was also added to circulate the lagoons and control the discharge and routing of the treated effluent to the various beds. In September 2015 the influent measurement weir was taken offline because of issues with the ultrasonic meter and recording devices. Influent measurement is now conducted with an inline meter[25].

Figure 2 shows the existing WWTP site. Figure 3 and Figure 4 show the flow routing and hydraulic profile based on record drawing information. Table 2 summarizes available record or design drawings of previous projects and the related changes to WWTP systems.

[25] John Becker, City of Wasilla: Phone Conversation with Stephanie Gould, Stantec. January 6, 2016.



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WASILLA VICINITY

DATE	FIGURE
3/31/17	1

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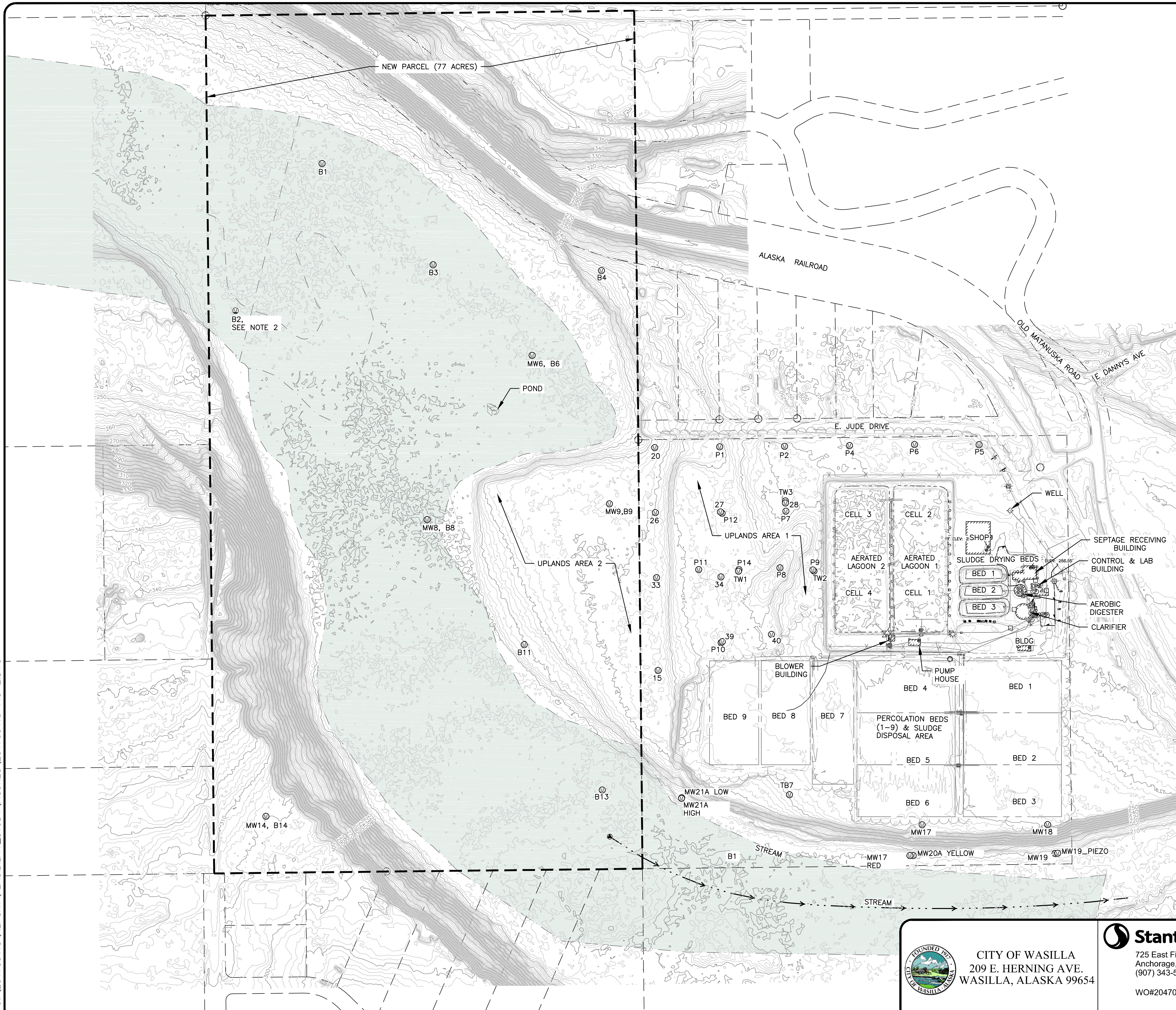

LEGEND

- APPROXIMATE STREAM CHANNEL
- PARCEL BOUNDARY
- WETLANDS
- MW-18 — 2016 BORINGS

NOTES:

1. CONTOURS SHOWN ARE BASED ON 2001 MSB LIDAR DATA. CONTOURS WITHIN NEW PARCEL WETLANDS HAVE BEEN ESTIMATED.
2. B2 WAS NOT FOUND DURING SURVEY AND LATER INVESTIGATED AND IS BELIEVED TO HAVE BEEN BROKEN.

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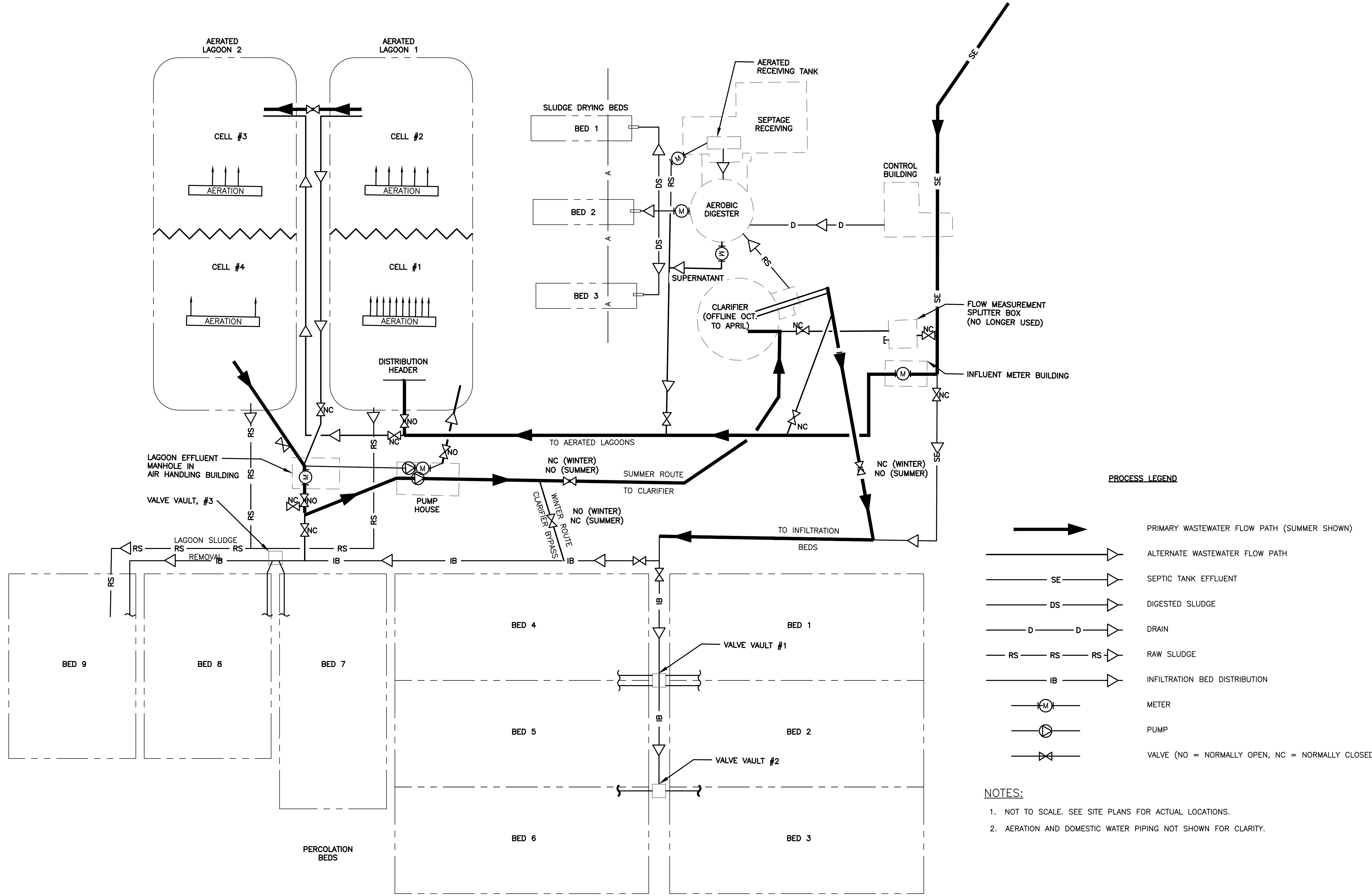
EXISTING WASTEWATER TREATMENT PLANT SITE

DATE	FIGURE
3/27/17	2

U:\204700415\REPORT\FEASIBILITY_STUDY\FIGURES\204700415-FIG-2.DWG



NOTES:

1. NOT TO SCALE. SEE SITE PLANS FOR ACTUAL LOCATIONS.
2. AERATION AND DOMESTIC WATER PIPING NOT SHOWN FOR CLARITY.

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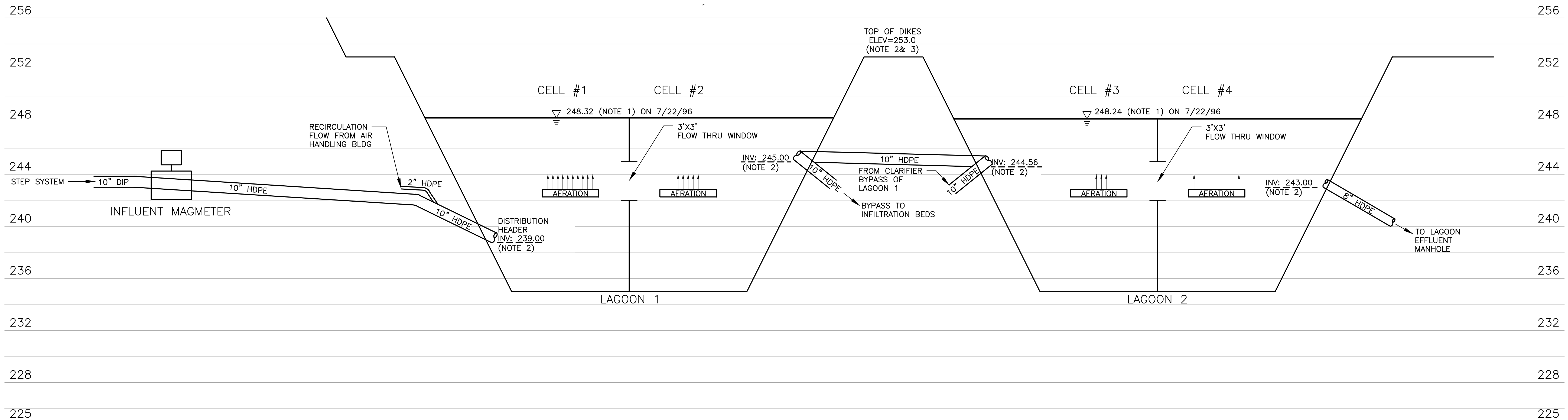
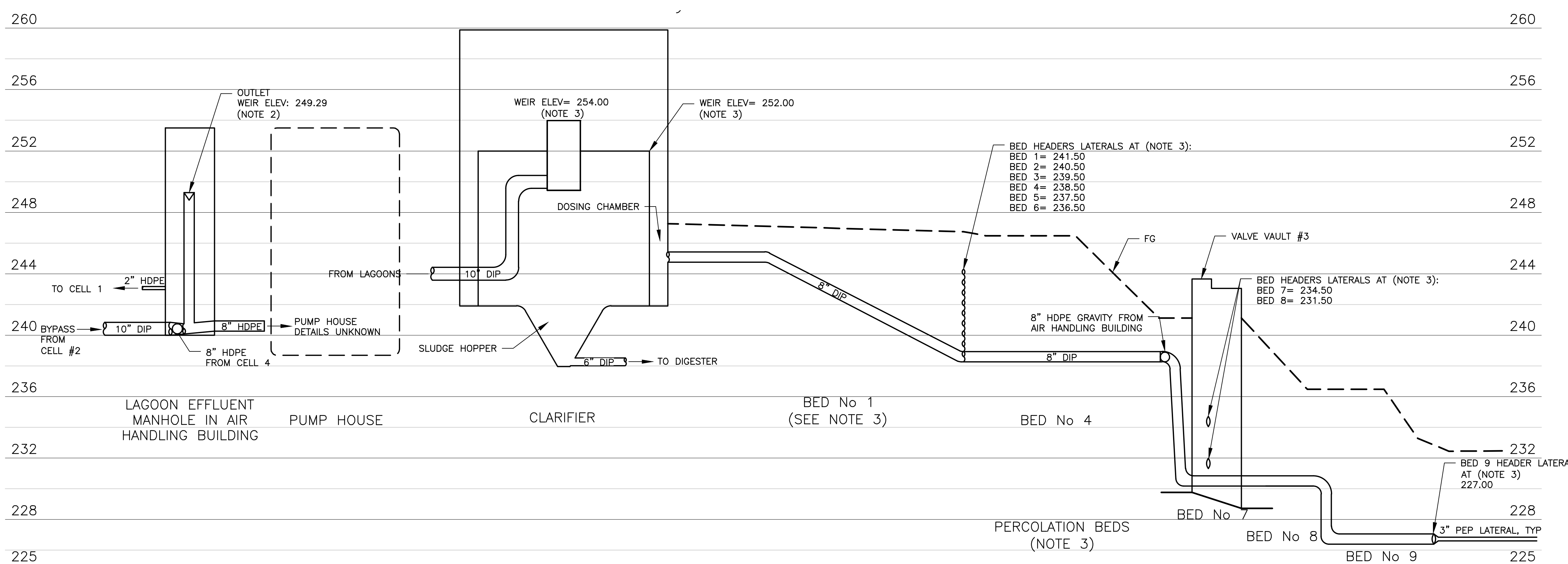
PLANT SCHEMATIC FLOW DIAGRAM

DATE	FIGURE
3/31/17	3

U:\204700415\REPORT\FEASIBILITY_STUDY\FIGURES\204700415-FIG-3.DWG





NOTES:

1. BASED ON TOPOGRAPHIC SURVEY BY ALASKA RIM ENGINEERING, REVISION DATE 03/07/97.
2. BASED ON WASILLA SEWERAGE FACILITIES TREATMENT SYSTEM DESIGN BY POLARCONSULT ALASKA, INC, DATED 03/15/93.
3. BASED ON WASILLA SEWERAGE FACILITIES TREATMENT SYSTEM DESIGN BY CH2M HILL DATED JUNE 1984.
4. TYPICAL BED SECTION CALLS FOR 6" OF FILTER ROCK BENEATH HEADER ELEVATION, SEE NOTE 3.

U:\204700415\REPORT\FEASIBILITY_STUDY\FIGURES\204700415-FIG-4.DWG

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PLANT HYDRAULIC PROFILE

DATE	FIGURE
3/31/17	4

Table 2: WWTP Improvement Projects[26]

Project Name	Construction Year (approx.)	Impacted System	Description
City of Wasilla - Sewerage Facilities	1985	Initial System Construction	Schedules C and T, Volume 3 of 4 Construction of STEP main, 3 sludge lagoons, clarifier, digester, control building, and 9 infiltration beds
Wasilla Sewerage Facility Waste Water Disposal Site	1986	Monitoring Wells	Survey of 19 monitoring wells and 1 water supply well with water levels, construction detail, and cross-sections
Wasilla Sewerage Facilities Treatment System	1994	Aerated lagoons	Construction of 2 aerated lagoons and air handling building
Clarifier Bypass Project	1999	Piping and valves	Piping construction to allow for clarifier bypass
Wasilla Septage Facility Improvements - Phase A	2000	Septage receiving building, Digester	Volume 3 Constructed Septage Receiving Building with associated well & digester improvements
Wasilla Septage Facility Improvements - Phase B	2001	Digester, Emergency generator	Volume 2 New emergency generator, and digester improvements
Wasilla Sewage Lagoon Aeration System Improvements	2001	Aerated lagoons	Included Parkson Biolac Treatment System Purchase: Blower Assembly & BioFlex/BioFuser

3.2 ADEC FACILITY PERMIT

The City WWTP is permitted under an ADEC wastewater discharge permit, 9622-DB006, which allows discharge to the subsurface. The permit was to expire December 1, 2001, and has been administratively continued as of the writing of this report.

Under the permit a maximum of 400,000 gpd of treated wastewater may be disposed. Monitoring and effluent limitations are summarized in Table 3[27]. As discussed in Section 3.3.1, this is within the expected capacity of the lagoon treatment system, but exceeds the capacity of the existing percolation beds. Note that "effluent" parameters are sampled in ground water monitoring wells a short distance downstream from the beds. The WWTP property boundaries are such that there is very little distance available between point of discharge and point of compliance for dilution or dissipation into the groundwater.

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26 Only projects with reviewed record or design drawings are listed here.
27 Alaska Department of Environmental Conservation (ADEC). Table based on Permit No. 9622-DB006, issued December 16, 1996.

Table 3: Effluent Permit Conditions

Monitoring Description	Effluent Limitation	Monitoring Frequency	Sample Type
Effluent Metals			
Lead	Report	Annual[1]	Grab
Chromium	Report	Annual[1]	Grab
Cadmium	Report	Annual[1]	Grab
Mercury	Report	Annual[1]	Grab
Silver	Report	Annual[1]	Grab
Groundwater[1]			
Fecal Coliform	1 FC / 100 mL	Quarterly/Annually[2]	Grab
Nitrate as Nitrogen	10 mg/L	Quarterly/Annually[2]	Grab
Conductivity	Report	Quarterly/Annually[2]	Grab
pH	6.5 to 8.5	Quarterly/Annually[2]	Grab

Notes:

1. Sampling to be done in June from monitoring wells 7, 17A, 18A, and 19.
2. Quarterly sampling to be done in March, June, September, and December from monitoring wells 7, 17A, 18A in the upper aquifer, and in June as an annual sample from Monitoring Well 19 in the lower aquifer.

3.2.1 ADEC System Classification

The WWTP is classified by ADEC as a Class 2 treatment facility. In Alaska, wastewater systems are classified based on a point rating system for both treatment and collection systems. Point values are assigned for each of the various components found in the WWTP per Alaska Administrative Code (AAC) Title 18 Chapter 74 (18 AAC 74). The City's current treatment scoring is shown in Table 4 as provided by ADEC. [28]

[28] ADEC. *Alaska Certified Water/Wastewater Operator Database*. 2015.Available at https://dec.alaska.gov/Applications/Water/OpCert/Home.aspx?p=SystemSearchRecord&d=122&search=Wasilla.

Table 4: Existing Wasilla Wastewater Treatment Classification Score

Score Category	Score
Size (Peak day design capacity, gpd) – 100,001 to 500,000	9
Pretreatment – Influent Pumping	2
Pretreatment – Manually Cleaned Screens	1
Pretreatment – Fine Screens, including microscreens	3
Pretreatment – Grit Removal	2
Secondary Treatment - Aerated lagoons	8
Secondary Treatment – Secondary Clarifiers	4
Sludge Thickening and Dewatering – Evaporative sludge drying by means of drying beds	2
Sludge Stabilization and Conditioning – Aerobic Digestion	5
Solids Disposal – Land Application, if controlled and operated by the operator as part of routine system operations	5
Total	**41**

Should the Wasilla system complexity change, the system could be reclassified as indicated below:

- Class 1: Score 1 to 30.
- Class 2: Score 31 to 55.
- Class 3: Score 56 to 75.
- Class 4: Score greater than 75.

The Wasilla WWTP can gain up to 14 more points before being reclassified to a Class 3 plant. A few of the elements that would increase the WWTP scoring include increase to size (3-point increase for 500,001gpd to 1 million gallons per day [mgd]), chemical addition (3-point increase to clarifier), biological nutrient removal (12-point increase), and effluent pumping or aeration (2-point increase). The WWTP employs operators with level 1, level 2, and level 3 certificates. No changes to operator certifications are expected to be required by the alternatives proposed in this project[29].

[29] ADEC. *Alaska Certified Water/Wastewater Operator Database*. 2015. Available at https://dec.alaska.gov/Applications/Water/OpCert/Home.aspx?p=SystemSearchRecord&d=122&search=WASilla

3.3 CONDITION OF EXISTING FACILITIES - WASTEWATER TREATMENT PROCESS

The existing City wastewater treatment process is shown in Figure 2 Existing Wastewater Treatment Plant Site, Figure 3 Plant Schematic Flow Diagram, and Figure 4 Plant Hydraulic Profile. Septic tank effluent is pumped through the STEP main to the WWTP. At the WWTP, the flow is measured, routed through aerated lagoons and then a clarifier (summer only) for treatment, and finally discharged to percolation beds. The clarifier is bypassed in the winter to avoid freezing issues. Septage is collected from the onsite septic tanks and trucked to the receiving facility where it is sent through a bar rack and grit screen and into an aerobic digester for reduction. Approximately monthly, sludge is dewatered using a screen press before being sent to the sludge drying beds. Sludge drying beds are “emptied” in May or June each year and placed on top of the percolation beds. Supernatant from the digester is either sent to the lagoons, or discharged to the drying beds.

The following sections highlight existing wastewater treatment system elements considered elsewhere in this report.

3.3.1 Aerated Lagoons

There are two partially mixed, aerated lagoons at the facility. Each lagoon includes a floating curtain wall to form two cells (four total) and allow for decreasing levels of aeration. The lagoons are the same size with top dimensions of 172 feet long by 453 feet wide, and bottom dimensions of 100 by 381 feet. The lagoons are approximately 15 feet deep and have a capacity of approximately 5.8 million gallons each. The lagoons are surrounded by a dike with a top elevation of approximately 253 feet and a 10-foot width, allowing for approximately 3 feet of freeboard. The aeration system is design to provide approximately 50, 25, 15 and 10 percent air to each cell according to design drawings[30,31].

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30 Based on design drawing C-2 “*Treatment Facility and Lagoon Site Plan*”, Wasilla Sewerage Facilities Treatment System, Polarconsult Alaska, Inc. Dated 5/8/1993.

31 LCMF Incorporated and GV Jones & Associates, Inc. *Wasilla Sewer Master Plan*. 1999. Reports design aeration at 50, 25, 20, and 5 percent.

Treated effluent from the lagoons is routed to a manhole in the blower building where it is measured with a weir and ultrasonic meter. From the effluent manhole, flow goes to a vault south of the blower building where it can be either pumped to the clarifier or directed to the percolation beds. Recirculation from the effluent manhole back to the lagoons (Cell 1) is accomplished with a small 1.5-inch pump. Recirculation rates vary, but are very small, reported at between 0.38 and 4.82 percent of treated effluent flows in 2015 [32]. Recirculation in this type of lagoon system does not provide a known treatment purpose. The recirculation was a component of the original design and the operators believe it is done to keep the larger pumps to the clarifier or percolation beds primed[33], as these pumps are located several feet above the surface of the lagoon, and lose prime if suction is not maintained on the pump intake header.

The two lagoons are cleaned on a three-year rotation so that each lagoon is cleaned every six years. Sludge from the lagoon bottoms is pumped to the surface of percolation beds 7, 8 or 9. It could be argued that the current dredging rotation is not sufficient for the maintenance of these lagoons, given the BOD levels reported in previous summers, but the cause for these upsets is unknown.

As part of a 2006 evaluation, NTL Alaska, Inc. (NTL)[34] reviewed analytical data as a basis for treatment capacity. The lagoons were found to be performing within expected ranges, meeting criteria for secondary effluent. NTL predicted the treatment capacity of the lagoon system for BOD and TSS removal was between 0.4 and 0.6 mgd.

3.3.2 Clarifier

The up-flow clarifier has an inside diameter of 40 feet with an overall 50-foot diameter footprint. Flow coming into the clarifier enters an influent well at the center. As sludge falls to the bottom, rakes direct it to the center and the sludge hopper. Clarified wastewater discharges over an internal weir at the wall of the central chamber and into the dosing chamber. Two dosing pumps direct flows from the clarifier out to the percolation beds.

Clarifier

32 Based on calculations from monthly logs provided by John Becker, City of Wasilla, January 7, 2016.
33 John Becker, City of Wasilla: Onsite conversation with Stephanie Gould and Dean Syta, Stantec. February 4, 2016.
34 Michael Pollen, NTL Alaska, Inc., letter to Dean Syta, USKH Inc. February 23, 2007.

Constructed with the initial WWTP, the clarifier was originally the primary means of treatment. After the construction of the aerated lagoons, freezing issues caused the clarifier to be removed from service during the winter. It is now used only during the summer, approximately May to September, where it is used to minimize the settleable material (primarily algae) reaching the percolation beds. Very little material settles in the clarifier. The benefits of its use are seen as minimal and operators report that sludge is typically only drawn off at the end of the season for cleaning and not because of capacity issues[35]. Chemical coagulant addition would potentially enhance performance of the clarifier, but because the WWTP does not have a TSS discharge limit, this was not examined in detail. Chemical removal of the TSS would have only minor effect on nitrate levels.

3.3.3 Percolation Beds

There are nine below grade percolation beds on the south side of the WWTP site. Each bed has a bottom area of approximately 48,400 sf, just over an acre each. Table 5 summarizes design values. The beds consist of distribution piping and a layer of drain rock, buried about 4 to 7 feet below ground surface. Beds 7, 8, and 9 include a sand layer beneath the drain rock and over native soils. Pressure networks are used to distribute wastewater among the cells.

Leakage at Toe of Percolation Bed 6

Bed 9 is not used because of its location and high rate of leakage. Operators report that rotation of the beds is not done as intended because old equipment (e.g., electrically actuated valves in below grade manholes) will not function as designed.[36] At present four beds are in use at a time.

The initial CH2M design from 1985 called for the cells to be rotated, six in use at a time, such that each was in service for approximately 12 months and out of service for 6 months. Application rate was to be 1.5 gpm /sf in final design, providing a total capacity of 440,000 gpd, with six beds online. During construction a design review determined this capacity was unrealistic.

35 John Becker, City of Wasilla: Onsite conversation with Stephanie Gould and Dean Syta, Stantec. February 4, 2016.

36 John Becker, City of Wasilla. Email message January 7, 2016.

Table 5: Percolation Bed Design

Bed	Length (feet)	Width (feet)	Area (sf)	Length to Width Ratio	Header Elevation (feet)
1	302.5	160	48,400	1.9:1	241.50
2	302.5	160	48,400	1.9:1	240.50
3	302.5	160	48,400	1.9:1	239.50
4	302.5	160	48,400	1.9:1	238.50
5	302.5	160	48,400	1.9:1	237.50
6	302.5	160	48,400	1.9:1	236.50
7	380	127.33	48,385	3.0:1	234.50
8	320	151.25	48,400	2.1:1	231.50
9	320	151.25	48,400	2.1:1	227.00

Analysis by CH2M and RSE Engineers (RSE) in November 1986 determined that a flow of 180,000 gpd (0.6 gpd/sf) would submerge the beds and result in springs from the WWTP bluff. RSE reported that a flow of no more than, but potentially less than100,000 gpd (0.3 gpd/sf) was the highest application rate that can be maintained without flooding the beds and developing springs. A layer of dense, native till (soil) under the percolation beds limits the ground infiltration rate. Any excess effluent applied springs from the bluff and seeps out into the wetlands below the WWTP.

The 1999 *Wasilla Sewer Master Plan*[37] *(1999 Master Plan*) reports the percolation beds have a capacity of 200,000 to 290,000 gpd, (0.6 gpd /sf) depending on how many are online, but given the rate of leakage from the bluff at current flows, this capacity seems optimistic.

In 2008, S&W performed stability analysis on the existing WWTP bluff. They found the slopes were generally stable under static conditions, but the leakage of effluent present at that time likely would contribute to instability under seismic conditions. It does not appear that the failure plane reaches into the percolation beds, but a seismic event could result in significant slump and mass movement into the wetlands adjacent the bluff. It was observed that this had already occurred at several small slump locations.

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[37] LCMF Incorporated and GV Jones & Associates, Inc. *Wasilla Sewer Master Plan*. 1999.

Leakage at Toe of Percolation Bed 3

A small stream originates in the vicinity of the WWTP, in the wetlands just below the percolation beds. In February 2016, Stantec observed seepage during sampling events. The small stream near the toe of the percolation beds was roughly measured at between 4 to 8 feet wide, at 12 or 6 inches deep. The surface velocity was estimated at about 0.6 feet per second. This equates to a stream flow of 2.4 cubic feet per second (cfs), or 1,074 gallons per minute (gpm) (about 1.5 mgd). A significant flow of water from the bluff, presumed to be effluent was mixing with and contributing to the stream flow.

As discussed in Section 3.7, grab samples were taken from the stream upstream of the WWTP, and again near the percolation beds. No fecal coliforms were detected above the WWTP, while the stream was positive for fecal coliforms at the WWTP. Likewise, nitrate levels were found to be much higher at the WWTP, than above the WWTP. This suggests that a portion of the stream flow is effluent from the WWTP.

3.3.4 Septic Solids

Only septage[38] from the City STEP systems are handled at the WWTP. Commercial septic pumping entities throughout the Matanuska-Susitna Valley deliver non-STEP septage to the Anchorage Point Woronzof facility, at least at this time. As of May 2014, the Anchorage Water and Wastewater Utility (AWWU) was reporting that they expected pressure from the United States Environmental Protection Agency (EPA) to limit receipt of waste from outside their service boundaries[39].

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38 Septage is the incoming, partially treated sludge from septic tanks.

39 Hollander, Zaz. "Trucked-in Valley Waste Flowing Outgrowing Anchorage Facilities", Alaska Dispatch News, May 17, 2014. http://www.adn.com/article/20140517/trucked-valley-waste-flow-outgrowing-anchorage-facilities.

The septage handling process at the WWTP includes: a pumper bay, bar screen, aerated holding tank, grit removal, screen press, aerobic digester, and sludge drying beds. The aerobic digester is a 35-foot diameter concrete structural where sludge is allowed to periodically settle with supernatant routed to either the lagoons or percolation beds. The digester has a nominal volume of 143,000 gallons. Sludge is discharged to a sludge-drying bed as digester capacity is needed, approximately once a month; averaging 58,900 gallons a month, with one bed used at a time. A summary of septage processing since 2013 is provided in Table 6. There are three sludge-drying beds each 158 feet long by 50 feet wide with an approximate volume of 156,000 gallons in each[40]. The sludge beds are unlined and rely on losses to the air and soil to dry the processed sludge. Occasionally capacity issues with the aerated digester require that the operators waste sludge from the holding tank directly to Cell 1. The drying beds may be one of the sources of nitrate found in the groundwater as discussed in Section 3.6.

Table 6: Septage Processing Summary (2013-2015)

Year	Septage (gallons)	Raw Sludge to Lagoons (gallons)	Sludge to Drying Beds (gallons)	Digester Supernatant to Lagoons (gallons)
2013	1,223,312	0	550,070	467,935
2014	1,057,221	149,844	715,796	186,762
2015	1,063,739	62,781	854,570	146,737
Annual Average	1,114,757	70,875	706,812	267,145
as a daily flow (gpd)	3,054	194	1,936	732

Treated septage solids and sludge from the aerated lagoons are periodically distributed over the top of the percolation beds. Beds 8 and 9 in particular have a large deposit of sludge on the surface. This means of disposal is not assumed to be space limited at this time in the existing configuration. While this practice does not appreciably contribute to the discharge of effluent from the WWTP, it likely does contribute to the overall release of nitrate from the facility. The beds are bermed to reduce surface runoff, but nitrates in the sludge percolate into the ground and then seep into the ground water, or seep out the surface of the bluff, and from there run off the ground surface in stormwater into the wetlands and monitoring compliance points just south of the WWTP bluff.

The capacity of the septage treatment facilities is outside the scope of this report, but based on current practice has reportedly been exceeded. Design initially called for digestion for approximately a year while current practice is approximately one month.

[40] LCMF Incorporated and GV Jones & Associates, Inc. *Wasilla Sewer Master Plan*. 1999.

3.4 NEW PARCEL

The City acquired the 77 acres to the west of the WWTP in February 2014 to allow for treatment expansion. The parcel is undeveloped, however the Alaska Railroad and Old Matanuska Highway rights-of-way run through the northeast portion of the property, separating and isolating the very northeast corner of the parcel. The potential use of the remaining bulk of the parcel for treatment and / or disposal of effluent is the focus of this *Feasibility Study*.

With the road and railroad to the north and the WWTP along over half of the east side, residential properties bound the remainder of the parcel on the west and south. There is a significant natural grade separation, with the north, east, and southwest edges of the parcel being much higher than the center of the wetland complex that continues to the northwest and southeast. Within the property itself, the grades are slight, however, there is approximately 4 feet of fall from the northwest corner to the southeast corner over about 1,500 feet. Grade is not uniform, but averages about 0.25 to 1.0 percent.

3.4.1 Watershed and Wetlands

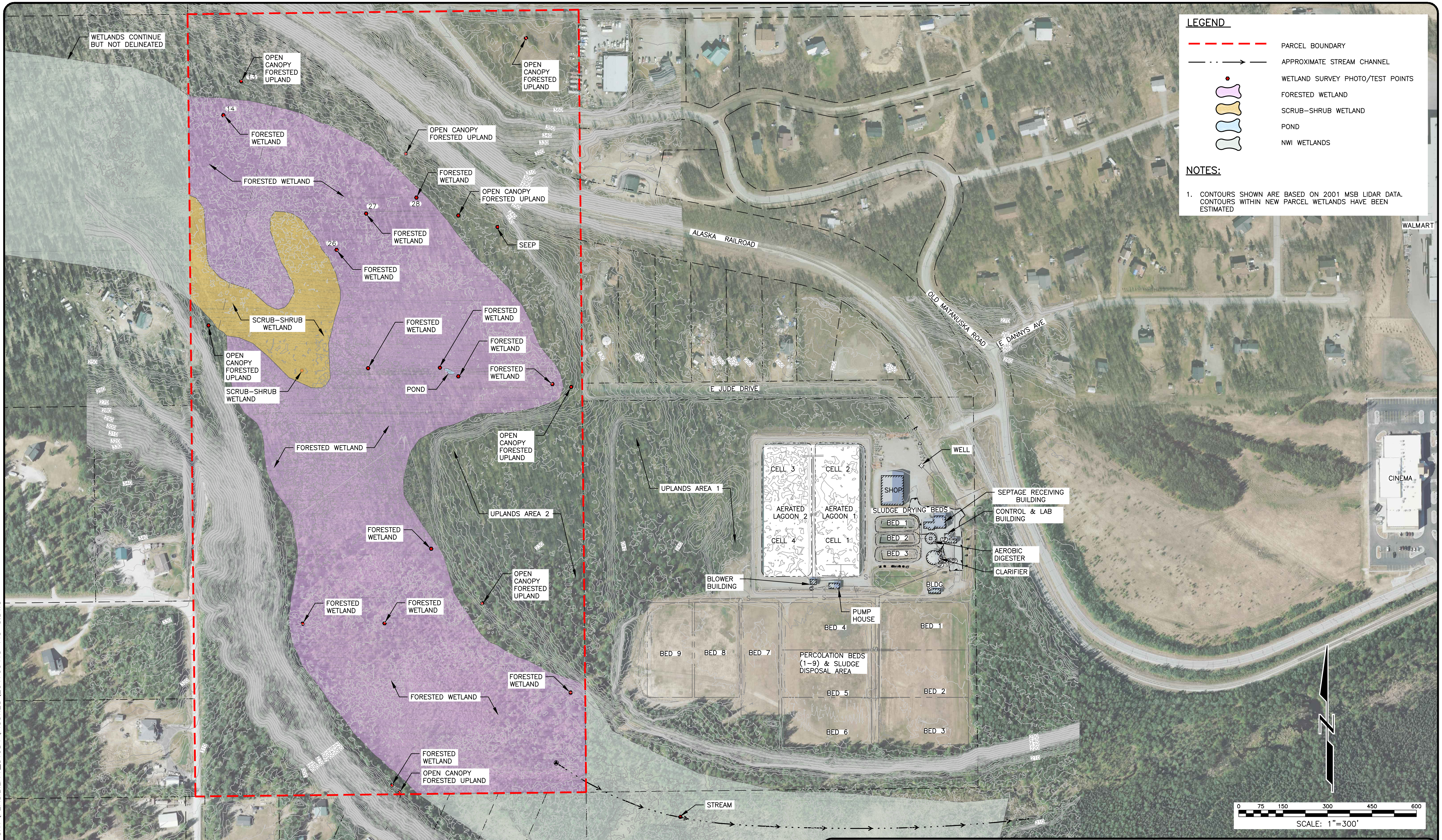
In September 2014, Stantec delineated wetlands and assessed habitat within the parcel. The survey delineated and classified wetland and upland habitats within the 77-acre parcel in accordance with the USACE *Wetlands Delineation Manual* [41], as well as the *Regional Supplement to the USACE Wetland Delineation Manual: Alaska Region*[42]*,* examining vegetation, soils, hydrology, and habitat characteristics.

The property was found to be a mix of uplands, forested wetlands, and scrub-shrub wetlands, with a single small pond as shown on Figure 5. Table 7 provides a summary of the habitat types and acreage from the delineation.

A small stream drainage emerges from the wetlands in the southeast corner of the property, and continues flowing to the east towards East Fairview Loop. The stream is only a few feet wide at most locations, and the width and definition depend on level of flow and rainfall. The stream is likely ephemeral in some locations, disappearing into the ground in dryer weather. It does not appear to have an obvious connectivity to other bodies of surface water as it disappears in the field and wetland areas to the south. As noted in Section 3.3.3, the flowing stream in February 2016, was estimated at 2.4 cfs, with flowing portions estimated at 4 to 8 feet wide, with depths ranging from 6 to 12 inches. National Wetland Inventory (NWI) mapping and aerial photography indicate that the wetland complexes may extend to Rabbit Slough, which ultimately outlets into Knik Arm, a traditional navigable water of the U.S.

41 1987. USACE. Wetlands Delineation Manual.

42 2007. USACE. Wetland Delineation Manual: Alaska Region (Version 2.0).



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DELINEATED WETLANDS

DATE 3/31/17

FIGURE 5

A USACE jurisdictional determination (JD) has been received indicating that the parcel contains waters of the US and / or wetlands under USACE regulatory authority. Authorization (a permit) will be required if dredged or fill material are to be placed in the wetlands[43]. The USACE does not regulate discharges of water, including wastewater or storm water. However, the EPA and by extension the ADEC has establish restrictions on discharges to wetlands, with the ADEC indicating (see Existing Facilities) that discharge to a jurisdictional wetland will require meeting surface water standards at end of pipe unless the wetland is removed from USACE jurisdiction. The permitting of a discharge to the parcel wetlands is discussed in Section 6.0.

Table 7: New Parcel Habitat Type Summary

Habitat Type	Acres	Percent of Parcel
Forested Wetlands	36	47%
Scrub-Shrub Wetlands	3	4%
Pond	<0.01	<0.01%
Open Canopy Forested Uplands	38	49%
Total	**77**	**100%**

The parcel includes an old slough channel running from the northwest to the southeast with defined slopes along its western and eastern sides. The wetlands were mapped only within the study area and are typically connected to larger extents of the same wetland type beyond the parcel boundary. The presence of wetlands appears to be driven by topography. The topography of the study area consists of a low-lying depression surrounded by rising topography.

Run-on from the west is assumed to be minimal as LIDAR contours indicates a grade break to the west and east at about the parcel boundary with flow through the parcel to the southeast ending with a small stream that forms around a small knoll just northwest of the percolation beds. Two channels form: one along the toe of the percolation beds and a second further to the south.

There is one small pond in the study area, which is specifically characterized as palustrine, emergent, persistent, permanently flooded. The pond lies within the forested wetland complex in a small depression and is less than 0.01 acres.

Photo 1 - B-6 Infiltration Test

43 Letter dated March 24, 2016 from Julie Ruth, USACE. Available in Appendix A.

The full wetlands delineation report is included in Appendix D[44].

3.4.2 Geotechnical Investigations

In March 2015 S&W began geotechnical investigations on the new parcel. Access to the site is limited due to the elevated bluffs surrounding the property. Within the property, the soft ground further impedes access. By conducting the investigation in late winter, it was hoped the ground would be frozen enough to support the equipment; however, the ground at that time was too wet to allow drill rig access because of a warm winter and rains the preceding months. Only one boring was completed before mechanical issues with the drill rig halted the attempt. It was necessary to wait for seasonal drying.

After clearing additional access, the field investigations were completed in July 2015. A final monitoring well was added to the top of the bluff to the west in February 2016. The S&W geotechnical investigations for this project included ten soil borings, three monitoring wells, soil sampling and percolation testing. Borings ranged in depth from 20.5 to 151 feet below ground surface. Full data results from the investigation are available in Appendix B.

Groundwater was collected from the monitoring wells (MW6, MW8, and MW9) when the wells were developed in June 2015 and analyzed as summarized in Table 8[45] for Resource Recovery and Conservation Act (RCRA) metals and total nitrate/nitrite. Two “grab” groundwater samples were collected from Boring B-14, one from the deep observation well and one from the shallow observation well, and tested for nitrate and nitrite levels as included in Table 8.

44 2015, December. Stantec. Wetland Delineation Report, City of Wasilla, Parcel Lot 1B.
45 Based on information in *Geotechnical Data Report*, Appendix D

Table 8: 2015 Sampling Data

Parameter (unit)	**Test Method**	**Drinking Water MCL/SDWR**	**MW 6** (6/3/2015)	**MW 8** (6/3/2015)	**MW 9** (6/2/2015)	**B 14 Shallow** (3/7/16)	**B 14 Deep** (3/7/16)
Temperature (ºC)	Field parameter	-	5.5 ºC	3.42 ºC	4.89 ºC	-	-
Specific Conductivity (µS/cm)	Field parameter	-	115	108	6.68	-	-
ORP (mV)	Field parameter	-	-162.4	-152.6	-22.6	-	-
Turbidity (NTU)	Field parameter	-	8.48	460.7	107.5	-	-
pH	EPA Method SM21 4500	6.5 – 8.5	7.90	7.80	7.80	-	-
Total Nitrate/Nitrite (mg/L)	EPA Method SM21 4500	10L	0.0500 U	0.0500 U	0.937	-	-
Nitrate (mg/L)	EPA Method 300.0	10	-	-	-	0.380	0.126
Nitrite (mg/L)	EPA Method 300.0	1	-	-	-	0.0600 J	0.0500 U
Arsenic (mg/L)	SW 6020	0.010	0.0126	0.00866	0.00375 J	-	-
Barium (mg/L)	SW 6020	2.0	0.0176	0.0159	0.0285	-	-
Cadmium (mg/L)	SW 6020	0.005	0.00100 U	0.00100 U	0.00100 U	-	-
Chromium (mg/L)	SW 6020	0.10	0.00144 J	0.00123 J	0.00638	-	-
Lead (mg/L)	SW 6020	0.015	0.000500 U	0.000500 U	0.00129	-	-
Mercury (mg/L)	SW 6020	0.002	0.000100 U	0.000100 U	0.000100 U	-	-
Selenium(mg/L)	SW 6020	0.05	0.0100 U	0.0100 U	0.0100 U	-	-
Silver (mg/L)	SW 6020	0.10 *	0.00100 U	0.00100 U	0.00100 U	-	-

Notes:

* There is no MCL for silver and instead the cleanup level as listed in Table C, 18 AAC 75.345 (January 2016) is given. For all other metals the cleanup value and MCL are the same.

MCL/SDWR = Maximum Contaminant Levels under Secondary Drinking Water Regulation (SDWR)

mg/L = milligram per liter

J = The quantitation is an estimation.

U = Indicates the analyte was analyzed for but not detected. Number listed is quantitation limit.

Photo 1 - Pond

Borings generally encountered decomposed organic material overlying granular material interbedded with thin silt layers. For borings in the wetland area (7) the organic materials were very soft to soft brown soil ranging from 2.2 to 13 feet deep. The two borings (B-04 and B-09) in the east upland area, found 2 to 3 feet of silt with sand and occasional organics at the surface, while the boring (B-14) in the west upland area encountered a foot of organic material at the surface. Granular materials encountered beneath surficial layers consisted of sand and gravels with some silt and were identified as interfingered zones of alluvium/outwash and glacial till. Cobbles were also encountered throughout. The borings encountered the upper aquifer, but it does not appear any of the borings reached the lower aquifer under the dense confining till layer that underlies the wetlands.

Table 9: New Parcel Infiltration Results

Location	Test method	Water level above bottom (in)	Short-Term Infiltration Rate Constant Head (in/hour)	Short-Term Infiltration Rate Falling Head (in/hour) [2]	Suggested Range for Total Correction Factor (CF_T)
Upland Area PIT	PIT (small scale)	11	48	22	0.2 to 0.3
Upland Area PIT	Grain Size	N/A	--	3.1 (preliminary long-term)	0.1 to 0.2
Boring B-6	Double Ring	6	0.7	--	0.1 to 0.2
Boring B-8	Failing Head	6	--	14.4	0.1 to 0.2
Boring B-12	Failing Head	8	--	7.6	0.1 to 0.2

Notes:

1. PIT stands for pilot infiltration test.
2. Short-term infiltration rate refers to the infiltration rate measured during the test and does not represent the infiltration rate expected for a permanent infiltration structure. For the “grain size” test method, the table values refer to the “preliminary long term” infiltration rates. Infiltration rates for the falling head test period represent an average of multiple infiltration rates calculated over the falling head period.
3. Suggested correction factors assume CF_m = 0.9 and should be varied depending on the anticipated performance and maintenance schedule. Furthermore, these correction factors do not account for the potential effects of groundwater mounding at the proposed facility.

Infiltration testing on the site was conducted with the methods and results shown in Table 9[46]. Extended duration infiltration rates are obtained by multiplying the field measurement by the correction factors. In the drier portions of the site, initial infiltration rates are thus on the order of 0.3 to 3 inches per hour of infiltration. However, once the ground is saturated, the hydraulic conductivity of the underlying aquifer will govern infiltration. Excess water applied to the surface will not infiltrate, rather, it will run off. Groundwater modeling discussed in Section 5.2.3 examines the steady state infiltration capacity of the wetlands, and the run off fraction for several loading scenarios.

3.5 WASILLA WASTEWATER PRODUCTION

The City provides wastewater service to approximately 800 service connections. The metered sewer service is provided at a rate of $10.32 per thousand (1,000) gallons, subject to a monthly minimum of $51.58 plus City sales tax. The WWTP is limited by permit to 400,000 gpd as discussed in Section 3.2. The WWTP is operating at about 85 percent of the permitted effluent discharge.

Records from 2013 to 2015 indicate that monthly flows average 338,300 gpd. Average, minimum, maximum, and total annual flows recorded at the WWTP for 2013 to 2015 are summarized below in Table 10, Table 11, and Table 12. The increase in flows between influent and effluent can be explained as the precipitation that accumulated in the ponds, as well as inputs from septic solids processes.

Table 10: Annual Flows 2013 - 2015

Period	Influent Flow (gallons)	Effluent Flow to Beds (gallons)
2013	140,090,600	124,959,562
2014	108,802,922	125,392,016
2015	121,516,441	124,119,560
Average	123,469,988	124,823,713
Average as a daily flow	338,274	341,983

[46] Based on Appendix C table, Geotechnical Data Report, Appendix B.

Table 11: Monthly Influent Summary 2013 to 2015

Period	2013 (gallons)	2014 (gallons)	2015 (gallons)
January	9,259,900	8,369,456 [1]	10,587,700
February	9,066,300	8,369,456 [1]	10,017,600
March	10,487,200	10,346,800	10,967,600
April	11,933,300	9,630,500	9,530,500
May	14,280,100	9,343,400	10,164,800
June	10,933,300	8,369,456 [1]	10,126,370
July	12,515,700	8,369,456 [1]	10,126,370
August	12,204,400	8,043,700	10,126,370
September	14,250,300	7,588,600	10,126,370
October	15,945,100	10,246,000	10,126,370
November	10,122,500	9,881,700	9,711,891
December	9,092,500	10,244,400	9,904,500
Total Annual	140,090,600	108,802,922	121,516,441
Maximum Monthly	15,945,100	10,346,800	10,967,600
Minimum Monthly	9,066,300	7,588,600	9,530,500
Average Monthly	11,674,217	9,066,910	10,126,370
Annualized gpd [3]	383,810	298,090	332,922

Notes:

1. In 2014 meter issues prevented data collection in January, February, June, and July. Average of remaining months were used for these four months.
2. In 2015 meter issues again prevented data collection in June, July, August, September, and October. Average of remaining months were used for these five months.
3. The annualized gpd is calculated as the annual total divided by 365.

Table 12: Monthly Discharge Summary 2013 to 2015
Treated Effluent to Beds

Period	2013 (gallons)	2014 (gallons)	2015 (gallons)
January	9,395,100	10,977,891	10,593,606
February	8,801,900	9,864,595	9,642,548
March	9,809,280	11,249,100	11,314,995
April	10,117,000	10,596,366	9,528,611
May	10,758,842	10,672,891	10,256,400
June	10,503,200	10,015,490	9,730,300
July	10,047,100	13,809,990	10,410,100
August	11,070,946	13,059,951	10,974,900
September	11,910,829	5,967,735	10,729,600
October	11,881,393	8,865,890	11,589,900
November	10,666,286	10,023,539	9,782,100
December	9,997,687	10,288,579	9,566,500
Total Annual	124,959,562	125,392,016	124,119,560
Maximum Monthly	11,910,829	13,809,990	11,589,900
Minimum Monthly	8,801,900	5,967,735	9,528,611
Average Monthly	10,413,297	10,449,335	10,343,297
Annualize gpd [1]	342,355	343,540	340,054

Notes:
1. The annualized gpd is calculated as the annual total divided by 365.

3.6 MONITORING HISTORY

As noted in Section 3.2, the WWTP monitors for lead, chromium, cadmium, mercury, and silver in its effluent and fecal coliforms, nitrate (as nitrogen), conductivity, and pH in area groundwater. Monitoring is conducted in four wells: 7, 17A, and 18A in the upper aquifer, and 19 in the lower aquifer. Table 13 summarizes data from 1997 to 2015.

Table 13: Monitoring Well Results 1997 to 2015

Monitored Characteristic	Effluent Limitation	Result Range	Maximum Value
Lead	Report	Upper aquifer 0 to 126 mg/L 4.3 mg/L average Lower aquifer 0 to 2.1 mg/L 0.1 mg/L average	126 mg/L at MW 18A 6/2003
Chromium	Report	Upper aquifer 0 to 8.5 mg/L 0.3 average Lower aquifer Two detections 2.06 and 0.0124 mg/L	8.47 mg/L at MW 18A 6/2004
Cadmium	Report	Upper aquifer 0 to 2.15 mg/L 0.2 mg/L average Lower aquifer Single detection 0.00051 in 1997	2.15 mg/L at MW 17A in 6/2005
Mercury	Report	2 detections 0.00036 (MW7) and 0.000253 mg/L (MW17A, same event)	0.00036 mg/L at MW 7 in 6/1999
Silver	Report	Single detection	0.000403 mg/L at MW 18A in 6/2007
Fecal Coliform	1 FC / 100 mL	Upper aquifer 0 to 67 col/100mL, 1.3 col/100mL average Lower aquifer (MW19) 0 to 7 col/100 mL 0.9 col/100 mL average	67 FC / 100 mL at MW 17A in 3/2003
Nitrate as Nitrogen2	10 mg/L	Upper aquifer 0 to 77 mg/L 12.76 mg/L average Lower aquifer (MW19) 0 to 15.34 mg/L 1.34 mg/L average (7 detects, only 1 exceedance)	77 mg/L at MW 17A in 6/1997

3.7 ADDITIONAL SAMPLING

The elevated levels of fecal coliforms and nitrates, presumably from the WWTP, found during routine monitoring indicates these are a concern. Sampling during the geotechnical investigation at MW-14 found nitrate levels of 0.380 mg/L in the shallow well and 0.126 in the deep, well below the permitted 10 mg/L. Nitrite levels were below the limits of quantitation and estimated at 0.0600 mg/L shallow and 0.0500 mg/L deep. Note that these sample locations are adjacent to, but slightly “up gradient” from the WWTP. These samples were collected to establish a baseline for the new 77-acre parcel, and to determine if the property had been previously impacted by the WWTP.

During site visits to the WWTP in early 2016, grab samples were taken and analyzed for fecal coliform and total nitrates as indicated in Table 14. Complete laboratory results are provided in Appendix F.

Table 14: Sample Results

Location	2/4/2016 Total Nitrate/Nitrite as Nitrogen (mg/L)	2/4/2016 Fecal Coliform (col/100 mL)	2/19/2016 Total Nitrate/Nitrite as Nitrogen (mg/L)	2/19/2016 Ammonia-N (mg/L)	2/19/2016 Fecal Coliform (col/100 mL)
Seep from Bluff at Toe of Percolation Bed	0.408	73			
Seep from Bluff at Toe of Percolation Bed	2.36	280	6.21	3.40	3100
Head of Stream/Spring upstream of WWTP	4.56	Not detected	9.16	Not detected	39

Notes:

1. Fixed locations have not been established and results should be considered as generalized from the source, not representative of a location.

The seeps in Table 14 were actively flowing rivulets from the face of the gravel bluff below the percolation beds. These are believed to be excess effluent that cannot percolate in the ground, but instead leaks out the face of the bluff. Interestingly, the nitrate results from the seeps are not particularly high. However, fecal coliform levels are well over permit levels.

A sample was also taken near the origination of the stream. This is slightly up gradient from the nine percolation beds, approximately 150 to 200 feet south west of Bed 9 and monitoring wells 21A High and 21A Low. Even so, this flowing water had a high level of nitrates. Beds 8 and 9 are the primary location for disposal of sludge from lagoon cleaning and from the septage drying beds. It is suspected that nitrates are leaching from the surface application of sludges in this area and migrating to the stream, either through the groundwater, or thru rainwater runoff.

Additional information will need to be gathered to establish baseline values for fecal coliforms, nitrates, and other parameters in the wetland. A discussion of these parameters and potential pilot study efforts is provided in Appendix G.

4.0 PROJECT NEED

The City of Wasilla wastewater treatment facility provides a basic sanitation service to the community. The WWTP's effluent disposal system is known to be overloaded and limited by the capacity of its percolation beds. The following sections address specific needs for the outfall project with respect to four areas: health and sanitation; security; system age and operations and maintenance (O&M); and growth.

4.1 HEALTH AND SANITATION

The major health and sanitation concern at the Wasilla WWTP is nitrate levels. The WWTP is permitted up to 10 mg/L of nitrate at the compliance monitoring wells, whereas measured average annual nitrate levels in the monitoring wells range anywhere from 6 to 25 mg/L, with annual maximums frequently in the 30 to 50 mg /L range. Concentrations of up to 77 mg/L have been recorded.

Nitrates are "nutrient" byproducts of the wastewater treatment. Consumption of nitrates in ground water present health risks, and consequently, are a regulated contaminate. When nitrate levels are exceeded, the WWTP is not in compliance with the operating permit.

The area around the WWTP is underlain by two primary aquifers (see Section 5.2.3). The first is an unconfined aquifer that is the receiving water from the percolation beds. This shallow aquifer also includes the surface organics layer of the wetland area. The aquifer is monitored for nitrates quarterly at three downgradient wells (7, 17A, and 18A) south of the percolation beds on the WWTP property. At present, it appears the upper aquifer is impacted by the nitrate release from the WWTP.

Impacts to the lower aquifer, if any, have been minimal, with a single exceedance in 2005 (15.3 mg/L, see Section 3.6), and all other values at 1.86 (mg/L) or below, with results typically reported as non-detect or below the method reporting limits. The second, deeper aquifer is monitored annually in June from a single well (MW19) in the southeast corner of the parcel.

In addition to addressing elevated nitrate levels, the City is also concerned about general WWTP capacity and treatment.

4.2 SECURITY

The existing site is adequately fenced with locking doors on the buildings. Fencing is generally an 8-foot chain-link in good condition with barbed wire outriggers. The access restrictions help prevent animal and human trespass into the facility, specifically the open lagoons. When gates are open there have been incidents of moose and other animals entering the facility.

The primary security concern identified relates to potential failure of the disposal system and impacts to adjacent properties in the event of an earthquake; specifically slope failure. As discussed in Section 3.3.3, the possibility of significant slope failure during a seismic event exists. It does not appear the failure slope would reach the buried percolation beds, but would likely result in mass wasting of soil and slump or slide into the wetlands south of the WWTP (private property impacts, not owned or controlled by the WWTP) [47].

4.3 AGING INFRASTRUCTURE AND SYSTEM O&M

Maintaining the WWTP as a functional and high performing facility is important for achieving treatment goals. The existing facility requires operator time to take samples, adjust and exercise pumps and valves, and clean and oversee the facility. Common activities include maintaining and operating the pumps and buildings systems, and in the summer, skimming the lagoons. As the system ages and treatment requirements increase, Wasilla has seen and is projecting increasing need for maintenance activities. Known O&M issues include:

- Foam forms during aeration, particularly in the summer. The foam is believed to be the result of soaps from laundries and car washes.
- Odor complaints result from spring turnover of the facility.
- Automatic control valves on the percolation beds do not work. Bed rotation requires vault entry, a hazardous confined space, to work the valves.
- Digester capacity is exceeded often enough that some raw septage is sent to the lagoons. Digestion of remaining septage is not for the full design year, but is for approximately a month before discharge to the drying beds.
- The quality of the septage is highly variable, with some restaurants believed to empty fats, oils, and greases (FOG) to the STEP systems.
- Moose, fox, birds and other wildlife are common at the site.

4.4 REASONABLE GROWTH

As noted in Section 2.3, Wasilla is the largest community in one of Alaska’s fastest growing areas. At the current time, the City wastewater utility does not fully serve the incorporated area. Many residents are on private septic systems. As unregulated systems, particularly as population densities increase, septic systems are frequent pollutant sources for nitrates, fecal coliform, and other contaminants.

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47 Shannon & Wilson, Inc. Geotechnical Report – Wastewater Treatment Plant Percolation Cell, Wasilla, Alaska. May 2008.

While the City utility would like to serve additional area, the WWTP is presently constrained by the capacity issues with the percolation beds (Section 3.3.3). Improvements in disposal capacity will be necessary to accommodate additional system growth and maintain current service.

The treatment capacity of the sewer lagoons is not presently a limiting factor, but could be eventually. As discussed in Section 3.3.1, the lagoons have a capacity of between 0.4 and 0.6 mgd.

With current flows averaging 338,300 gpd, increased treatment capacity is desired.

5.0 DESIGN CRITERIA

The following sections outline design standards and regulatory requirements applicable to this project, as well as assumptions and goals. Note that the project scope is limited to use of the newly purchased parcel (Section 3.4) through land application of wastewater or effluent. Modifications to existing lagoons or treatment processes are discussed only as relevant to land application.

5.1 DESIGN STANDARDS AND REGULATORY REQUIREMENTS

Proposed improvements considered in this *Feasibility Study* must be designed and constructed in accordance with applicable standards. These standards and regulatory requirements are expected to include:

5.1.1 Alaska Department of Environmental Conservation

The ADEC, Division of Water, Wastewater Discharge Program regulates wastewater treatment and disposal under Alaska Water Quality Standards contained within Title 18, Chapter 70 of the AAC (18 AAC 70), and Alaska Wastewater Disposal Regulations contained within 18 AAC 72. Wastewater facilities designs must be submitted to the ADEC for plan review prior to construction. There are several items to be considered in this project:

- Wastewater discharges must comply with the 2003 ADEC Water Quality Standards regulations, as these are the latest wastewater regulations approved by the EPA[48].
- 18 AAC 72.020 establishes separation distances and generally requires a 100-foot separation horizontally to mean annual high water of a water body or a 100 feet to a drinking water source. There are a number of drinking water wells in the project vicinity as well as a small pond and stream.
- Secondary treatment under 18 AAC 72.990(59) requires that effluent meet the following standards:
  - 30-day average of the 5-day biochemical oxygen demand (BOD_5) that does not exceed 45 mg/L and a percent removal that is not less than 65 percent by weight; maximum average BOD_5 of 65 mg / L in any 7-day period.
  - 30-day average of TSS that does not exceed 70 milligrams per liter.

[48] "Mixing Zones" ADEC. 2015. Last updated:9/15/2015. Accessed January 2016. http://dec.alaska.gov/water/wqsar/wqs/mixingzones.html

- pH between 6.0 and 9.0.

- For discharge to surface water (e.g. the stream, wetland), the 2013 General Permit AKG573000[49] requirements should be considered as they differ slightly from the standard secondary treatment requirements[50].

  - BOD_5 that does not exceed 30 mg/L as a monthly average, 45 mg/L as a weekly average, and 60 mg/L daily. BOD5 average monthly percent removal that is not less than 65 percent.

  - pH between 6.5 to 8.5 (note narrower band than secondary treatment requirement).

  - Total suspended solids (TSS) that does not exceed 45 mg/L as a monthly average, and 65 mg/L as a weekly average. TSS average monthly percent removal that is not less than 65 percent.

  - Fecal coliform is limited to 20 FC per 100 milliliters (FC/100 mL) on average monthly and 40 FC/100 mL daily.

  - Note that this permit does not apply for discharges to land, subsurface, or wet areas that are not designated waters of the U.S.

5.1.2 City of Wasilla

The City has adopted standard construction specifications. The specifications do not specifically speak to wastewater treatment facilities.[51]. However, the City of Wasilla Title 16 Land Development Code does include the following requirements potentially pertinent to development at the WWTP:

- 16.24.030 B: Industrial uses or buildings must be set back a minimum one hundred (100) feet from any residential zoned lot line. Commercial buildings must be set back thirty (30) feet from any R-1 - single-family residential district zoned lot line. A setback of at least 100 feet has been assumed in the development of potential alternates.

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49 Authorization to Discharge Under the Alaska Pollutant Discharge Elimination System for Domestic Wastewater Treatment Lagoons Discharging to Surface Water, General Permit Number AKG573000 available at http://dec.alaska.gov/Applications/Water/WaterPermitSearch/Detail.aspx?id=9854&v=1

50 Listed requirements are for a Class B discharge to fresh water as would be the case for the Wasilla WWTP.

51 City of Wasilla Standard Specifications and Details available at http://www.cityofwasilla.com/departments-divisions/public-works/utilities/wastewater/sewer-standard-specifications

- 16.24.030 C1: The setbacks may be reduced up to ten (10) percent by the city planner after an investigation and finding that the resulting lesser setback would meet the purpose of the standards.

- 16.33.030: Landscaping is required for 5% of the total lot area. Given the nature of the proposed project and its use of wetlands, it is assumed that these shall not apply.

- 16.33.030G: Screening is required between public and residential uses and may consist of:

  - A fence, a berm, or fence constructed on top of a berm, having a total height of not less than six feet. A berm used to provide screening shall be constructed entirely on the lot that is the subject of the application, and shall not interrupt natural drainage courses. To ensure privacy between buildings of different heights, tree plantings may be required to make screening more effective.

  - An area of native vegetation located adjacent to the lot line on the lot that is at least twenty-five (25) feet deep, and which has a screening effect equivalent to a fence or berm.

5.1.3 Federal Regulation

5.1.3.1 Floodplain

Under Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2 percent (500-year) floodplain or protect the facilities to the 0.2 percent chance flood level. Wastewater treatment facilities are critical facilities. The Wasilla WWTP, is within the 500-year floodplain, as is much of the MSB.

5.1.3.2 Wetlands

As noted in Section 3.4 and the wetland delineation in Appendix D, much of the new parcel is wetland. The Clean Water Act (CWA) Section 404 regulates the discharge of dredged or fill material into waters of the U.S., including wetlands. Section 404 permits are administered by the USACE. Work outside previously disturbed areas and in the water or wetlands will require a USACE Section 404 wetlands permit for unavoidable impacts to wetlands and waters of the U.S.

Mitigation may be required if impacts to wetlands cannot be avoided. The degree of mitigation is determined on the basis of the Functional Capacity Index (FCI) of the impacted wetlands, compared with the FCI of available mitigation banks. FCI scores depend on the physical, chemical, and biological functions of a wetland[52]. The USACE will decide the score. There are two mitigation banks within the service area Su-Knik Mitigation Bank and Pioneer Mitigation Bank[53]. Depending on availability of wetland credits, either mitigation banks can be considered for negotiation of credits as directed by USACE. An In-lieu of Fee Program of the Great Land Trust might also be an acceptable means of mitigation.

If it can be demonstrated that the functional capacity of the impacted wetlands is enhanced through physical, chemical, or biological function improvements, mitigation may not be required[54]. The USACE cannot comment on potential mitigation requirements until a specific project is under review.

Wetland permitting and need for mitigation is complicated by discharge permit requirements of the CWA, as administered by ADEC. ADEC has indicated that they are not allowed to permit the use of a natural wetland in the USACE inventory for wastewater treatment. Any discharge to a jurisdictional wetland or “Water of the U.S.” must meet the water quality standards of 18 AAC 70, for BOD_5, TSS, fecal coliforms, metals, and all other regulated contaminates at the point of discharge. This would force significant treatment upgrades at the WWTP.

The wetlands must be removed from USACE inventory through use of the mitigation banks or other USACE negotiation, before they can be permitted for use a wastewater treatment and disposal system.

5.1.3.3 Wildlife

Migratory birds are protected under the Migratory Bird Act and many projects in Alaska require that the USFWS time periods for avoiding vegetation clearing to protect migratory birds be followed. This is often a condition of USACE permit. According to the USFWS *Land Clearing Timing Guidance for Alaska*, this would exclude clearing in the project area from April 1st to July 15th of any calendar year[55], because of the potential for migratory passerines, Canada geese, and swan.

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52 Su-Knik Mitigation Bank South-Central Alaska, *Umbrella Mitigation Bank Instrument*. 2009.

53 Mitigation credits at Su-Knik Mitigation Bank were $25,000 per acre for a perfect score according to a phone conversation with Jerome Ryan (2/8/2016).

54 Title 33 – *Navigation of Navigable Waters*, Part 332 – *Compensatory Mitigation for Losses of Aquatic Resources*. 33 U.S.C. 401 et seq.; 33 U.S.C. 1344; and Pub. L. 108-136. 73 FR 19670, Apr. 10, 2008. U.S. Army Corps of Engineers (USACE). https://www.gpo.gov/fdsys/pkg/CFR-2012-title33-vol3/xml/CFR-2012-title33-vol3-part332.xml

55 USF&WS. *Land Clearing Timing Guidance for Alaska*, available at http://www.fws.gov/alaska/fisheries/fieldoffice/anchorage/pdf/vegetation_clearing.pdf

If an eagle's nest is found to be within 1-mile of the project area, a Federal permit for non-purposeful take of eagles from the USFWS will be required as eagles are protected under the Bald and Golden Eagle Protection Act. The permit will allow construction in the vicinity of the nest but requires that measures be taken to avoid and minimize the potential to the degree practicable.

5.2 DESIGN ASSUMPTIONS

In addition to regulatory requirements there are a number of design calculations that require establishment of consistent values. For purposes of this report and the design calculations that follow, the following values will be used:

- Flows for the three years available (2013 – 2015) average 342,000 gpd to the infiltration beds. The WWTP is targeting improved treatment, as well as increased capacity to address the well-established needs at the facility. The current flow rate of approximately 350,000gpd will be used as a basis for alternative evaluation. If feasible, a 1.0 mgd capacity is desired, otherwise calculations are to determine maximum capacity.

- Based on previous evaluations as discussed in Section 3.3.1, the capacity of the existing lagoons for treatment of BOD_5 and TSS is assumed to be 0.5 mgd. Treatment to 1.0 mgd will be assumed to require either twice the current lagoon capacity or treatment by another means. Accordingly, the existing land immediately west of the existing lagoons (Uplands Area 1, Figure 2) has been assumed reserved for future expansion of the lagoons (525 feet by 400 feet).

- Based on information discussed in Section 3.3.4, the capacity of the septage treatment facilities is assumed to be 0.3 to 0.5 mgd. Currently sludge is wasted more frequently than originally intended, because of capacity issues so it is assumed that treatment to 1.0 mgd will require either two to three times the current digester and drying bed capacity or treatment by another means. Evaluation of septage treatment is outside the scope of this report; however, space has been reserved for septage treatment in Uplands areas 1 or 2 (Figure 2) although these are not as convenient as the existing beds. Disposal of treated sludge by spreading over the percolation beds is not assumed to be space limited at this time.

- Disinfection is required for discharges to land after secondary treatment only if there is a potential health hazard. Provided the facility is adequately fenced and signed, disinfection should not be required given the additional treatment provided by wetlands.

- As higher value wetland, the scrub-shrub wetland complex on the northwest side of the new parcel will be avoided to the extent practicable.

5.2.1 Climate

The proposed project sub-region is southcentral Alaska, which lies within the Cook Inlet Zone, a transition between maritime and continental climatic zones. The Cook Inlet Zone is characterized by maritime summer temperatures moderated by Cook Inlet, and continental winter temperatures moderated by sea ice presence during the coldest months.

Temperatures in Wasilla range from a high of 91 degrees F to a low of -41 degrees F. Extreme temperatures vary widely with over 50 degrees in range between maximum and minimum every month. A summary of temperature information is provided in Table 15[56].

Precipitation shows less variability with 15.27 inches of year on average. The extreme maximum for a year was 25.78 inches in 1930, with 2.48 inches in a single day in September 1925[57].

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56 "Climate Summaries, Station 505733 Matanuska AES, Alaska". Western Regional Climate Center. Accessed Dec. 14, 2015. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak5733

57 "Climate Summaries - Precipitation, Station 505733 Matanuska AES, Alaska". Western Regional Climate Center. Accessed Dec. 14, 2015. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak5733

Table 15: Temperature and Precipitation Summary Station 505733 Matanuska AES

Month	Monthly Mean Temperature (°F)	Daily Extreme Low Temperature (°F)	Daily Extreme High Temperature (°F)	Monthly Mean Precipitation (in.)	1 Day Maximum Precipitation (in.)	Monthly Mean Snowfall (in.)
January	13.1	-40	52	0.84	1.36	8.3
February	18.7	-41	56	0.71	1.3	8.3
March	25.1	-30	65	0.5	0.8	6.2
April	36.8	-16	73	0.44	1.1	2.2
May	47.2	8	83	0.71	1.13	0.2
June	55.0	27	91	1.38	1.61	0
July	57.8	31	85	2.17	1.83	0
August	55.6	27	87	2.59	2.05	0
September	47.7	15	75	2.44	2.48	0.1
October	35.1	-11	69	1.47	1.32	4
November	20.9	-26	66	0.96	1.8	7.9
December	14.4	-37	55	1.06	1.5	10.6
Annual	**35.6**	**-41**	**91**	**15.27**	**2.48**	**47.7**

Degree days below freezing can be used to calculate depth of freeze and ice formation. It is calculated based on departures from the daily mean temperature with negative values ignored. The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information[58] has calculated this information for a number of return periods as shown in Table 16.

Table 16: Air Freezing Index Return Periods Station 505733 Matanuska AES

1.1 Year (10%) (°F-Days)	2 Year (50%) (°F-Days)	2.5 Year (60%) (°F-Days)	3.3 Year (70%) (°F-Days)	5 Year (80%) (°F-Days)	10 Year (90%) (°F-Days)	20 Year (95%) (°F-Days)	25 Year (96%) (°F-Days)	50 Year (98%) (°F-Days)	100 Year (99%) (°F-Days)
1524	2317	2465	2619	2794	3026	3208	3259	3404	3529

58 "Air-Freezing Index Return Periods and Associated Probabilities Spreadsheet". NOAA NCDC. Accessed December 14, 2015. https://www.ncdc.noaa.gov/climate-information/statistical-weather-and-climate-information/frost-protected-shallow-foundations

5.2.2 Detention Time and Nitrate Removal

Along with increasing capacity, the purpose of this feasibility study is to provide a compliant facility, which means improving the treatment for nitrates. As discussed in Section 3.6, the facility is exceeding its permit limit of 10 mg/L nitrate as nitrogen in groundwater.

Nitrate removal in the percolation beds is assumed to be minimal and any reductions between discharge and testing in monitoring wells is assumed to be the result of dilution. The maximum allowable levels in freshwater for the various forms of nitrogen are as follows based on the *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (Water Quality Criteria Manual)*[59]. These will be the treatment targets for this project:

- Nitrate (as nitrogen) 10 mg/L (18 AAC 80.300(b))
- Nitrite (as nitrogen) 1 mg/L (18 AAC 80.300(b))
- Total nitrate and nitrite (as nitrogen) 10 mg/L (18 AAC 80.300(b))

Conventional wastewater treatment removes ammonia through the nitrification process, in which biological activity converts the ammonia to nitrate. This process occurs readily in the presence of oxygen, which is abundant in aerated lagoons. While nitrification is more rapid at warmer temperatures, it can continue in low temperatures.

Subsequent removal of the nitrate is the "denitrification" process. Denitrification is a process of nitrate reduction by primarily heterotrophic facultative anaerobic bacteria. In environments with the proper temperature regime (50 to 60 deg F), low oxygen levels, and a carbon source (e.g. organic matter) these bacteria reduce nitrates to molecular nitrogen (N_2). Because of the temperature and anoxic conditions required, it is difficult to perform in a lagoon system. For those reasons denitrification is usually performed in specialized tertiary mechanical treatment equipment, such as recirculating sand filters, after secondary treatment is complete. Examination of mechanical denitrification processes is outside the focus of this feasibility study. In any case, biological denitrification is unlikely to be viable year around, as winter effluent temperatures will greatly slow or halt the process.

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59 "Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances". ADEC. As amended through December 12, 2008. Available at http://dec.alaska.gov/water/wqsar/wqs/pdfs/Alaska%20Water%20Quality%20Criteria%20Manual%20for%20Toxic%20and%20Other%20Deleterious%20Organic%20and%20Inorganic%20Substances.pdf

Vegetative uptake is another common method of nitrate removal, performed by applying effluent to vegetated land or wetlands. In a land application, nitrates are removed from the effluent by absorption directly via plant roots. In a wetland setting, in addition to plant uptake, nitrates are removed by natural denitrifying facultative bacteria in the anoxic (low oxygen) organic soils and in wetland sediments. These processes function when plants are growing or when temperatures are above about 40 to 50 deg F. Land application, and the use of the WWTP wetland parcel is the focus of the proposed disposal alternatives.

In addition to removal of nitrates, fecal coliform and other bacteria are removed via filtration through vegetation and soil, exposure to sunlight and temperature swings, and simply die off because conditions are not favorable for reproduction.

The EPA has published several case studies and guidance manuals related to wastewater treatment by wetlands. Of particular note for this project:

> *The Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment Design Manual* [60] *suggests 6-7 days as the optimal detention time for treatment of secondary wastewater streams. The manual notes that shorter detention times do not provide adequate treatment and longer detention times can lead to stagnant, anaerobic conditions. Depth of effluent is recognized to effect detention times. The effluent depth is a function of season with 4 inches recommended in the summer and 12 inches recommended in the winter to minimize the effects of cooling and freezing on detention time* (although 12 inches is probably not sufficient for Wasilla).

- EPA 625/1-81-013, *Process Design for Land Treatment of Municipal Wastewater*[61] is also applicable. These manuals suggest that 7 to 10 days of wetland detention will remove 40 to 90 percent of nitrates and about 90 percent of fecal coliform.

- The University of Minnesota, which has designed year-round wetlands, has published papers recommending 10 to 13 days for cold regions. 62

Designs for this report will target at least 6 to 10 days of detention time for nitrate and fecal coliform removal.

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60 "Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment Design Manual", EPA/625/1-88/022. EPA, Office of Research and Development, Center for Environmental Research Information. September 1988. Available at http://www.epa.gov/nscep

61 "Process Design Manual for Land Treatment of Municipal Wastewater", EPA 625/1-81-013. EPA, Center for Environmental Research Information. October 1981. Available at https://nepis.epa.gov.

62 "Innovative Onsite Sewage Treatment Systems: Constructed Wetlands". College of Agricultural, Food, and Environmental Sciences, University of Minnesota. 2001.

5.2.3 Groundwater

Design of the WWTP processes that impact groundwater requires an understanding of the existing hydrogeologic system. Once effluent encounters groundwater at depth it is assumed that the temperature (cold) and lack of biological treatment will impede any further treatment or removal of nitrate. At that point only dilution will impact contaminant levels. Depth to groundwater also affects the infiltrative capacity of the soil. Once the soil is saturated, infiltration is governed by aquifer conductivity rather than initial percolation rates.

Groundwater measurements were taken in both existing monitoring wells and new soil borings, and the sites surveyed. S&W developed a groundwater elevation contour map of this information (Appendix C[63], Figure A-5). The contouring is for the upper aquifer as only a single boring and an existing well are believed to have encountered the lower aquitard. None of the test borings, and none of the existing water wells in the vicinity of the project appear to have penetrated the aquitard into the lower aquifer. A perched zone of groundwater was also identified in earlier investigations under and around the lagoons on the WWTP site. Essentially, the lagoons and percolation beds are sitting on an aquitard that inhibits downward drainage.

According to S&W, the hydrogeologic system in the area includes four primary layers: an upper unconfined aquifer which includes the wetland surface organics; an upper "confining" layer with low hydraulic conductivity (aquitard of till or till-like deposits); a middle confined or semi-confined aquifer of interbedded sand and gravel; and a lower aquitard of till or till-like deposits. It is likely that additional aquifer/aquitard sequences underlie the lower aquitard. Groundwater in the greater regional area moves generally north to south, with local variations near waterbodies (e.g. ponds, streams). The S&W model, indicates that the groundwater in the immediate area of the WWTP flows generally south to southeast (Appendix C[64], Figure A-6). This differs from surface flows, which tend to flow southerly, and then due east.

S&W model results are discussed further in Section 6.3.4 related to potential development.

5.2.3.1 Area Wells

There are many drinking water wells in the project vicinity serving residential and commercial properties. Known wells documented with the Alaska Department of Natural Resources (ADNR)[65] are shown in Figure 6. There are also a number of likely wells on the residential properties immediately north of the WWTP, but there is no information on location or depth available in that location.

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63 *Hydrogeologic Assessment*, Appendix C.
64 *Hydrogeologic Assessment*, Appendix C.
65 Alaska Department of Natural Resources (ADNR), Division of Mining, Land, and Water, Alaska Hydrologic Survey Water Well Log Tracking System (WELTS), available at https://dnr.alaska.gov/welts/#show-welts-intro-template.

The depth of the wells along the bluff to the south and southwest of the new parcel indicate that many of these wells are likely completed in the upper aquifer, at approximately the same elevation as the wetland parcel. This is to say that the wells are drawing from the upper aquifer, not the lower one, and consequently wells could in theory be impacted by WWTP effluent discharges, either from the existing percolation beds, or from the proposed wetland effluent disposal. However, in most locations the groundwater gradient is southeasterly, essentially flowing past, rather than towards the various wells. In most cases, there is effectively no gradient between the WWTP and the various wells, so the direction of the groundwater gradient thus minimizes impacts from the WWTP effluent. The groundwater modeling calibration (Figure A-5) and Existing Conditions (Figure A-6) both show the existing ground water flow patterns and influence of existing WWTP discharge to the percolation beds.

The wells in the immediate vicinity of the WWTP are included on the groundwater modeling figures in Appendix C[66]. Figure A-5 shows the groundwater gradient in the project area, while Figure A-6 is a "particle plot" showing the shape and directionality of the WWTP effluent release into the groundwater. Note that the particle plots do not in any way correlate to concentration of contaminants or nitrate, rather it just shows the potential mixing region or "plume". Note also that the existing effluent discharge at the WWTP percolation beds affectively creates a "mound" in the groundwater table, raising the local groundwater in a large area under and around the WWTP 2 to 5 feet higher than it would be otherwise.

There were no wells found in the ADNR database for the residential lots along East Jude Drive; immediately north of the WWTP; however, this may just mean that the data is not in the ADNR WELTS database. Wells in this location are close to the WWTP, and within the WWTP groundwater mounding influence. It is possible for effluent and nitrate from the WWTP to migrate towards these properties and any wells that may be located there.

The homes on Southview Drive to the northeast of the WWTP are also on wells; however, these homes are outside of the localized WWTP gradient, and would not be affected by the WWTP.

Further north and east of the WWTP, the City utility map[67] indicates that water service has extended along Old Matanuska Road to Broadview Avenue to the northwest, and northeast to Walmart and the movie theater.

---

66 *Hydrogeologic Assessment*, Appendix C

67 City of Wasilla. 2016. Water & Sewer Utility Map, available at http://www.cityofwasilla.com/home/showdocument?id=4037, dated April 2016, accessed November 9, 2016.

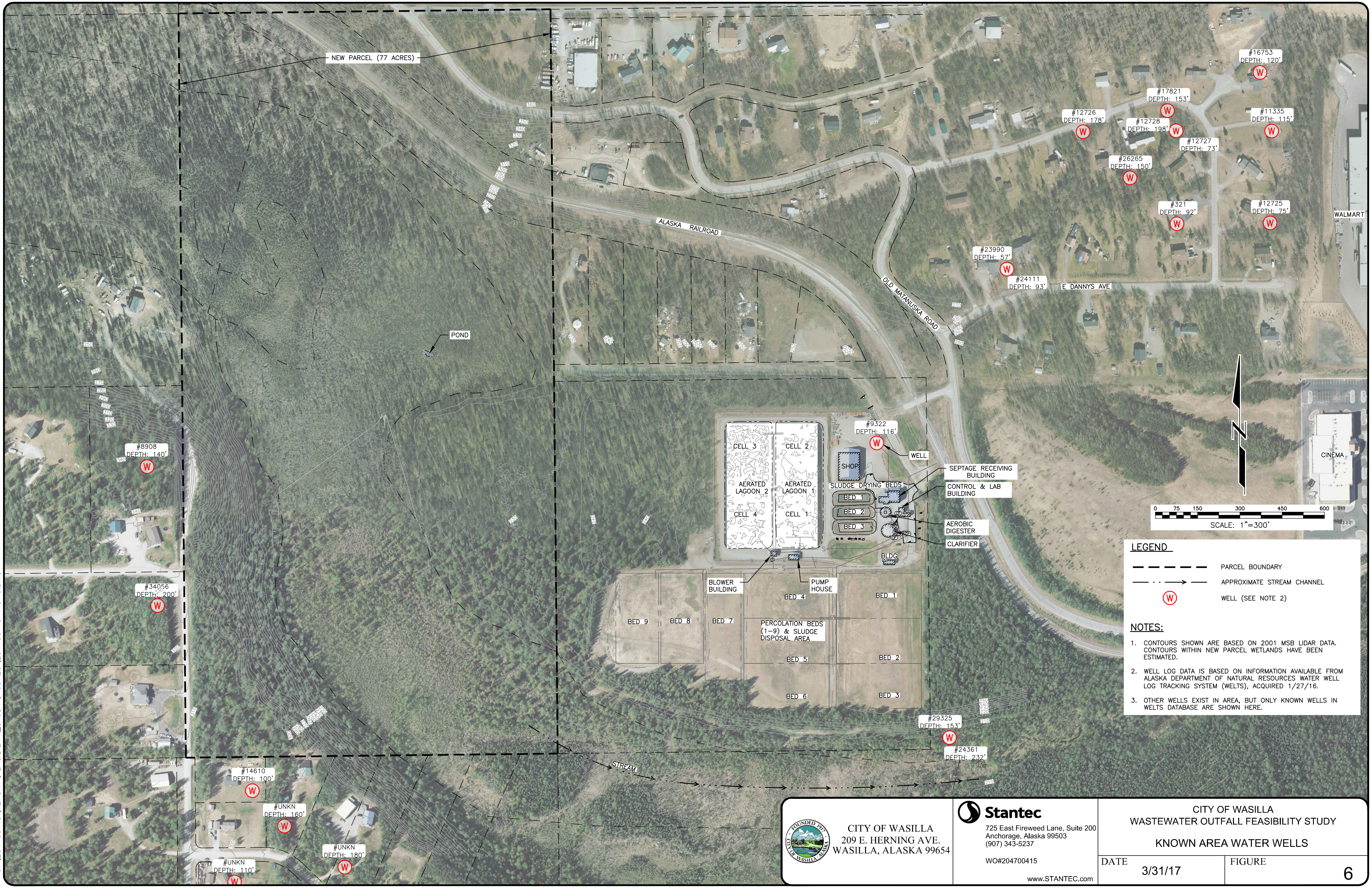
5.2.1 Treatment Compliance / Calculation End Point

While monitoring requirements and locations for the WWTP are currently established and not likely to be changed, it is important to consider where treatment results from development in the new parcel will be measured. The southeastern most corner of the new parcel at the 100-foot setback line is proposed based on the following considerations:

- The City requires a 100-foot setback for industrial uses from residential lot lines (Title 16.24.030 B). This setback matches the 100-foot distance required by ADEC as a separation distance from a drinking water source (e.g. well).
- The proposed point roughly corresponds to the origination of the stream flowing out of the wetlands parcel.

Application to land will require permitting as a new discharge. It is assumed that the effluent will be treated to meet secondary treatment standards (e.g. lagoons will still be used), prior to discharge into the wetlands.

As noted in Section 5.1.3, ADEC has noted that under water quality rules, the statutory point of compliance to a water of the US, (including a wetland) is at the point of discharge, e.g., the end of the pipe, unless a defined mixing zone is authorized. In order to obtain a discharge permit with a point of compliance after the wetlands, it will be necessary to remove the wetlands from USACE jurisdiction.



NEW PARCEL (77 ACRES)
POND
ALASKA RAILROAD
OLD MATANUSKA ROAD
E DANNYS AVE
WALMART
CINEMA
STREAM
#16753 DEPTH: 120'
#17821 DEPTH: 153'
#12726 DEPTH: 178'
#12728 DEPTH: 198'
#11335 DEPTH: 115'
#12727 DEPTH: 73'
#26265 DEPTH: 150'
#321 DEPTH: 92'
#12725 DEPTH: 75'
#23990 DEPTH: 57'
#24111 DEPTH: 93'
#9322 DEPTH: 116'
#8908 DEPTH: 140'
#34056 DEPTH: 200'
#29325 DEPTH: 153'
#24361 DEPTH: 232'
#14610 DEPTH: 100'
#UNKN DEPTH: 160'
#UNKN DEPTH: 180'
#UNKN DEPTH: 110'
CELL 3
CELL 2
AERATED LAGOON 2
AERATED LAGOON 1
CELL 4
CELL 1
SHOP
WELL
SEPTAGE RECEIVING BUILDING
CONTROL & LAB BUILDING
SLUDGE DRYING BEDS
BED 1
BED 2
BED 3
AEROBIC DIGESTER
CLARIFIER
BLDG
BLOWER BUILDING
PUMP HOUSE
BED 4
BED 9
BED 8
BED 7
PERCOLATION BEDS (1-9) & SLUDGE DISPOSAL AREA
BED 1
BED 5
BED 2
BED 6
BED 3
0 75 150 300 450 600
SCALE: 1"=300'
LEGEND
PARCEL BOUNDARY
APPROXIMATE STREAM CHANNEL
WELL (SEE NOTE 2)
NOTES:
1. CONTOURS SHOWN ARE BASED ON 2001 MSB LIDAR DATA. CONTOURS WITHIN NEW PARCEL WETLANDS HAVE BEEN ESTIMATED.
2. WELL LOG DATA IS BASED ON INFORMATION AVAILABLE FROM ALASKA DEPARTMENT OF NATURAL RESOURCES WATER WELL LOG TRACKING SYSTEM (WELTS), ACQUIRED 1/27/16.
3. OTHER WELLS EXIST IN AREA, BUT ONLY KNOWN WELLS IN WELTS DATABASE ARE SHOWN HERE.
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WASTEWATER OUTFALL FEASIBILITY STUDY
KNOWN AREA WATER WELLS
DATE 3/31/17
FIGURE 6

6.0 IMPROVEMENT ALTERNATIVES CONSIDERED

6.1 ALTERNATIVES CONSIDERED BUT NOT DEVELOPED

In 2006-8, Stantec (then USKH Inc.) conducted geotechnical, hydrologic, and engineering analysis of the existing percolation beds and 30-acre WWTP site to determine the maximum capacity of the facility, and potential corrections for the nitrate issue. After analysis of groundwater and effluent quality data, Stantec suggested several alternates for addressing the compliance and capacity goals. Most of the alternatives required expensive or maintenance intensive treatment equipment, and were not expected to improve nitrate removal. The final recommended alternative was for the City to acquire additional land near the WWTP to expand area available for effluent disposal, or to allow moving the point of compliance further from the WWTP. The following options were considered in 2006-8, but for various reasons were determined to be unfeasible or otherwise not meet project goals. They are identified here as items considered, but are not developed further.

- Influent Screening**:** Screening is of minimal value for septic tank influent.
- Extended Aeration Activated Sludge (EAAS): An upgraded treatment process that would remove BOD_5 and ammonia better, but not nitrate.
- Recirculating Granular Media Filtration: An upgraded treatment process that would remove BOD_5 and ammonia better, but not nitrate.
- EAAS process with membrane filters (a membrane bio reactor or MBR): MBRs produce high quality tertiary treated effluent, but are comparatively expensive to operate, and greatly exceed the treatment quality required by the WWTF permit.
- Addition of polishing sand filters with denitrification: This one option is the only treatment upgrade capable of achieving nitrate reduction through the denitrification process. It uses a sand filter, operated in an anoxic configuration with carbon source addition (essentially bacterial food, from methanol) to create ideal conditions for biological denitrification. It may still have merit if the wetlands treatment and disposal alternatives are not feasible. Note however, the polishing filters only remove nitrate from the effluent, they do not address effluent disposal limitations.

- Sprinkler-type Land Application: This process would involve applying wastewater to the wetland area using a sprinkler system over a wide area, rather than the more concentrated application consider in Section 6.2 below. While this may be an improvement to the development currently considered involves a large increase in complexity and wetland disturbance. It would also potentially involve some level of aerosol release of the untreated wastewater and would require the pilot testing and verification recommended for the alternates discussed in Section 6.2 and so is not discussed further at this time.

- Freeze/Sublimation: Would involve a process similar to the sprinkler-type application but during winter conditions to allow loss of liquids to the atmosphere through sublimation with the remaining fraction applied to the site as ice or snow. This would release the untreated wastewater in the spring unless impounded which is not advisable (see Section 6.2.3) removing this process from consideration.

- Additional Buried Percolation Beds: Construction of additional percolation beds on upland areas of the WWTP was considered, but it was determined the additional beds would suffer the same limitations and confining soil layers as the existing beds. Construction of an additional 2 acres of percolation beds adds at most 100,000 gpd of disposal capacity, without addressing nitrate levels. If the existing beds were useable at the maximum loading considered feasible (100,000 gpd, see Section 3.3.3) this would still provide only 200,000 gpd capacity in the bed. Given that this just expands and perpetuates existing problems, this option was not pursued.

- Constructed Wetlands (CW): A review of research on the efficacy of CW systems in removing nitrogen identified many environmental and economic benefits to using CW in treating wastewater, in addition to many limitations, mostly due to challenges in cold climates. There is a well-defined “bench” west of the existing lagoons. This upland area (Upland Area 2, see Figure 7) is available for development and was considered for use with CWs. The issue with this site for any infiltrative use will be the expectation that it will experience issues similar to that at the infiltration bed and will mound groundwater sending effluent out radially. The use of this area has instead been “reserved” for other WWTP development such as additional lagoons or treatment processes. Redeveloping the existing wetland with constructed elements is possible, but would not be expected to be a dramatic improvement over existing.

- Winter Wastewater Storage: To maintain treatment in wetlands vegetation is required, a condition not available in Alaska during winter months. Development of storage for the non-growing season was considered; however, the mounding issues discussed in 6.2.3 make this option impracticable without achieving treatment before infiltration. Any storage option would therefore require lining and would consume the wetland space required for summer treatment.

6.2 NATURAL WETLANDS USE

The scope for this report focuses on use of the natural wetlands adjacent to the WWTP property for effluent treatment and disposal, to include nitrate removal to meet WWTP permit criteria. The use of the wetlands was considered in incremental modifications from least to most invasive, and as a means of determining capacity for various levels of development. It is known that wetlands can treat wastewater; the question is then what is the capacity of the land, and the impacts to the surrounding properties.

The use of wetlands is generally attractive for wastewater treatment because of three basic functions:[68]

1. Physical entrapment of pollutants through sorption in the surface soils and organic litter.
2. Utilization and transformation of elements by microorganisms.
3. Low energy and low maintenance requirements to attain consistent treatment levels.

For the City of Wasilla, it is primarily functions 2 and 3 that are driving the consideration of adding wetlands treatment as the effluent is low in particulate matter already.

The major drawback for use of wetlands, is that treatment is only available during the growing season, typically May 8 to October 5 each year, or 5 months out of 12[69]. However physical treatment and disposal may continue until the effluent freezes.

Most research on wetland treatment is based on CW, but from this it can be understood that the majority of nitrate removal occurs through bacterial processes in the soil, water, and surface of plant material that occur in anaerobic conditions and not through plant uptake, though plants will remove nitrates efficiently.[70] Limitations to nitrification, or conversion of ammonia to nitrate, include water temperatures; below 50 deg F (10 deg C) nitrification rates slow ; below 42 deg F (6 deg C) nitrification rates in water drop to zero.[71] Optimum temperatures for nitrification in soils in CWs range from 86 to104 deg F (30 to 40 deg C). Other limitations to nitrification rates include pH, which ideally is between 6.6 and 8 in CWs, alkalinity, inorganic carbon, and dissolved oxygen. [72]

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68 "Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment Design Manual", EPA/625/1-88/022. EPA, Office of Research and Development, Center for Environmental Research Information. September 1988. http://www.epa.gov/nscep
69 USACE. Wetland Delineation Manual: Alaska Region (Version 2.0). September, 2007.
70 Zhang, C., Wang, J., Liu, W., Zhu, S., Chang, S.X., Chang, J., and Ge, Y. *Effects of Plant Diversity on Nutrient Retention and Enzyme Activities in a Full-Scale Constructed Wetland*. Bioresource Technology, Vol. 101, 1686-1692. 2010.
71 Werker, A.G., Dougherty, J.M., McHenry, W.A., and Van Loon, W.A. *Treatment Variability for Wetland Wastewater Treatment Design in Cold Climates.* Ecological Engineering, Vol. 19, pp 1-11. 2001.
72 Vymazal, et al. Removal of Nutrients in Various Types of Constructed Wetlands. 2007.

Plants provide some level of insulation for the filtration bed, space for bacterial growth, nutrient uptake and storage, oxygen release, and antimicrobial properties that benefit denitrification. For all types of wetlands, the diversity and richness of plant communities enhances the removal of nitrogen. [73]

Denitrification, or the second process of taking the nitrates and converting them to nitrogen gas, is also strongly temperature dependent. Denitrification rates drop substantially, but can still proceed at temperatures below 41 deg F (5 deg C) in water. Optimum pH ranges from 6 and 8 for significant denitrification, slow at pH below 5, and non-existent below 4. [74] Other limitations to the conversion of nitrate to nitrogen gas in CWs are the diversity of relevant bacteria in the soil and water, the soil type, organic matter, and overlaying water.[75]

6.2.1 Description

In the simplest case, effluent from the WWTP would be discharge directly to the natural wetland via distribution piping on the new parcel in the summer allowing for nitrogen uptake by the existing wetlands. A portion of the treated effluent is expected to infiltrate and mix with ground water, while a portion will run off and mix with the existing stream flow near the WWTP, the difference being the effluent will have been treated by the wetlands to an expected much lower nitrate level.

The existing wetlands will have some treatment and hydraulic capacity in its natural state. Presumably, enhancing the wetlands to increase hydraulic capacity or detention time could improve both treatment and disposal potential. Accordingly, the incremental improvements considered for the new parcel are:

1. The basic case of application to unimproved wetlands as shown on Figure 7, which develops the piping and support infrastructure to allow application of flows to the wetland (described below) without additional improvements.

2. Application to “enhanced wetlands” as shown on Figure 8, which adds low berms to the wetland, impounding water, increasing detention, and redistributing flow.

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73 Bachand, P., Horne, A. Denitrification in Constructed Free-Water Surface Wetlands: II. Effects of Vegetation and Temperature. Ecological Engineering, Vol 14, pp 17-32. 2000.

74 Werker, A.G., Dougherty, J.M., McHenry, W.A., and Van Loon, W.A. *Treatment Variability for Wetland Wastewater Treatment Design in Cold Climates*. Ecological Engineering, Vol. 19, pp 1-11. 2001.

75 Vymazal, J. *Removal of Nutrients in Various Types of Constructed Wetlands*. Science of the Total Environment. Vol. 380, pp. 48-65. 2007.

3. Application to pond and enhanced wetlands as shown on Figure 9, which increased the berm heights and associated impoundment depth of the water at the outfall. This further increases detention to a maximum degree. Ponding depths of 4 to 5 feet deep were assumed as an initial minimum to avoid freezing and potentially allow year-round use of the site for effluent disposal.

These three alternatives are discussed more fully in the following sections.

6.2.2 Construction Requirements

Construction of a means to discharge effluent to the wetlands will include development of a pipe alignment, access, and outfall. Additionally, it is expected that use of the wetlands will require some measure of perimeter control to protect the public from wandering onto the property and contacting the partially treated effluent. These components are common to all considered uses of the wetland and are discussed in the following sections.

6.2.2.1 Pipe Alignment

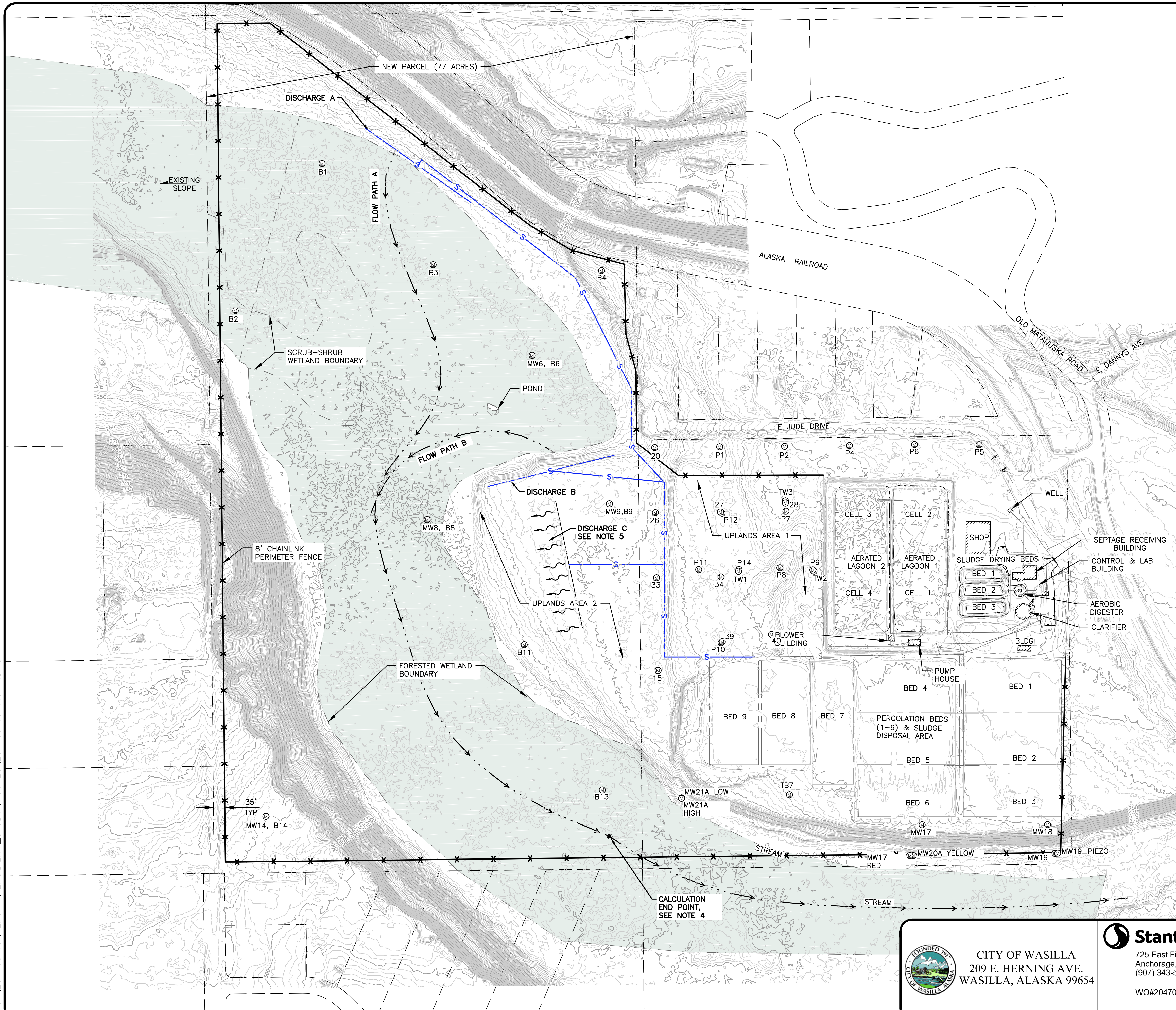
Three different discharge points were considered as shown on Figure 7 to Figure 9, each is associated with a different flow path length in the wetland, as well as a different area of land presumed to be “used” by the effluent for treatment. All piping runs are taken west and then north along the edge of Upland Area 1 to leave space for additional lagoons or other development.

Discharge Point C was considered as an application to the available uplands slope, but was not considered extensively as it used less than half of the available wetlands and would limit the future use of Upland Area 2. The location requires the length of piping (approximately 860 linear feet[LF]) of the three discharge locations considered.

Discharge Point B applies effluent to the wetland approximately 875 feet from Aerated Lagoon 2. This location requires additional piping (approximately 310 LF more or 1,170 feet total) and improves the flow path length in the wetland. For the pond option this location makes sense as it minimizes pipe and in-water structures could be used to direct flows to prevent short circuiting.

Discharge Point A is the basis for calculations. This location applies effluent at the northern and highest point in the wetland to allow it the longest flow path, i.e. time for treatment. This location does require the longest run of piping (approximately 2,150 LF)

As shown on the figures, piping extended from the lines to beds 8 and 9 west down the slope to Uplands Area 2 so that Uplands Area 1 is available for later development. The alignment then runs parallel with the slope for ease of construction and to retain the majority of Uplands Area 2 for other uses. Approximately the first 565 LF of the alignment is the same for all discharge locations, with the next 250 LF common to discharges A and B. At the edge of Uplands Area 2 the alignments diverge with a route running west to Discharge B and further north for Discharge A. For Discharge A, the alignment is routed in the upland areas as directly as possible to the discharge location along the railroad embankment. Routing is in uplands to minimize wetlands disturbance. Table 17 summarizes differences between alignment quantities.



LEGEND

- APPROXIMATE STREAM CHANNEL
- PARCEL BOUNDARY
- POTENTIAL FENCE ALIGMENT
- POTENTIAL PIPE ALIGMENT
- WETLANDS
- MONITORING WELL (MW–18)

NOTES:

1. CONTOURS SHOWN ARE BASED ON 2001 MSB LIDAR DATA. CONTOURS WITHIN NEW PARCEL WETLANDS HAVE BEEN ESTIMATED.
2. APPROXIMATE FLOW PATHS SHOWN ARE THE BASIS FOR LENGTHS USED IN CALCULATIONS.
3. PIPES AND FENCELINES SHOWN ARE BASIS FOR COST ESTIMATES.
4. POINT OF COMPLIANCE IS ASSUMED TO BE EXISTING MONITORING WELLS AND / OR SURFACE WATER SAMPLING AT EDGE OF CITY PROPERTY. CALCULATION ENDPOINT IS BASED ON A 100–FOOT OFFSET FROM THE PARCEL BOUNDARY AND IS USED SOLELY FOR CALCULATIONS.
5. DISCHARGE C CONSIDERED DISCHARGE AS A TRICKLE TO SURFACE OF UPLANDS SLOPE, BUT ONLY USES A LIMITED PORTION OF THE AVAILABLE LAND. OTHER OPTIONS MAKE BETTER USE OF LAND AND DISTANCE.

N

0 75 150 300 450 600

SCALE: 1"=300'

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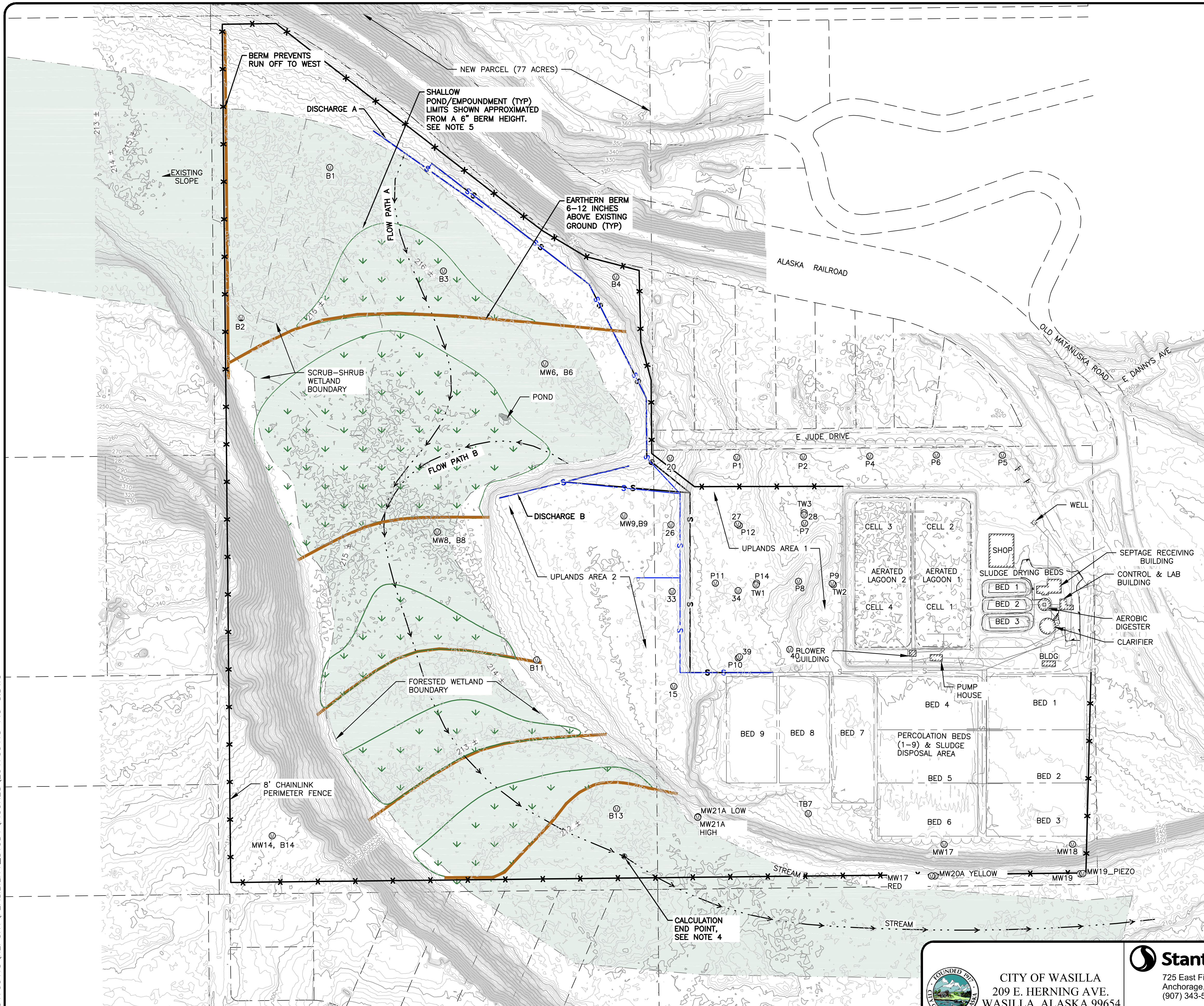
CITY OF WASILLA
WASTEWATER OUTFALL FEASIBILITY STUDY

APPLICATION TO UNIMPROVED WETLANDS

DATE	FIGURE
3/31/17	7

U:\204700415\REPORT\FEASIBILITY_STUDY\FIGURES\204700415–FIG–7.DWG



LEGEND

- APPROXIMATE STREAM CHANNEL
- POTENTIAL BERM
- PARCEL BOUNDARY
- POTENTIAL FENCE ALIGMENT
- POTENTIAL PIPE ALIGMENT
- WETLANDS
- ENHANCED WETLAND (DEPTH VARIES 0 TO 6 INCHES)
- MONITORING WELL (MW–18)

NOTES:

1. CONTOURS SHOWN ARE BASED ON 2001 MSB LIDAR DATA. CONTOURS WITHIN NEW PARCEL WETLANDS HAVE BEEN ESTIMATED.
2. APPROXIMATE FLOW PATHS SHOWN ARE THE BASIS FOR LENGTHS USED IN CALCULATIONS.
3. PIPES AND FENCELINES SHOWN ARE BASIS FOR COST ESTIMATES.
4. POINT OF COMPLIANCE IS ASSUMED TO BE EXISTING MONITORING WELLS AND / OR SURFACE WATER SAMPLING AT EDGE OF CITY PROPERTY. CALCULATION ENDPOINT IS BASED ON A 100–FOOT OFFSET FROM THE PARCEL BOUNDARY AND IS USED SOLELY FOR CALCULATIONS.
5. HATCHES SHOWN APPROXIMATE IMPOUNDMENT FROM 6–INCH HIGH BERMS. 12–INCH HIGH BERMS MAY BE USED TO COVER ENTIRE WETLAND AREA WITH 0 TO 12 INCHES OF IMPOUNDED WATER.

N

0 75 150 300 450 600

SCALE: 1"=300'

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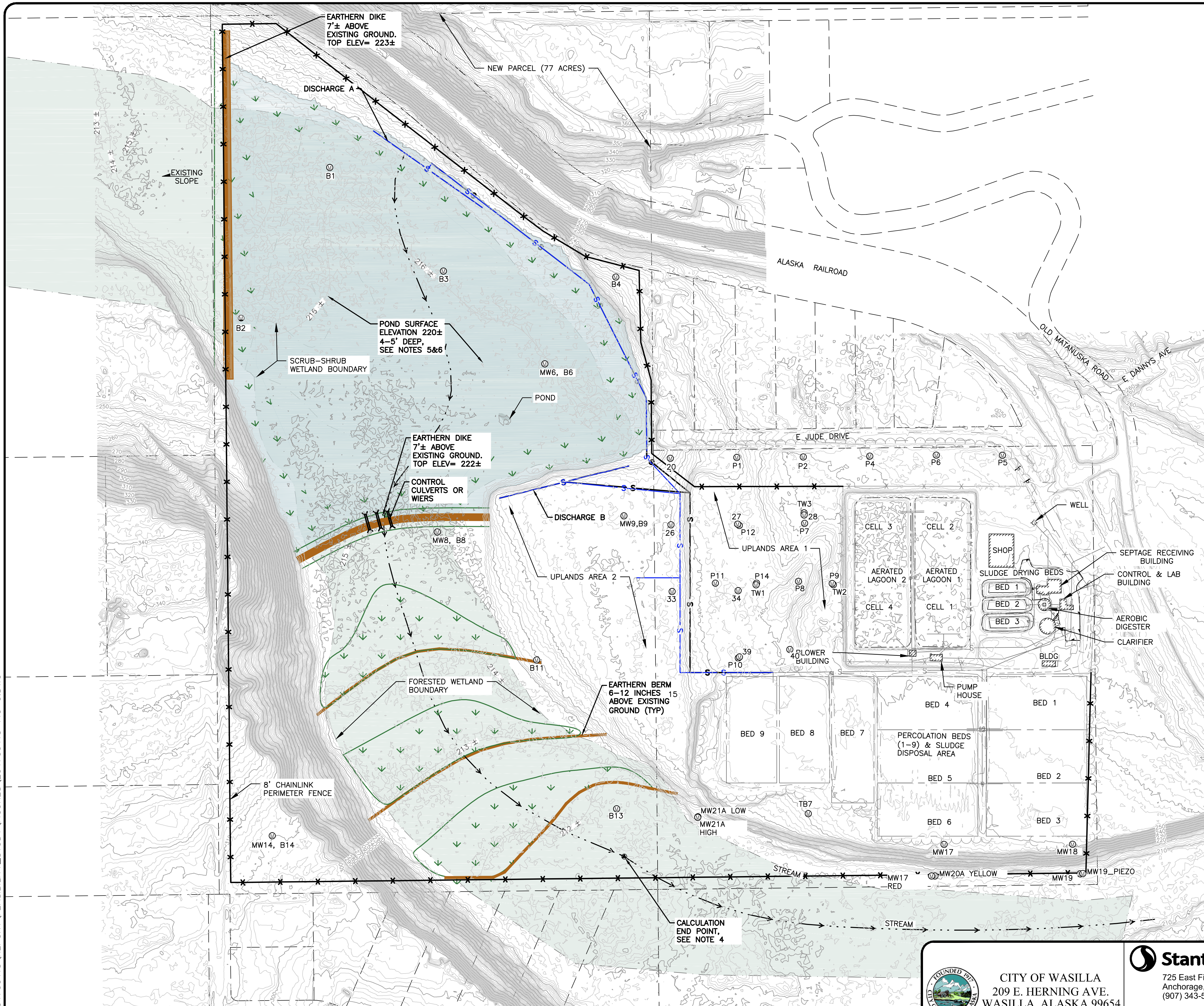
DATE	FIGURE
3/31/17	8

U:\204700415\REPORT\FEASIBILITY_STUDY\FIGURES\204700415-FIG-8.DWG



LEGEND

- APPROXIMATE STREAM CHANNEL
- POTENTIAL BERM
- PARCEL BOUNDARY
- POTENTIAL FENCE ALIGMENT
- MW-18 POTENTIAL PIPE ALIGMENT
- WETLANDS
- ENHANCED WETLAND (DEPTH VARIES 0 TO 6 INCHES)
- CONSTRUCTED POND
- MW-18 MONITORING WELL

NOTES:

1. CONTOURS SHOWN ARE BASED ON 2001 MSB LIDAR DATA. CONTOURS WITHIN NEW PARCEL WETLANDS HAVE BEEN ESTIMATED.
2. APPROXIMATE FLOW PATHS SHOWN ARE THE BASIS FOR LENGTHS USED IN CALCULATIONS.
3. PIPES AND FENCELINES SHOWN ARE BASIS FOR COST ESTIMATES.
4. POINT OF COMPLIANCE IS ASSUMED TO BE EXISTING MONITORING WELLS AND / OR SURFACE WATER SAMPLING AT EDGE OF CITY PROPERTY. CALCULATION ENDPOINT IS BASED ON A 100–FOOT OFFSET FROM THE PARCEL BOUNDARY AND IS USED SOLELY FOR CALCULATIONS.
5. POND LIMITS SHOWN ARE BASIS FOR GROUND WATER MOUNDING MODEL. ACTUAL POND WILL BE SIZED BASED ON INFILTRATIVE CAPACITY AND WILL LIKELY BE SMALLER.
6. POND WILL INCLUDE INTERIOR DIKES TO BAFFLE OR PARTITION FLOW AND MITIGATE SHORT CIRCUITING.

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DATE	FIGURE
3/31/17	9

U:\204700415\REPORT\FEASIBILITY_STUDY\FIGURES\204700415-FIG-9.DWG

Piping will be extended from the 8-inch ductile iron pipe (DIP) serving Bed 9 at an elevation of about 227 feet, to the midpoint of the distribution header. The new pipe can be Wasilla standard[76] polyethylene pipe, 6-inch for flows to 350,000 gpd and 8-inch for flows to 0.5 mgd. A flow of 1.0 mgd would require a 10-inch pipe. The surface elevation at the end of the pipes varies as shown in Table 17. If the pipes will be for seasonal use only, they do not need heat trace or cover for insulation, these would be needed if year-round use is planned. The final elevations will be set to match the headers.

Table 17: Pipe Route Summary

	Units	Discharge A	Discharge B	Discharge C
Pipe Length to be Constructed to Discharge	LF	2,150	1,170	860
Elevation at Header Midpoint	Feet	218	227.0	229.5
Elevation Difference from Bed Distribution Pipe to Outfall	Feet	9	0	-2.5
Wetlands Flow Path Length	LF	2,520	2,010	1280
Note: Length are estimates based on available aerial photography and LiDAR data.				

Piping trenches will require bedding for the pipe, and non-native backfill due to minimal cover provided by bedding and road section. Pipe will have 1-foot of cover to top of road surface when in the access road prism and can be exposed elsewhere.

6.2.2.2 Access

To maintain the piping and allow maintenance access to the headers, a 15-foot wide access road will be developed in the pipe corridor over the pipe. The road is not specifically shown on the figures.

The new road will be constructed by clearing brush and vegetation, removing surface organics and unacceptable soils to expose the underlying granular subgrade, approximately 12 inches; and then bringing in a minimum of 12 inches of fill (Select Material Type A) and 6 inches of crushed aggregate surface course (Grading E-1). Excavation will be minimal and result in a road only minimally elevated from the surrounding ground. Occasional cross-culverts may be desirable to maintain drainage.

[76] 2013. City of Wasilla. *Standard Construction Specifications for "STEP" Pressure Sewer System*. Available at http://www.cityofwasilla.com/departments-divisions/public-works/utilities/wastewater/sewer-standard-specifications.

Contractor access through the WWTP site and on the residential Jude Street will need to be considered in planning with the contractor to minimize impacts. There is almost a 9-foot drop from the end of East Jude Drive to the proposed pipe alignment putting the new road below the elevation of neighboring residential lots and making this access point more difficult than first appears, particularly as road development will need to stay outside the delineated wetland (approximately 80 feet).

6.2.2.3 Outfall

The outfall header does not have to be a complicated system and would be a perforated pipe along the discharge slope approximately one standard pipe size larger than the distribution pipe. The header will be placed at grade and field perforated to distribute flow, with a perforation approximately every 10 feet. A header length of 400 feet has been used for consistency although there is more space along Discharge A in particular that could be used for flow distribution.

There is only approximately 1-foot in elevation change at Discharge A from the header location shown to the wetland, while there is approximately 12 feet at Discharge B. The goal is to have effluent trickle down the slope through the vegetated mat and shrubs in the woodland. Nitrates are removed by both the vegetation and the soils.

6.2.2.4 Perimeter Control

Although the wetland parcel is not easily accessed except from East Jude Drive. It is assumed that as a wastewater treatment facility, perimeter control will be required to separate the public from the effluent in the wetlands. An 8-foot chain-link fence with barbed wire to match the existing facility has been assumed, approximately 8415 LF as shown on Figure 7. Setting the fence at least 35 feet inside the property line on the west and south will allow for maintenance of native vegetation approximately 25 feet deep for screening even with a cleared corridor for fence maintenance. This screening is required by City Land Development Code 16.33.030G although it may be determined by the City and public to be more intrusive than beneficial.

The 35-foot offset from the property line is maintained except on the north where approximately 10 feet from the railroad is used and on the east where the offset varies. Along the southeast at the percolation beds the fence is shown to match existing fencing and gates. Near East Jude Drive the fencing is again nearer the lot lines (about 15 feet off) to allow pipe and road construction without entering the wetland.

As shown, the routing encompasses the entire property to minimize construction in the wetland. During design it is likely that this routing can be reduced or eliminated. As a public facility development concurrent for public use could also be considered, although green space is not generally lacking in the area.

6.2.2.5 Enhanced Wetlands Development

The wetland enhancements envisioned on Figure 8 consists of several low, 6- to 12-inch berms, placed to redistribute flow and prevent channelization and associated short circuiting. The berms would impound water to support emergent vegetation and are expected to be simple 8-foot wide gravel access paths to support construction and maintenance through the wetland. The berms may use drain rock to allow diffuse flow, and / or compost or silt sock (a flexible, log like erosion control product) used to provide a means of leveling and impounding water. Construction is expected to require clearing, placing woven geotextile over the surface mat and then placing 12 to 18 inches of material [77]. Construction during the winter might be advantageous as it may be easier over the soft soils of the wetland. For a firmer surface the trails can be topped with a structural grid. In some cases, these open grid materials could be used in place of some of the fill; however, use as a fill replacement would be dependent on cost and has not been assumed at this time.

Winter construction would allow access without the issues caused by the wet, compressible soils that exist when thawed. Existing snow and vegetation within 6 inches of grade would be removed. Any ice in excess of 6-inch depth would also need to be removed. Tundra mats or other means of stabilization may be required if winter construction is not feasible.

Regrading of the pathways and berm to address seasonal movement and settlement within the existing wetland soils should be anticipated. Initially placing 24 inches of fill is expected to create a 12-inch high berm or pathway after settling, particularly the first summer.

Berm locations shown on Figure 8 are spaced approximately along contours and are for presentational purposes only. Actual locations are expected to be field determined based on channel development. As groundwater modeling (see Section 6.2.3) indicates that impoundments at the north end are not desirable due to potential drinking water well impacts, the northern-most berm is most likely to be omitted entirely.

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[77] *Hydrogeologic Assessment*, Appendix C, see Section 5.4.

6.2.2.6 Pond Development

Figure 9 shows the concept considered for allowing use of the wetlands year-round. Disposal and treatment in a completely frozen wetland is not possible. However, if sufficient water depth is available, infiltration can continue into the unfrozen soil beneath the pond. Likewise, biological denitrification will continue in the anoxic pond sediments, at least until temperatures fall below 41 deg F (5 deg C). Developing a pond at the northern end of the parcel would require use of a higher berm (approximately 7 feet) on both the south and west sides to achieve ponding depths of 4 to 5 feet deep. These depths were an initial assumption to avoid freezing to the bottom of the pond. As discussed in Section 6.2.3, this concept was not developed beyond preliminary concepts because 1) groundwater impacts make it infeasible[78] and 2) It appears the leakage from a large pond in this area would make it difficult to keep the pond full at current WWTP effluent production rates.

6.2.2.7 Changes to Existing Facilities

The wetlands alternatives considered here have minimal impact to existing WWTP facilities. There are only two apparent impacts – perimeter fencing, and connections to existing WWTP piping.

The pipe connection can be accomplished in either of two ways. If Bed 9, which is currently not in use, were decommissioned, a connection to the existing 8-inch DIP could be made. This would disconnect Bed 9 and extend the buried feeder to supply the wetlands distribution system. The defunct 8-inch butterfly valve and operator in Vault 3 would be replaced at that time, with an 8-inch direct buried gate valve immediately outside Vault 3.

If Bed 9 is to be retained, then the existing valve could still be replaced and a tee with two direct buried gate valves would be added at the connection to direct flow to either Bed 9 or the wetlands. This would cost an additional $5,000 over what is discussed in Section 6.2.8 and detailed in Appendix H.

6.2.3 Groundwater Impacts

A major consideration in the evaluation of the wetlands treatment scheme is the potential impact to groundwater, and the surrounding residential drinking wells.

78 *Hydrogeologic Assessment*, Appendix C, see Section 6.

To consider the impacts associated with use of the wetlands parcel, S&W developed a hydrogeologic, numerical model[79]. The goal of the model was to estimate the impact of the proposed development scenarios on local groundwater conditions – gradient, flow, mounding, and contaminant transport. US Geological Survey's (USGS) MODFLOW-2005 was used as the underlying model to simulate flows based on the general understanding of the area geology described in Section 3.4.2. A full description of the model design and assumptions is provided in the Hydrogeological Assessment (Appendix C). The model used three flows, 350,000 gpd, 500,000 gpd and 1.0 mgd for each of the scenarios shown on Figure 7 to Figure 9. Model results are summarized in Table 18[80].

Some portion of the effluent, 4 to 54 percent, in all model runs is expected to become surface runoff, which would appear as stream flow south of the WWTP. This is not untreated effluent, rather it receives the same level of treatment as all the effluent, this is just the portion that does not soak into the groundwater table. It is unclear if the stream flow will actually increase or not, since a signification portion of the existing flow is already likely from the WWTP; the deliberate wetlands discharge just changes the point of application to further upgradient.

In addition to estimating the fractions of effluent disposed of via infiltration, runoff, and evapotranspiration (ET), the model used particle tracking to indicate routing of effluent flows in the subsurface. *Hydrogeologic Assessment* Figure A-6 shows discharge to the existing percolation beds. As noted in Section 5.2.3, the groundwater in the immediate area of the WWTP is expected to flow generally south to southeast from the mounding at the WWTP. Particle tracking is not indicative of concentration; it simply is a good visualization of the groundwater flow paths resulting from the discharge. Wells that are outside of the particle path are unlikely to be impacted by the discharge, as the effluent discharge basically does not flow to that well. Conversely, a well inside the particle path will arguable be influenced by the effluent to some variable degree. It may or may not receive nitrate levels of concern, as the discharge is being 1) treated by the wetlands and 2) diluted before it reaches the wells.

For Scenario 1, application of effluent to unimproved wetlands, the model shows that flows continue south and east, with additional influent to the north as flows increase (Figure A-7). The model has assumed some diffuse infiltration along the center of the wetland as surface flow continues. The mounding at the WWTP percolation beds is assumed to have dissipated in the model. Flow is predominately to the southeast, although there is also flow on the northern side of the WWTP. For flows on the order of 350,000, ground water under the influence of the effluent discharge flows past, all of the known wells on the southern bluff. This is an improvement over the existing percolation beds, which current tend to drive flow from the WWTP towards the wells. However, the wetlands discharge is potentially now sending more effluent toward the wells on the north of the WWTP. (The location and depth of those wells is unknown.

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79 *Hydrogeologic Assessment*, Appendix C
80 Based on *Hydrogeologic Assessment* (Appendix C) Table 4.

For Scenario 1, at flows above 0.5 mgd, water begins to mound and directs water north and west. So while the use of the wetlands for existing flows is still feasible at those flows, groundwater will need to be monitored as flows increase above 350,000 gpd to avoid impacting wells to the northeast. At 1 mgd the model indicates capacity of the groundwater aquifer has been exceeded, a groundwater mound forms above the ground surface, and flow begins to run west along the slough. Without consideration of nitrate treatment, it appears disposal of effluent under this methodology would be acceptable at current levels and up to the current 400,000 gpd permit limit, possibly more. Nitrate levels would be expected to decrease, just from dilution alone. Nitrate levels would need to be monitored however, because for application at Discharge A, the modeling shows potential to increase impacts to residential properties on the north.

Similar results and groundwater flow patterns are seen in themodel for the flows into the enhanced wetland (Scenario 2, figures A-10 to A-12). However, the enhanced wetland does send more effluent to the north. This is due to ground water mounding associated with the first "enhancement berm" located closest to the discharge to Point A. It is likely that eliminating the first berm, or moving it further south would mitigate the increased offsite impacts seen in Figure A-10. Also, the S&W model does assume 12-inch berms so the effects can be expected to be less pronounced with lower berms. With these modifications, it appears that the Enhanced Wetlands concept would also be acceptable to current discharge levels, up to the current permit level of 400,000 gpd and possibly more.

Scenario 3 modeling application to a pond with some shallow berms in the remaining wetland (figures A-13 to A-15), shows immediate radial groundwater flow from the pond area in all directions, especially to west, north, and east. The pond appears to extend impacts well beyond current limits or any of the other wetland schemes. The model also indicates that the expected WWTP flows are not able to keep the pond full to the desired depth.

This concept was primarily under consideration to allow continued disposal into the winter. Since it appears to have unacceptable offsite impacts, and because achieving the required depth is questionable, it was not considered any further.

Table 18: Groundwater Model Results

Description	Model Scenario	Application Rate (gpd)	Estimated Allocation (%)		
			Infiltration	Runoff	ET
Application to Unimproved Wetlands	Scenario-1a	350,000	57%	37%	6%
	Scenario-1b	500,000	49%	44%	7%
	Scenario-1c	1,000,000	41%	54%	5%
Application to Enhanced Wetlands	Scenario-2a	350,000	63%	27%	10%
	Scenario-2b	500,000	51%	41%	8%
	Scenario-2c	1,000,000	43%	51%	6%
Application to Pond and Enhanced Wetlands	Scenario-3a	350,000	82%	4%	14%
	Scenario-3b	500,000	71%	17%	12%
	Scenario-3c	1,000,000	47%	47%	6%

6.2.4 Wastewater Treatment

To determine the capacity of the wetland to actually treat the nitrates in the WWTP effluent, a number of evaluations were completed. These include a Subwet 2.0 Wetlands Treatment Model and several "rule of thumb" calculations. These efforts are summarized here, and documented more fully in Appendix E.

6.2.4.1 Hydraulic Loading

Hydraulic loading rates (HLRs) using the 37 acres of wetlands are shown in Table 19. A suitable HLR normally ranges from 0.2 to 30 cm/day[81] and in arctic climates it has been suggested that a more appropriate range is 1 to 2 cm/day[82], indicating that treatment of flows over 500,000 gpd is feasible.

Table 19: Hydraulic Loading Rates for 37 acres

Effluent Flow (gal / day)	Hydraulic Loading Rate (cm / day)
350,000	0.88
400,000	1.01
500,000	1.26
1,000,000	2.53

81 Wood, A., 1995. Constructed wetlands in water pollution control: fundamentals to their understanding. Water Science and Technology, 32(3):21-9

82 Doku, I.A. and Heinke, G.W. 1993. The potential for use of wetlands for wastewater treatment in the Northwest Territories. Department of Municipal and Community Affairs. Government of Northwest Territories.

6.2.4.2 Organic Loading

Organic load refers to the soluble and particulate organic matter applied to a system. The organic loading rate (OLR) can have important influences on both biological and chemical treatment processes. Too low and organisms have no food, too high and aerobic organisms will consume the available oxygen, converting the system to an anaerobic environment with aerobic organisms dying and an increase in odors. BOD_5 is a measure of the organic loading and is the amount of oxygen consumed by microbes per liter of sample. Standard BOD testing is done for 5 days (BOD_5) to measure oxygen demand for 5 days of incubation at 20 deg C. OLRs were calculated both at the 2015 average annual BOD_5 exiting the lagoons of 134.28 mg/L and at the 2015 maximum observed value of 400 mg/L. The lower number is much more typical of WWTP effluent; the 400 mg/L is the maximum ever observed, and is likely a process upset. Results from these calculations are shown in Table 20.

Table 20: Organic Loading Rates for 37-acres

Effluent Flow (gal / day)	Organic Loading Rate at 134.28 mg/L BOD5 (kg BOD_5 / ha /day)	Organic Loading Rate at 400.00 mg/L BOD_5 (kg BOD_5 / ha /day)
350,000	11.88	35.40
500,000	16.97	50.55
1,000,000	33.95	101.13

Kadlec and Wallace[83] suggest that values not exceed 60 to 80 kg BOD_5/ha per day to achieve a treatment effluent less than 30 mg/L BOD_5. Doku and Heinke[84] suggest that arctic wetlands (e.g. tundra wetlands) not receive organic loading greater than 8 kg BOD_5/ha per day to ensure adequate aerobic conditions persist within the wetland. Again, this is a simplified calculation meant to provide an order of magnitude evaluation. Wasilla is subarctic, and much more temperate climate than the arctic tundra, so an acceptable loading probably lies somewhere between the two ranges. OLR loading for the normal WWTP effluent are probably acceptable to at least the 500,000 gpd range.

[83] Kadlec, R. H. and Wallace, S. D., 2009. Treatment wetlands (2nd Edition). Boca Raton, FL: CRC Press.
[84] Doku, I.A. and Heinke, G.W. 1993. The potential for use of wetlands for wastewater treatment in the Northwest Territories. Department of Municipal and Community Affairs. Government of Northwest Territories.

6.2.4.3 SubWet Model

For a more sophisticated approach a three-dimensional, horizontal subsurface flow modelling program, SubWet 2.0, was employed to evaluate the potential for the 37-acre wetland to treat the WWTP effluent. SubWet was originally developed for warm climate constructed wetland applications, but recent modifications allow for its application to cold climate natural wetlands[85].

The SubWet model incorporates the influence of several factors simultaneously by employing 25 differential process equations and 16 parameters (e.g., rate coefficients such as temperature coefficient of nitrification). The model requires values describing the physical features of the wetland, including length, width, depth, slope, hydraulic conductivity, temperature etc. In addition, the model requires inputs on the expected influent, such as volume and water quality. Initial assumptions were made based on available data as described in Appendix E.

Table 21: SubWet Model Results

	Influent Level (mg/L)	Effluent Level at 350,000 gal/day 16.4 days HRT	Effluent Level at 400,000 gal/day 14.4 days HRT	Effluent Level at 500,000 gal/day 11.54.4 days HRT
Nitrate (mg/L)	26.7	0.034	0.032	0.045
BOD$_5$ at 134 mg/L	77	0.040	0.050	0.072
BOD$_5$ (mg/L)	134.28	1.35	21.30	57.59
Nitrate at 26.7 mg/L	400	UNK	UNK	UNK
UNK = unknown value, model failed to stabilize				

Model results with varying flow (0.35, 0.4, and 0.5 mgd), nitrate and BOD5 levels in the lagoon effluent (wetland influent) are shown in Table 21. These results indicate that with an influent (WTP effluent) nitrate even as high as the 2015 maximum recorded value of 77 mg/L flows leaving the wetland will have values less than 0.1 mg/L for flows up to 500,000 gpd.

For BOD$_5$ at average 2015 levels of 134 mg/L coming into the wetland, the effluent is expected to have a BOD$_5$ level of 1.35mg/L for current annual flows (350,000 gpd). Above that flow, BOD is still removed, but not as effectively. Predicted BOD at a flow of 500,000 gpd is 57.6 mg/L. The model fails when run with a BOD$_5$ in the wetland influent of 400 mg/L (2016 process upset), but BOD that high is not expected. However, it will be important to monitor the WWTP for process upsets, since excess levels of BOD in the wetlands could result in septic conditions, resulting in odor and damage to vegetation.

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85 The model can be freely downloaded at the United Nations Environmental Programme, International Environmental Technology Centre (UNEP-IETC) website http://web.unep.org/ietc/.

One of the important aspects of the SubWet 2.0 modelling software is the ability to calibrate the model with empirical data[86]. Without calibration to the City wetland, the expected modeling results are within 25 percent of potential observed values, but with calibration that can be reduced to 5 percent, or less. A preliminary outline for a pilot study has been developed and provided in Appendix G. The pilot study outlines a plan for data collection before and during application of WTP effluent to determine treatment results and related impacts. The pilot study plan is a starting point and is expected to require modification with project stakeholders (e.g. ADEC, USACE, City) prior to implementation. Discussions with ADEC and the USACE to date indicate that with no development within the wetland (testing only of application to unimproved wetlands) no permits would be required to conduct a pilot study, beyond plan review of the proposed study.

6.2.5 Environmental Impacts

The most obvious and anticipated impacts from this project will be to groundwater and the wetland. Increased treatment is expected to improve groundwater quality overall, with benefits from both dilution and treatment as discussed in Section 6.2.3. It appears that the proposed wetlands disposal has less offsite groundwater impacts, and is less likely to impact surrounding wells than the current subsurface percolation beds. This is because the wetlands disposal has less influence on the groundwater gradient that the effluent mounded under the WWTP at present. This mound is about 5 feet higher than any groundwater elevation possible in the wetlands discharges. Wetland impacts will result from increased nutrients and water inputs. These impacts are difficult to predict, some occurring in the short-term while others in the long-term, and are wetland-specific. Even modest additions of nutrients can increase wetland productivity relatively quickly and potentially increase flora and fauna diversity in the long-term. The influent discussed here has already received primary and secondary treatment and would provide a moderate amount of additional nutrients to the wetland and would likely result in a modest increase in productivity. In addition, the increased water input would likely increase or prolong soil saturation promoting emergent vegetation species in the long-term. There is mounting evidence that Southcentral Alaska (and elsewhere) is experiencing significant wetland drying with clear patterns of reductions in emergent vegetation communities that are being replaced by woody vegetation assemblages.[87] Adding water (in the form of effluent) is likely to be beneficial to the wetlands.

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86 Chouinard, A., Balch, G.B., Wootton, B.C., Jørgensen, S.E. and Anderson, B.C. 2014b. Modelling the performance of treatment wetlands in a cold climate. In Ecological Modelling and Engineering of Lakes and Wetlands. Jørgensen, S.E.; Chang, N.B.; Fuliu, X., Eds. Elsevier: Amsterdam, Netherlands.

87 Klein, E., Berg, E. E., and Dial, R. 2005. Wetland drying and succession across the Kenai Peninsula Lowlands, southcentral Alaska. *Canadian Journal of Forest Research*, *35*, 1931–1941. doi:10.1139/X05-12; Berg, E. E., Hillman, K. M., Dial, R., and DeRuwe, A. 2009. Recent woody invasion of wetlands on the Kenai Peninsula Lowlands, southcentral Alaska: a major regime shift after 18 000 years of wet Sphagnum –sedge peat recruitment. *Canadian Journal of Forest Research*, *39*(11), 2033–2046. doi:10.1139/X09-121; Smeltz, Scott T, 2013. Interactions between vegetation and hydrology: 1) Forest structure and throughfall, 2) Spruce expansion following wetland drying. Master Thesis, Alaska Pacific University.

With the loss of emergent vegetation, a related decline can be seen in shorebirds and other species who are dependent on the habitat[88]. (e.g. Morrison et al 2001). There is some potential for increased use of the site by birds, especially if open water is expanded. This may eventually require some management as excessive bird habitation will increase fecal coliforms in the system, which may result in permit issues. However, if water depths are kept low enough, the emergent vegetation and taller grasses will continue to ward off the bird population.

With the increased water levels and the promotion of emergent and wetland obligate vegetation there will be a concurrent reduction in facultative species, such as some shrubs, black spruce (*Picea marianna*) and birch (*Betula papyrifera*). This fundamental shift in vegetation assemblages would in essence reverse some of the impacts of wetland drying, but would take place over many years. However, too much water could in fact reduce flora and fauna diversity. Careful documentation of wildlife presence on the site and management of water levels and minimization of open water will be necessary. The pilot study outlined in Appendix G seeks to document vegetation and water level changes and establish protocols for long-term monitoring.

The public perception of the use of this site as a wastewater treatment process remains to be seen. There are no currently known uses for the site and there was no visible evidence of frequent visitation (e.g. litter, trails) of the site which is generally wet and difficult to access. The site is well separated from the surround residential areas by the tall bluff. While the effluent disposal is not expected to be readily visible, or generator offsite impacts, designation as a part of the WWTP could have negative impacts on surrounding property values, spreading the expected depression being near a facility of this nature has. The type of treatment, improvements in overall impacts to the area groundwater and downstream should mitigate this if an appropriate public involvement process is developed. This process should be initiated with any implementation of the pilot study and seek to address concerns and mitigate impacts. Some consideration might also be given to increasing the public value of the facility by increasing access and providing trails and educational opportunities.

No other impacts to floodplains, other important land resources, endangered species, historical and archaeological properties, etc., have been identified at this time. No new residuals or wastes are anticipated with this treatment process.

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88 Morrison, R.I.G., Y. Abry, R.W. Butler, G.W. Beyersbergen, G.M. Donaldson, C.L. Gratto-Trevor, P.W. Hicklin, V.H. Johnston, and R.K. Ross (Morrison et al.). 2001. Declines in North American shorebird populations. Wader Study Group Bulletin. 94:34-38. April.

6.2.6 Land Requirements

Use of the natural wetlands as described in this section, makes use of only the 77-acre City parcel. No additional easements or sites will be required. The land will remain largely as is with disturbances only for access road, pipe (40-foot wide corridor) and fence construction (20-foot wide corridor in uplands). Additional disturbances will also result from wetland enhancement if berms are placed (10- 15-foot corridor).

6.2.7 Potential Construction Problems

Due to the soft nature of the surface organic soils in the wetland, construction in the wetland will be more difficult than in upland areas. Additionally, the slopes of the site upland areas, further restrict access. Winter construction will need to be considered in design of any project.

Access issues, as discussed in Section 6.2.2.2, will need to be addressed early in collaboration with neighboring property owners.

6.2.8 Sustainability Considerations

Sustainable utility management practices include environmental, social, and economic benefits that aid in creating a resilient utility.

6.2.8.1 Operations and Maintenance (O&M)

This concept requires minimal additional O&M activities. Anticipated activities include:

- <u>Seasonal Flow Change:</u> Operators will need to operate valves in the spring and fall to direct flow to or away from the wetlands and the subsurface percolation beds.

- <u>Pipe and Access Inspection:</u> Within the wetland system periodic inspection of the effluent distribution pipe, fencing and the access road and any constructed pathways or berms will be required. Following pathway / berm construction, season rolling and / or placement of additional gravel should be expected.

- <u>Bird Control:</u> Birds like wetland ponds, but this can lead to increased fecal coliform levels in the effluent. The solution minimizing open water and tall vegetation, including planted cattails and rushes that discourage flocks of birds.

- <u>Vegetation Control:</u> Generally harvesting or removal of vegetation is not necessary, although in some cases it will be considered to prevent changes to the hydraulic profile, bypass/blockage, and channelization.

- Institutional Controls: To prevent public access to the treatment area and potentially attractive ponds of effluent, fencing and signs will be needed. Inspection, repair and / or replacement of signs and fencing will be necessary.

6.2.8.2 Water and Energy Efficiency

Providing wetland treatment requiring only use of existing pumping systems, is a low energy means of improving WWTP treatment potential. This option allows use of the WWTP effluent as a resource maintaining a wetland rather than a waste product. The wetland will require some additional maintenance in terms of maintenance of fencing and any berms constructed.

6.2.8.3 Green Infrastructure

By its very nature the use of a natural wetland for wastewater treatment is a green infrastructure preserving and mimicking natural processes in the management of a waste stream.

As the wetland becomes a managed facility it is expected that there may be occasional need for harvest of vegetative material to avoid filling, or as discussed in Section 6.2.2.5, berm addition or other modification to address potential channelization and associated short circuiting.

The pilot study (Appendix G) and ongoing monitoring will need to watch for flow changes out of the wetland as part of the site management so that runoff volumes and peak flows remain addressed. Flow peaks are expected to result from spring thaw when melting snow underlain by frozen soils results in the extreme runoff events. As these events will occur when the wetland is not in use for treatment issues are not anticipate, but if and as WWTP volumes increase this will need to be monitored particularly with the known issue of the leaking percolation beds.

6.2.8.4 Other

The use of natural wetlands for treatment has been kept as operationally simple as possible. The facility will not address all the WWTP needs nor is it expected to allow more than moderate increases in treatment capacity, but it does allow the community to reasonably operate the existing facility for an extended period.

7.0 SELECTION OF AN ALTERNATIVE

A single alternative, use of the new wetlands parcel for additional treatment was the focus of this study. The use of the wetlands for nitrate treatment of WWTP effluent to an order of about 500,000 gpd outside of the winter months appears to be feasible.

Treatment effectiveness and capacity are based upon modeling and estimated factors, and variability is expected. Prior to committing to a new, long term discharge, a pilot study should be completed to develop the necessary information to confirm the concept, the treatment capacities, and to provide information necessary for regulators to permit the project.

Initial project construction would be for the simple application to the natural wetlands, without enhancement. Then, construction of the wetland enhancement should be anticipated and scheduled within a few years (1 to 5) of wetland use, depending on WWTP flows, and the observed vegetation and development within the wetlands.

8.0 PROPOSED PROJECT - RECOMMENDED ALTERNATIVE

As noted in Section 7.0, the recommended project is a pilot study, followed by the phased construction of the enhanced wetland with initial construction in year 1 and berm/pathway construction in year 2 to 6.

8.1 PILOT STUDY

A preliminary outline for a pilot study has been developed and provided in Appendix G. The pilot study outlines a plan for data collection before and during application of WTP effluent to determine treatment results and related impacts. The study consists of establishing a network of surface and subsurface monitoring points, and collecting background data on existing conditions for a number of parameters, notably nitrate levels, fecal coliform levels, water elevations, and vegetation data.

Wastewater effluent will then be applied at a rate to be determined to the wetlands on the range of 100,000 to 350,000 gpd. Environmental samples will be collected from the network of monitoring points at regular intervals for comparison with the background data. The duration of the pilot study will need to be determined jointly with stakeholders and project regulators, but a period of at least a year, and preferable two is suggested.

The pilot study is expected to show the rate of infiltration vs runoff of the applied effluent, and to show the decrease in nitrate and fecal coliforms with distance from the discharge. These factors are then used to calibrate the SubWet 2.0 model, which may then be used to estimate performance at higher flows with increased accuracy.

The pilot study plan in Appendix G is a starting point and is expected to require modification with project stakeholders (e.g. ADEC, USACE, City) prior to implementation. Discussions with ADEC and the USACE to date indicate that with no development within the wetland (testing only of application to unimproved wetlands) no permits would be required to conduct a pilot study, beyond plan review of the proposed study.

8.2 PRELIMINARY PROJECT DESIGN

The preliminary project is as shown in Figure 7and Figure 8. The construction elements include:

- Perimeter fencing
- Connection to existing infiltration bed piping
- Piping to new effluent discharge

- Access road
- Pathways / berm across the wetland to disperse channelize flow

A detailed estimate construction costs is provided in Appendix H. The cost of initial construction of the discharge system is estimated at approximately $980,000, including a 20% estimating contingency. Nearly half of that cost is for 8,415 LF of perimeter fencing. The secondary construction of the wetland enhancements includes 4,700 LF of pathway / berm with an estimated cost of about $429, 000. Costs do not include permitting, design, or public involvement.

8.3 PROJECT SCHEDULE

A project schedule has not been established. The following items should be considered when planning the schedule:

- A pilot study will take at least a year and preferably two. During this time, funding for full construction can be programed or sought.
- Construction of the full project will start with clearing for road and pipe trenching. Clearing should be done before April 1 as required for protection of migratory birds. This will also allow for completion when the ground is frozen and mobility on the wetland easiest.
- Following clearing the fencing can be completed as desired. Fill placement for piping and road construction in upland areas should wait until the ground has thawed, which varies annually but can be expected sometime in April or May. Piping and road construction can be completed in approximately a week or two.
- Construction of pathways and berms across the wetland should be planned for within a few years (1 to 5) of the start of wetland use. Winter construction should be planned as discussed in Section 6.2.2.5.

8.4 PERMIT REQUIREMENTS

The primary permits identified for this project are:

- City Land Use Permit: The land use permit will require conformance with Title 16 Land Development Code.

- USACE Section 404 Wetland Permit: The wetlands to be used have been determined to be Water of the US and under USACE authority. The trigger for a USACE Section 404 permit is fill, not the application of water nor a conversion of use. Fill is not required in the wetland areas until berm/pathway construction is necessary; however, the ADEC cannot permit discharge to a Waters of the US unless all water quality parameters have been met. Some modification of the wetlands may be required to allow for USACE permitting and what amounts to removal of the wetland from inventory. This may require purchasing of wetlands mitigation credits or other negotiated compensation or development agreements with the USACE, such as an obligation to maintain the property as wetlands, even if it is removed from USACE jurisdiction.

- ADEC APDES Discharge Permit: The discharge permit will require the results of the pilot study to confirm the efficacy of the treatment. A pilot study as discussed in Appendix G is assumed to be required, based on discussions with ADEC (Appendix A). This permitting will require conversion of the wetland from a Water of the US before discharge of effluent at a secondary treatment level can be allowed. Otherwise as the wetlands do not have flowing water for a mixing zone, ADEC regulations would require that the effluent meet State Water Quality Criteria (18 AAC 70) at point of discharge or end of pipe. That will not be attainable, so if the wetlands are not removed from the USACE inventory, the discharge will not be permittable.

- ADEC Plan Review: The design of all wastewater facilities must comply with ADEC Wastewater Disposal regulations (18 AAC 72). Designs must be submitted to the ADEC for plan review prior to construction.

CITY OF WASILLA
WASTEWATER OUTFALL FEASIBILITY STUDY

Proposed Project - Recommended Alternative
April 3, 2017