City of Soldotna

2015 Soldotna Drainage Master Plan

City of Soldotna, Alaska
February 15, 2016

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List of Acronyms

The following is a list of acronyms and short forms used in this plan.

ADEC	Alaska Department of Environmental Conservation
ADOT&PF	Alaska Department of Transportation & Public Facilities
CIP	Capital Improvement Program/Capital Improvement Plan
CMP	Corrugated metal pipe
CPP	Corrugated plastic pipe
DMP	Drainage Master Plan
DLWD	Alaska Department of Labor and Workforce Development
FAA	Federal Aviation Administration
GIS	Geographical Information System
HDPE	High Density Polyethylene
KPB	Kenai Peninsula Borough
LID	Low impact development
MS4	Municipal Separate Storm Sewer System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
TAH	Total Aromatic Hydrocarbons
t_c	Time of concentration

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1 Introduction

1.1 Authorization

The City of Soldotna (City) has authorized HDR Alaska, Inc. to prepare the *2015 Soldotna Drainage Master Plan* (2015 DMP). Preparation of this plan was authorized by a contract between the City and HDR Alaska, Inc., under City Project Utility Master Plans SOLP 14-02.

1.2 Purpose

The purpose of the 2015 DMP is to evaluate the existing drainage system for deficiencies, prepare a Capital Improvement Plan (CIP) to address those deficiencies, and evaluate the City's stormwater regulations and design criteria to identify areas for further evaluation and revision. The plan will evaluate a projected 20-year time horizon (2016-2035) for the system and develop recommendations to maintain system functionality, provide for economic development and preserve the integrity and beauty of the Kenai River and Soldotna and Slicok Creeks.

1.3 Background

Soldotna is the commercial and recreational hub of the central Kenai Peninsula. Because of its location on the highway system and availability of developable land, the City has experienced both commercial business and residential growth. To manage the growth and develop a clear vision for a larger, livable Soldotna, the City prepared the *Envision Soldotna 2030 Comprehensive Plan*, adopted by the Soldotna City Council in January 2011. This plan noted that Soldotna has implemented a variety of measures to reduce water quality effects on the Kenai River watershed. The plan also acknowledges that while the City's site plan review requirements include a site stormwater plan, "no specific stormwater requirements have been adopted in the code to address stormwater retention, detention and/or treatment from development on non-residential properties (page 36)." Part of the purpose of the 2015 DMP is to provide policy and regulatory recommendations that will help the City attain the natural resource goals identified in *Envision Soldotna 2030 Comprehensive Plan* (DOWL HKM and Kevin Waring Associates. 2011).

This 2015 DMP will be Soldotna's first. Guidance for the contents of the drainage plan comes primarily from the comprehensive plan and discussion with city engineering staff. This guidance includes Soldotna's commitment to the health of the Kenai River watershed, a positive atmosphere for economic development and City growth, and resources for City staff and developers to minimize any negative effects of stormwater runoff.

1.4 Scope

The Scope of Work statement for preparing the 2015 DMP is generalized as follows:

- Prepare a comprehensive drainage master plan and associated CIP to implement the plan's recommendations. The plan will evaluate a projected 20-year time horizon
- Collect and organize data to support a drainage master plan. This is primarily in the form of Geographical Information System (GIS) data, developed under a separate task, but these data are used in the analysis.
- Develop a hydraulic model used to identify system deficiencies over the planning period.
- Recommend drainage system improvements and develop the CIP.
- Review City municipal regulations and design criteria policies and provide recommendations.

1.5 Study Areas

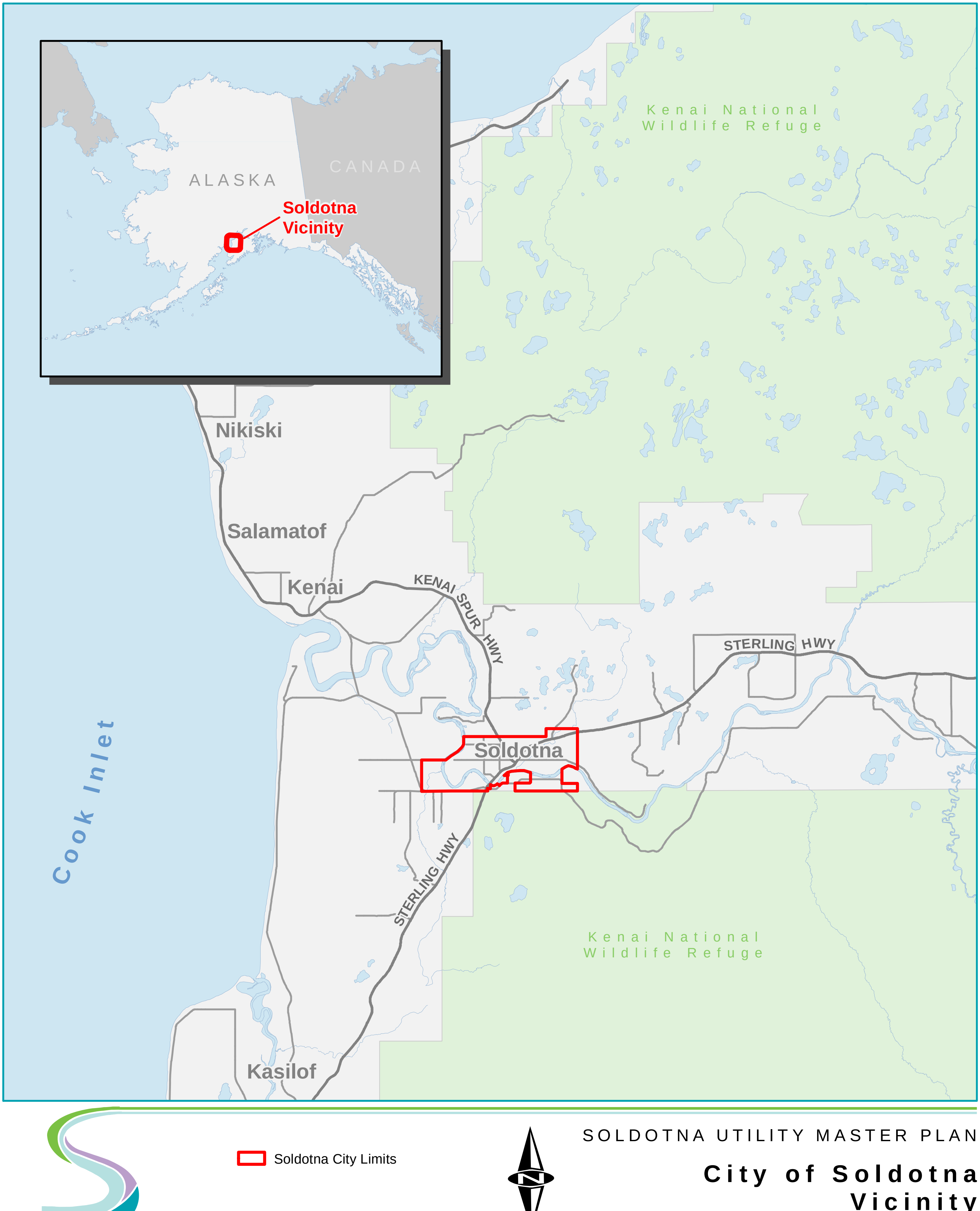
The City of Soldotna is located on the western side of the Kenai Peninsula in southcentral Alaska (Figure 1). The Kenai River, Soldotna Creek and Slikok Creek are the major surface water bodies within the City limits, forming the south, west and east boundary of the more densely populated urban area. The surrounding area is part of the Kenai National wildlife refuge and is home to numerous lakes and abundant wildlife. The topography is generally flat with a mixed deciduous and coniferous forest and numerous wetlands.

Soldotna has a moderate subarctic climate with cool summers and snowy winters, mainly due to its proximity to the Cook Inlet, which moderates the temperature. Table 1 includes a summary of monthly temperature and precipitation averages.

Table 1 Average Monthly Temperature and Precipitation[1]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Average High	22.4	27.3	35.3	45.3	55.9	62.1	65.5	63.7	55.2	41.7	27.4	25.0	44.0
Average Low	4.3	7.4	14.2	23.8	32.8	40.2	44.9	42.9	36.0	24.8	10.9	7.3	24.2
Average Precipitation	2.64	1.42	1.51	0.85	1.09	1.44	2.07	3.52	4.41	2.48	2.41	2.12	25.96
Average High	22.4	27.3	35.3	45.3	55.9	62.1	65.5	63.7	55.2	41.7	27.4	25.0	44.0
Average Low	4.3	7.4	14.2	23.8	32.8	40.2	44.9	42.9	36.0	24.8	10.9	7.3	24.2

[1] NOAA



SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

City of Soldotna Vicinity

Figure 1

HDR

The City is a blend of urban and rural land uses, mainly commercial zones along the Sterling Highway and the Kenai Spur Highway, and single family residential making up the remaining bulk of occupied properties. The City is mostly developed west of the Sterling and Kenai Spur Highways while the eastern part of the city contains a large area of vacant land for large lot single family development.

1.6 Regulatory Framework

1.6.1 State of Alaska Water Quality Standards

Water quality standards are regulated by the Alaska Department of Environmental Conservation (ADEC). As neither the Kenai Peninsula Borough (KPB) nor the City of Soldotna is regulated through a Municipal Separate Storm Sewer System (MS4) Stormwater Discharge Permit, the State's anti-degradation policy is the primary guidance when an individual permit is not issued.

The Federal Clean Water Act requires states to have an anti-degradation policy and implementation methods. Federal regulation at 40 Code of Federal Regulations 131.12 specifies States must have an anti-degradation policy that:

- Protects existing uses;
- Authorizes the lowering of water quality in high quality waters, where necessary for social or economic importance; and
- Provides mechanisms to provide additional protection for water of exceptional ecological or recreational significance.

Alaska's current anti-degradation policy, adopted in 1997, is found in the Water Quality Standards regulations at 18 AAC 70.015. ADEC's Anti-Degradation Policy and is provided in Appendix A.

1.6.2 City of Soldotna Regulations

Soldotna's Municipal Code contains guidance directed at managing stormwater discharges and maintaining water quality standards:

- 12.04.030 (B)(4) –Street Design Criteria: Minimize the amount of paved area to reduce stormwater runoff and thereby protect water resources;
- 12.04.030 (B)(5) –Street Design Criteria: Provide a drainage system that will handle a ten-year frequency storm from within the watershed and to protect streams, drainage ways and streets from erosion, sedimentation and increased runoff;
- 12.28.050 – Pollution of Water –Prohibited Acts: No person in a park shall throw, discharge or otherwise place or cause to be placed in the waters of any pond, lake, stream, bay, or other body of water in or adjacent to any park or any tributary, stream, storm sewer, or drain flowing into such waters, any substance, matter or thing, liquid or solid, which will or may result in the pollution of such waters;

- 13.14.050 –Interconnection of Sewers—System connection—Authorized dump stations: It is unlawful for a person, firm, or corporation to interconnect or cause to be interconnected, directly or indirectly, any part of a sanitary sewer system with any part of a storm sewer system, or cause to be admitted into a sanitary sewer any waters or wastes other than through an approved sewer extension and hookup, or at a sewage dump station or location which has been specifically approved by and designated in writing by the public works director.

1.6.3 Impaired Waters

Neither of Soldotna's main water bodies, the Kenai River and Soldotna Creek, is currently on ADEC's list of impaired water bodies (ADEC 2015). In 2006, the Kenai River was listed as impaired under Section 303(d) of the Clean Water Act. The impairment listing resulted from repeated exceedances of State Water Quality Standards established for Total Aromatic Hydrocarbons (TAH) resulting from motorized recreation. TAH levels dropped significantly and now meet water quality standards, prompting ADEC to remove the lower Kenai River from the 303(d) list in 2010 (EPA, 2011). No degradation from Soldotna's stormwater system has been reported.

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2 Population Projections and Land Use

2.1 Introduction

To estimate future development, population projections and expected geographic distribution was developed within the City limits. Estimates of population distribution and extent of commercial/industrial development were made for modeling purposes to estimate the drainage system capacity in 2035.

2.2 Current Population

2.2.1 Total Planning Area Population

The City of Soldotna had a total population of 3,750 in 2000 (Alaska Department of Labor and Workforce Development (DLWD)). In the 2010 census, the City grew to a total population of 4,163. The City experienced a growth of 11 percent (%) for this ten-year period. Population projections continue to indicate growth in the City with estimated 2014 population of 4,311. Table 2 summarizes the historical population of the City:

Table 2. Historic Population

Year	City of Soldotna
1960[1]	332
1970	1202
1980	2320
1990[2]	3,482
2000	3,750
2010[3]	4,163
2014	4,311

[1]Data from 1960 and 1980 from *Envision Soldotna 2030 Comprehensive Plan*.
[2]Years 1990 and 2000 data from http://laborstats.alaska.gov/pop/popest.htm Historical Data: Places.
[3]Years 2010 to 2014 data from http://laborstats.alaska.gov/pop/popest.htm Cities and Census Designated Places, 2000 to 2014.

2.3 Population Projections

2.3.1 Future Resident Planning Area Population

The Soldotna Planning Department made population projections for the City in the *Envision Soldotna 2030 Comprehensive Plan.* The comprehensive plan estimates were completed in 2009. These projections were based on growth of 7% per decade, or 0.70% per year, through 2030.

The DLWD Research and Analysis Section prepared population projections for Alaska and the Boroughs; DLWD does not prepare projections for areas smaller than boroughs.

Most recently updated in 2012, these data project population from 2012 through 2042. The portion of the DLWD projected growth rates applicable to this plan's planning period are shown in Table 3. These projections show a declining growth rate through the planning period.

Table 3 DLWD Estimated Annual Population Growth Rates 2012-2037

Year	Alaska	KPB
2012-2016	1.01%	0.85%
2017-2021	0.91%	0.72%
2022-2026	0.80%	0.55%
2027-2031	0.70%	0.38%
2032-2037	0.64%	0.24%

To prepare population estimates for this plan the following assumptions were made.

- The City of Soldotna will continue to grow at a greater rate than the KPB as a whole, as has been the case for the past decade.
- Growth rates over the planning period will slow at the rate indicated for KPB by DLWD projections.
- The City of Soldotna will continue to be the fastest growing city in the KPB and will receive a greater proportion of the total projected KPB population growth during the planning period.
- The total population growth projected by DLWD for the KBP will hold for the planning period. That is to say, the growth rates selected for the City could not result in in a larger KPB population than estimated by the DLWD. Adopting this criterion allowed for higher growth rates in the planning area but maintained the total KPB population equivalent to DLWD projections.

These criteria were used to develop growth rates and population estimates for use in this plan. The selected growth rates that provided the best fit estimate to the available data are show in Table 4.

Table 4. Estimated Annual Population Growth Rates 2012-2035

Year	KPB	City of Soldotna
2012-2016	0.85%	1.00%
2017-2021	0.72%	0.87%
2022-2026	0.55%	0.70%
2027-2031	0.38%	0.53%
2032-2035	0.24%	0.39%

The selected growth rates in Table 4 were used to prepare population estimates for the planning area through the planning period. These are presented in Table 5. The selected growth rates project a slightly greater population in the City in 2030 than is projected in the comprehensive plan, 4,881 versus 4,674.

Table 5. Estimated Planning Area Population 2016-2035

Year	KPB	City of Soldotna
2016	58,721	4,419
2017	59,220	4,458
2018	59,646	4,496
2019	60,076	4,535
2020	60,508	4,575
2021	60,944	4,615
2022	61,383	4,647
2023	61,720	4,680
2024	62,060	4,712
2025	62,401	4,745
2026	62,744	4,779
2027	63,090	4,804
2028	63,329	4,829
2029	63,570	4,855
2030	63,811	4,881
2031	64,054	4,906
2032	64,297	4,926
2033	64,452	4,945
2034	64,606	4,964
2035	64,761	4,983

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3 Existing System and Drainage System Analysis

3.1 Existing System and Capacity Analysis

Soldotna's drainage system is a mix of piped conveyance, open ditches, end-of-pipe treatment devices and low-impact development water quality facilities in 24 separate stormwater drainage basins. The City's drainage system is intertied with the Alaska Department of Transportation & Public Facilities (ADOT&PF) drainage system, which drains the Sterling Highway and the Kenai Spur Highway. In general, Soldotna and ADOT&PF each maintain their own systems; however they have collaborated on maintenance activities when needed.

Understanding pipe capacity is an important part of operating an effective and efficient drainage system. The stormwater conveyance system must have adequate capacity for additional flows as population grows and the system expands. As part of the 2015 DMP, several topics associated with stormwater pipe capacity management were evaluated and include:

- Pipe capacity evaluation criteria;
- System capacity and design flows;
- Potential capacity issues; and
- Recommendations for capacity management.

This section describes methods used to delineate the catchment areas, assumptions for system conditions, land cover mapping through image classification, and expected changes in land cover due to future development within the City limits. The hydraulic and hydrologic methods approximate run-off from a 24-hour, 10-year storm event, which is typical for conveyance criteria and the required flows as stated in Soldotna's municipal code (12.04.030 (B)(5)). This section also proposes evaluation criteria, discusses the results of the hydraulic modeling, identifies conveyance system deficiencies and provides capital improvement recommendations.

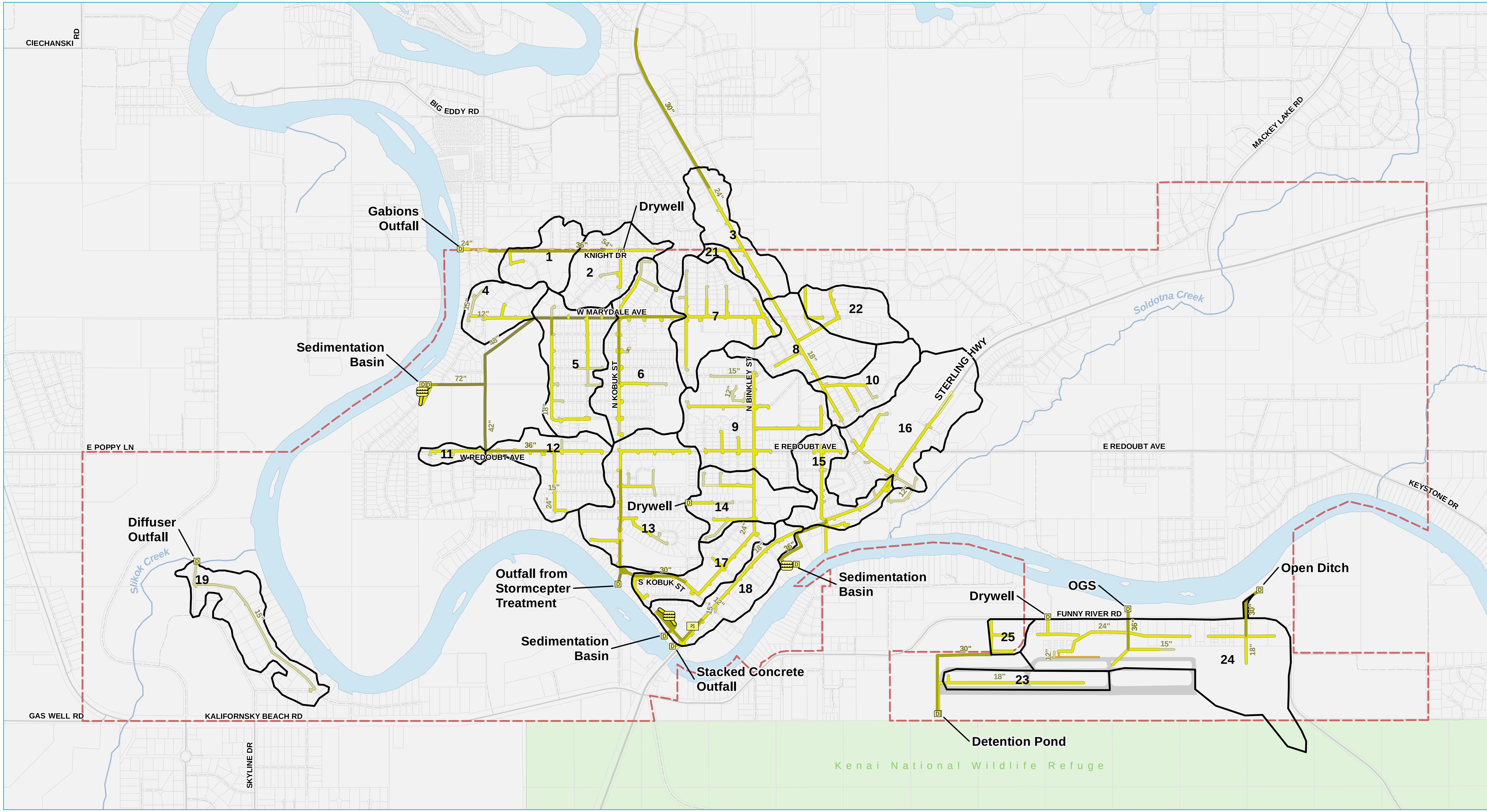
3.2 Basin Characterization

3.2.1 Basin Delineation

The basin delineation was performed using ArcGIS 10.3. The data provided by the City of Soldotna included five-foot contours, a digital elevation model and stormwater infrastructure. Basin delineation occurred through the use of the Flow Direction and Basin tools, and contour lines allowed for further refinement of the individual catchment areas as shown in Figure 2. Note that Figure 2 includes catchment area 20 near the eastern side of the City; although the drainage pipes, catch basins, and bioswale have been designed but not constructed, an analysis of this system is included

3.2.2 Conveyance System and Water Quality Treatment

Soldotna's drainage system consists of four distinct networks in the downtown area, with two additional systems south of the City center; one at the airport and the second in the southwest corner of the City adjacent to the Kenai River. These systems discharge to either drywells or the Kenai River; either directly through end-of-pipe treatment devices or indirectly through a low impact development (LID) treatment facility. The City owns and operates treatment pond at the end of Linda Lane. The DOT&PF owns and operates sedimentation basin near the Sterling Highway bridge over the Kenai River at the end of Binkley Circle. The conveyance system and water quality treatment facilities are shown on Figure 2.



SOLDOTNA UTILITY MASTER PLAN

Stormwater Drainage System Basin Delineation

Figure 2

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As previously mentioned, Soldotna's water quality treatment facilities are a mix of end of pipe treatment such as drywells and oil/grit separators, and LID facilities. The LID facilities are the City's best means for improving the water quality from stormwater discharges and maintaining the high value of the Kenai River Watershed.

A review of some of Soldotna's LID features follows. In general these function well with minimal maintenance, but there are examples of projects that are not correctly designed and thus have limited functionality.

Sedimentation Basins

There are three large sedimentation basins treating stormwater runoff from City streets. One sedimentation basin, the Marydale basin off Linda Lane is owned and operated by the City; the basin adjacent to the Sterling Highway at Riverside Drive and a second basin at the end of Binkley Circle are DOT&PF facilies (Figure 3 - Figure 5). Sedimentation basins are basins formed by excavation or construction of an embankment so that sediment-laden runoff is detained, allowing sediment to settle out before runoff is discharged. Although sedimentation basins are not designed to reduce stormwater volume such as an infiltration basin, they are very efficient at attenuating the rate of discharge thus minimizing hydromodification of stream channels.

Figure 3 Marydale Sedimentation Basin

Figure 4 Riverside Drive Sedimentation Basin

Figure 5 Sterling Highway DOT&PF Sedimentation Basin of Binkley Circle

Diffuser Outfall

Figure 6 shows Soldotna's diffuser outfall, an unconventional treatment system that does not fit into a traditional LID design, however it functions similar to one. Upstream of the diffuser outfall is an oil/grit separator to remove solids; stormwater then flows into an High Density Polyethylene (HDPE) perforated pipe and the discharge is spread over a wide area. Rocks are placed underneath the perforated pipe to prevent erosion, and after discharge water flows overland down a vegetated slope to a Slikok Creek, a small tributary to the Kenai River.

Figure 6 Sterling Highway DOT&PF Sedimentation Basin

This design attenuates flows and uses natural vegetation to filter out any remaining solids; infiltration will occur as long as the soil is not saturated. The design works well for its remote location but would likely not be viable in a neighborhood due to its size, uncharacteristic appearance and potential vandalism.

Rain Garden

The City constructed a rain garden at the City Park at South Birch Lane and States Avenue, Figure 7. The rain garden accepts flow from the parking area, pathways and grass. When visited the overflow drain was frozen which caused flooding of the infiltration area. It is reported that its capacity is insufficient to infiltrate for the volume of runoff to percolate into the soil rapidly enough to keep water from ponding for long periods. While this may be considered a less that desirable outcome for the project, it offers lessons on design details. In this case, surface overflow outlet that operates when frozen could prevent overtopping while still maintaining flow attenuation and water quality benefits.

Figure 7 City Park Rain Garden

3.2.1 System Conditions

Based on discussions with City Street Maintenance and Engineering staff, the drainage system functions well, due in part to the aggressive street sweeping program and active operations and maintenance. The age of the system is relatively young, with the majority of pipes installed in the 1980's or later; roughly 40% of the drainage pipes were installed at least 35 years ago. Nearly 75% of the pipes were installed by 1990, as shown in Figure 8. Approximately 65% of pipe is corrugated metal pipe (CMP) with another 20% is corrugated plastic pipe (CPP). System capacity assessment typically assumes clean pipes in good condition without significant deterioration, breaks or deformations. Typically, however, some pipes have maintenance issues such as sediment which restrict flows.

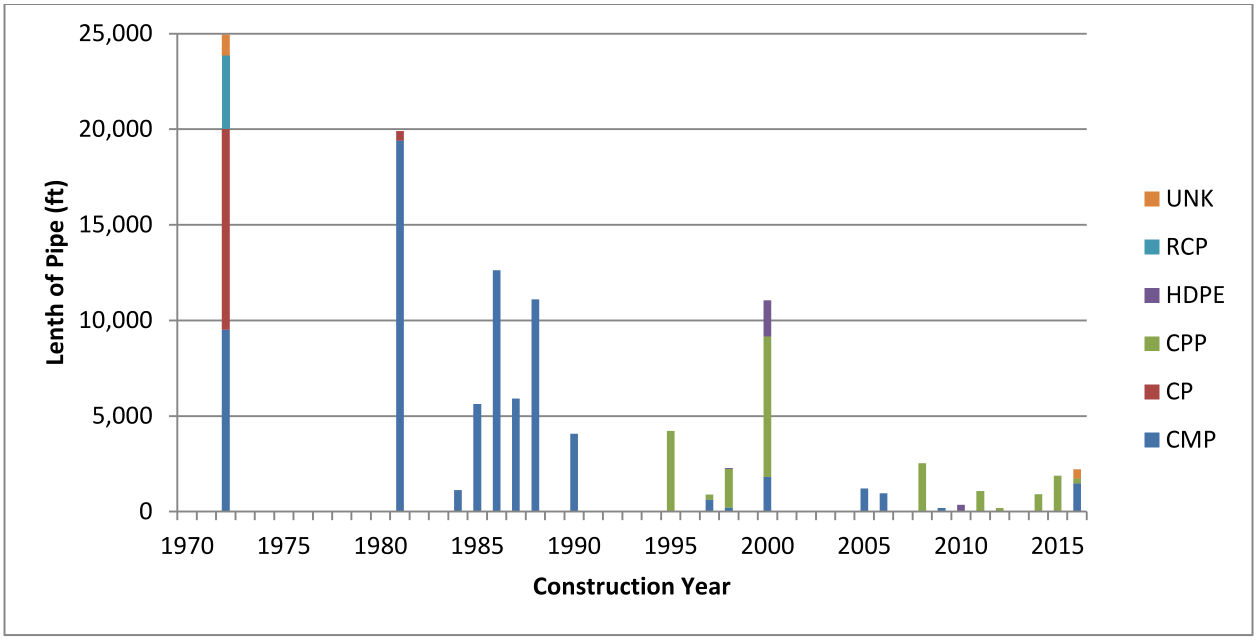

Figure 8 Length of Stormwater Pipe by Construction Year and Material

3.2.2 Land Cover

The land cover used in the analysis was created through image classification by drawing polygons around areas of relatively uniform appearance. The land cover classifications were then inputted as a variable in the runoff calculation model; the final land cover classification is shown in Figure 9.

3.2.3 Future Development

Data provided by Soldotna shows 300 vacant residential lots within the delineated catchment areas, shown in Figure 10. It is assumed that all vacant residential lots will be developed over the planning period. Unplatted vacant residential areas within the catchment areas were not considered developed by 2035 because slow growth would tend to discourage developers from opening up new areas in the City. As a result of vacant lot development, existing land cover conditions are expected to change by the following percentages:

- Vacant lots will be cleared and replaced by:
  - 25% buildings
  - 25% pavement
  - 50% lawn

These percentages were developed by averaging a random sampling of existing land cover on residential lots and input into the runoff calculation model.

Additionally, based on the 2004 Soldotna Airport Master Plan, future development at the airport is expected to occur primarily at the east end of the existing runways, apron and taxiway as shown on Figure 10. All fifteen acres of development are expected to be paved by 2035 and will increase run-off into the drainage system as a result.

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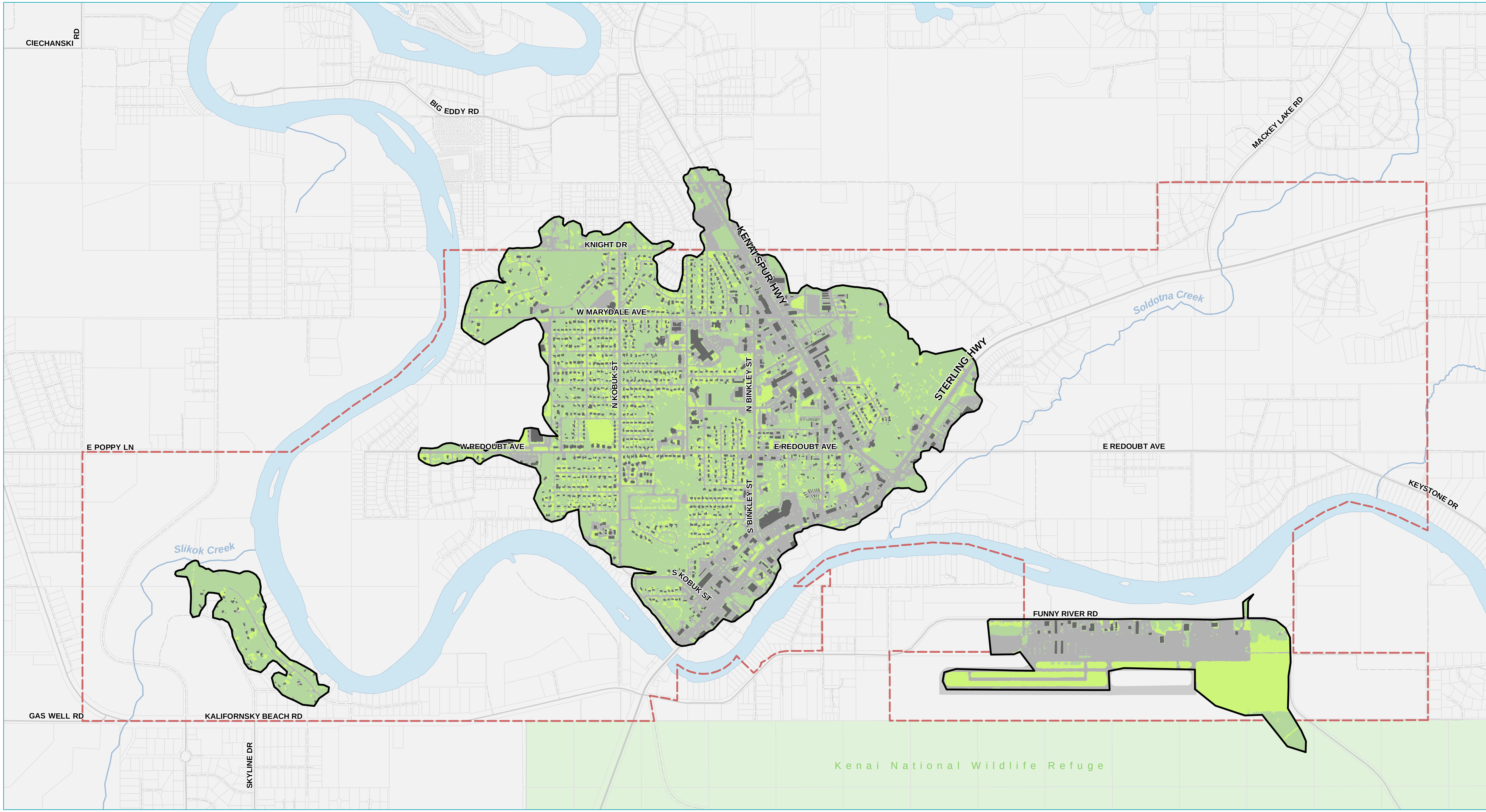

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Land Cover Type
- Buildings
- Pavement
- Trees and Vegetation
- Lawn
- Drainage Basin Boundary
- Drainage Basin Not Constructed
- City Limits
- State Highway
- Town Major Collector
- Town Medium Volume
- Creek
- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,800
FEET

SOLDOTNA UTILITY MASTER PLAN

Stormwater Drainage System

Existing Land Cover

Figure 9

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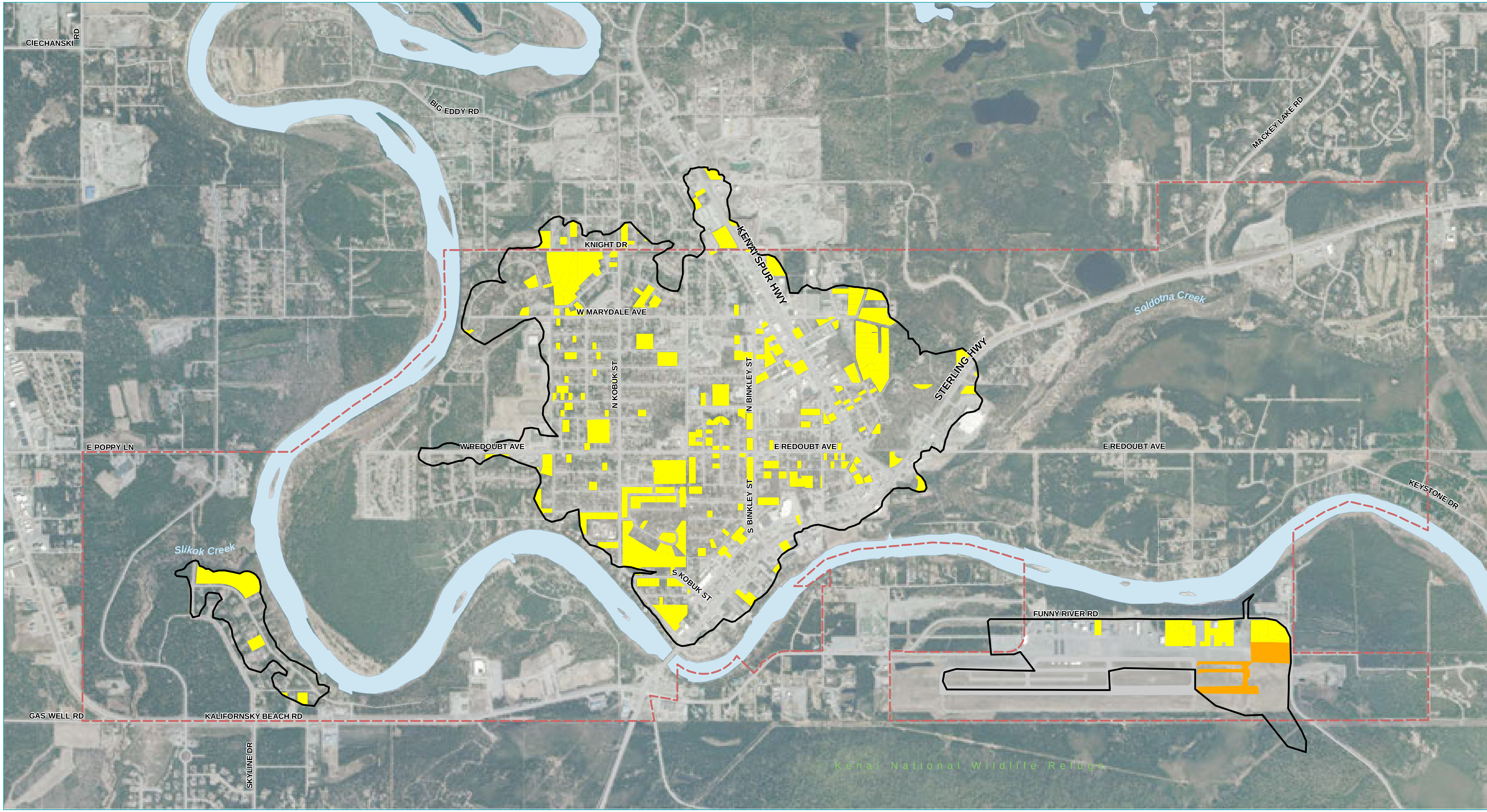

Existing Vacant Residential Property
Future Airport Development
Drainage Basin Boundary
Drainage Basin Not Constructed
City Limits
State Highway
Town Major Collector
Town Medium Volume
Water Body

0 1,800
FEET

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Stormwater Drainage System

Expected Development by 2035

Figure 10

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3.3 HYDRAULIC & HYDROLOGIC METHODS

3.3.1 Storm Characteristics

Modeling of the drainage conveyance system requires input of the 24-hour, 10-year storm characteristics including:

- Recurrence Interval and Storm Duration
- Storm Depth
- Time of Concentration
- Temporal Distribution
- Spatial Distribution

These hydrologic parameters are described in further detail below.

3.3.2 Recurrence Interval & Storm Duration

Although the City has not developed drainage design criteria standards, the municipal code requires conveyance design of stormwater facilities using the 10-year, 24-hour storm event. Although the 10-year recurrence interval is typically viewed as the average number of years between storms of certain intensity, the term is used to define a rainfall event that statistically has a 10% chance of occurring based on historical data.

A 24-hour storm event assumes that all parts of the drainage system experience the peak intensity conditions for the storm duration. In reality, this is rarely the case. Smaller, upstream system components are often more affected by short-duration, high-intensity storms while the larger, downstream components might be more affected by longer-duration, high-volume storms. This problem is further aggravated because the temporal distribution of shorter storms can be significantly different from the temporal distribution of the larger storms. Modeling realistic conditions, however, is computationally intensive and generally does not provide more substantive results.

3.3.3 Storm Depth

The National Oceanic and Atmospheric Administration's (NOAA) Atlas 14, Volume 7 contains precipitation frequency estimates for various locations throughout the country including Alaska. The closest NOAA station to Soldotna is the Funny River station (Site 50-3196). The City of Kenai also has a NOAA station, however because of the close proximity to Soldotna, the Funny River precipitation estimates were used for the analysis. For a 24-hour, 10-year storm event, NOAA's precipitation depth for the Funny River station is estimated to be 1.81 inches.

3.3.4 Time of Concentration

Time of concentration (t_c) is defined as the largest combination of overland flow time, swale or ditch flow, and stormwater pipe flow time. Given the average catchment area size of 61 acres, the ditch and pipe flow are assumed to equal zero since those flow times are insignificant relative to the time it takes for sheet flow.

While there are a variety of methods available for estimating time of concentration, this analysis utilized the Federal Aviation Administration (FAA) formula:

$$t_{c,min} = \frac{1.8(1.1 - \mathrm{C})\sqrt{L_o}}{\mathrm{S}^{1/3}}$$

where:

t_c=time of concentration (minutes)

C=rational method runoff coefficient

S=% slope

L_o= hydraulically longest distance to the nearest collection point (feet)

This formula was developed from airfield drainage data collected by the Army Corps of Engineers. The FAA formula is selected for the City's drainage system capacity analysis because it has been widely used for urbanized areas. Area 12 is an average sized catchment area, which encompasses 58 acres and is used as the representative area for determining t_c for all catchment areas. Using the percentage of each type of land cover within this catchment area, a weighted average runoff coefficient was calculated and used in this formula. The $t_{c,min}$ was calculated to be 38 minutes. To provide a conservative estimate of the storm peak intensity, the time increment used for the rainfall distribution was 1-hour.

3.3.5 Rainfall Temporal Distribution

The Natural Resources Conservation Service (NRCS) has developed dimensionless rainfall temporal patterns (type curves) for four different regions in the United States. The cumulative rainfall curves, shown in Figure 11 are based on a 24-hour rainfall event. The characteristic storm hyetograph for the City, according to the NRCS map shown in Figure 12, is Type I, which is applicable to Hawaii, Alaska, and the coastal side of the Cascade Mountains in California.

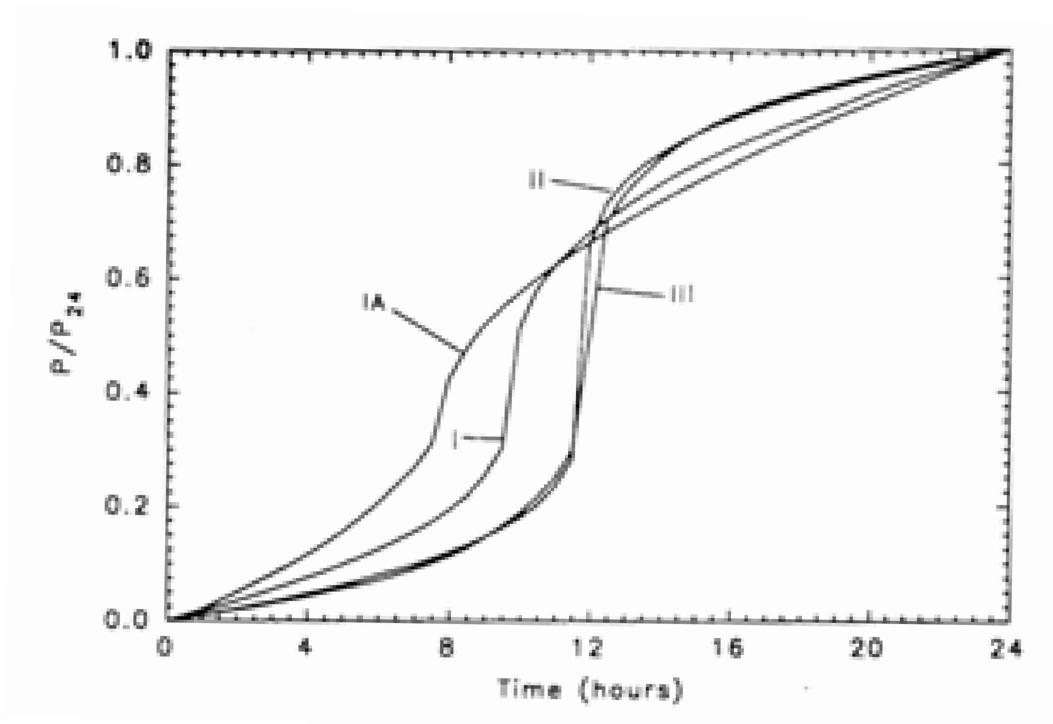


Figure 11 NRCS Storm Types as a Fraction of a 24-hour Rainfall Event versus Time
(reproduced from NRCS TR-55)

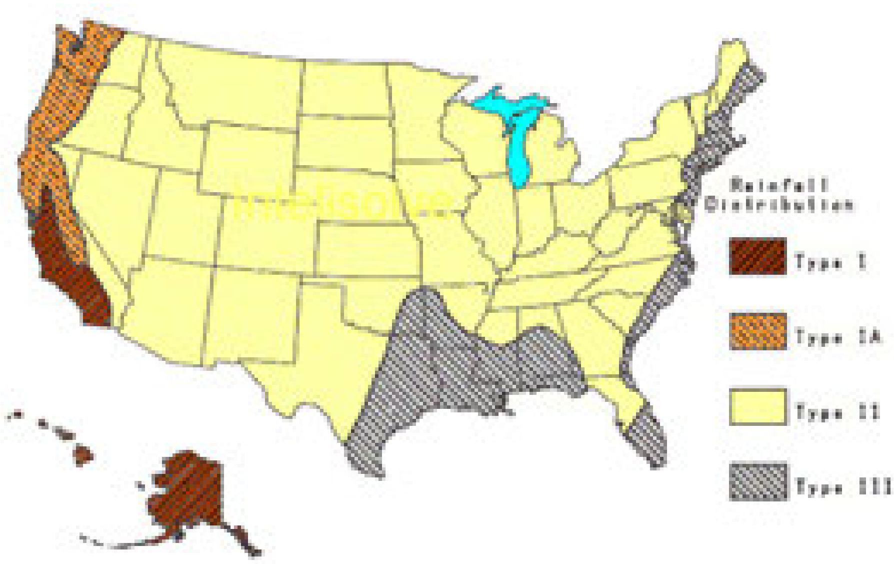


Figure 12 NRCS Rainfall Distribution Map
(reproduced from NRCS TR-55)

3.3.6 Rainfall Spatial Distribution

The point precipitation estimates of average precipitation depth are applied to the entire catchment area, but storm events with different spatial distribution can produce different responses in the drainage system for the same rainfall temporal distribution. For example, a storm that is moving from upstream to downstream of the system might produce significantly higher peak flows than the same storm moving from downstream to upstream, due to the phasing of peak flows from pipe laterals. It is typical for a drainage system assessment to ignore the issue of the spatial rainfall distribution because it does not necessarily produce more accurate results.

3.4 Rainfall – Runoff Response

There are a number of variables that affect the rainfall-runoff response for the catchment areas, including:

- Storage potential;
- Ground cover and soil type;
- Antecedent moisture conditions;
- Connected and unconnected impervious areas; and
- Inlet and snow & ice cover conditions

The runoff calculation methodology considers the impacts of varying these factors on the runoff response.

3.4.1 Runoff Calculation Methodology

The NRCS has developed peak discharge methods that classify the land cover and soil type by a single parameter called the *curve number*, *CN*. The NRCS method is used to estimate peak flows for catchment areas of less than 2,000 acres and curve numbers greater than 50. The entire catchment area for the City is approximately 1,500 acres and the curve numbers for each of the catchment areas are greater than 60 (described in Section 3.2.3). The NRCS peak discharge equation is as follows:

$$Q_p = q_u A Q_{in} F_p$$

Where:

Q_p is the peak discharge (cubic feet per second)

q_u is the unit peak discharge (cubic feet per square mile per inch of run-off)

A is the drainage or catchment area in square miles

Q_{in} is the run-off in inches

F_p is the pond adjustment factor

If ponds are spread throughout the catchment areas and are not considered in the t_c computation, an adjustment is needed. However in this case no ponds are found within the delineated catchment areas. Therefore F_p is assumed to equal 1.

3.4.2 Soil Classifications

The NRCS method requires classification of the soil within the catchment area into hydrologic soil groups according to their infiltration rates. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms when the soil is not frozen. According to the NRCS *Soil Survey of Western Kenai Peninsula Area, Alaska*, the Soldotna-area soils fall within Group B. Group B soils have a moderate rate of water transmission and infiltration when thoroughly wet.

3.4.3 Curve Number

The NRCS curve number is derived by land cover and soil type for any size homogeneous area. Land cover types include:

- Impervious (paved roadways, sidewalks, parking lots, driveways, roofs);
- Barren (considered to be open space in poor condition);
- Lawn (considered to be open space in good condition); and
- Forest (woods in good condition)

The curve number values come from the NRCS TR-55 table (reproduced below). A composite curve number for hydrologic soil group B is then calculated by weighting the curve number for each land cover area based on its proportion of the total catchment area.

Table 6. Curve Numbers by Hydrologic Soil Group
(reproduced from NRCS TR-55)

Cover description		Curve numbers for hydrologic soil group			
		A	B	C	D
Open space (lawns, parks, golf courses, cemeteries, etc.)	Poor condition (grass cover <50%)	68	79	86	89
	Fair condition (grass cover 50 to 75%)	49	69	79	84
	Good condition (grass cover >75%)	39	61	74	80
Impervious areas	Paved parking lots, roofs, driveways, etc. (excluding right of way)	98	98	98	98
Streets and roads	Paved; curbs and storm sewers (excluding right-of-way)	98	98	98	98
	Paved; open ditches (including right-of-way)	83	89	92	93
	Gravel (including right of way)	76	85	89	91
	Dirt (including right-of-way)	72	82	87	89
Western desert urban areas	Natural desert landscaping (pervious area only)	63	77	85	88
	Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	96	96	96	96
Urban districts	Commercial and business (85% imp.)	89	92	94	95
	Industrial (72% imp.)	81	88	91	93
Residential districts by average lot size	⅛ acre or less (town houses) (65% imp.)	77	85	90	92
	¼ acre (38% imp.)	61	75	83	87
	⅓ acre (30% imp.)	57	72	81	86
	½ acre (25% imp.)	54	70	80	85
	1 acre (20% imp.)	51	68	79	84
	2 acres (12% imp.)	46	65	77	82
Woods	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77

3.4.4 Antecedent Conditions and Initial Abstraction

Runoff response varies based on soil moisture and standing water, therefore the runoff response can be different for two otherwise identical storms. The difference will be in the amount of rainfall that will be stored before the runoff begins. Runoff occurs when rain falls on a saturated catchment area that is unable to absorb additional water. In some cases initial rainfall losses will be negligible if there has been another storm just prior to the design storm. Runoff can also occur if a very large amount of rain falls on a dry catchment area faster than what can be absorbed by the soil. Moist soil conditions are assumed for the City's drainage system capacity analysis.

Initial abstraction is the total amount of water intercepted by depressions. The NRCS method assumes the initial abstraction is equal to 20% of the storage capacity. Storage capacity is calculated from the curve number.

$$S = {}^{1000}/_{CN} - 10$$

The unit peak discharge, q_u, for each catchment area is determined by using Figure 13 below. The variable P is the precipitation depth in inches for a 24-hour, 10-year event. The vertical red line in Figure 8 represents the time of concentration, t_c, estimated to be 38 minutes or 0.63 hours as discussed in Section 3.3.4.

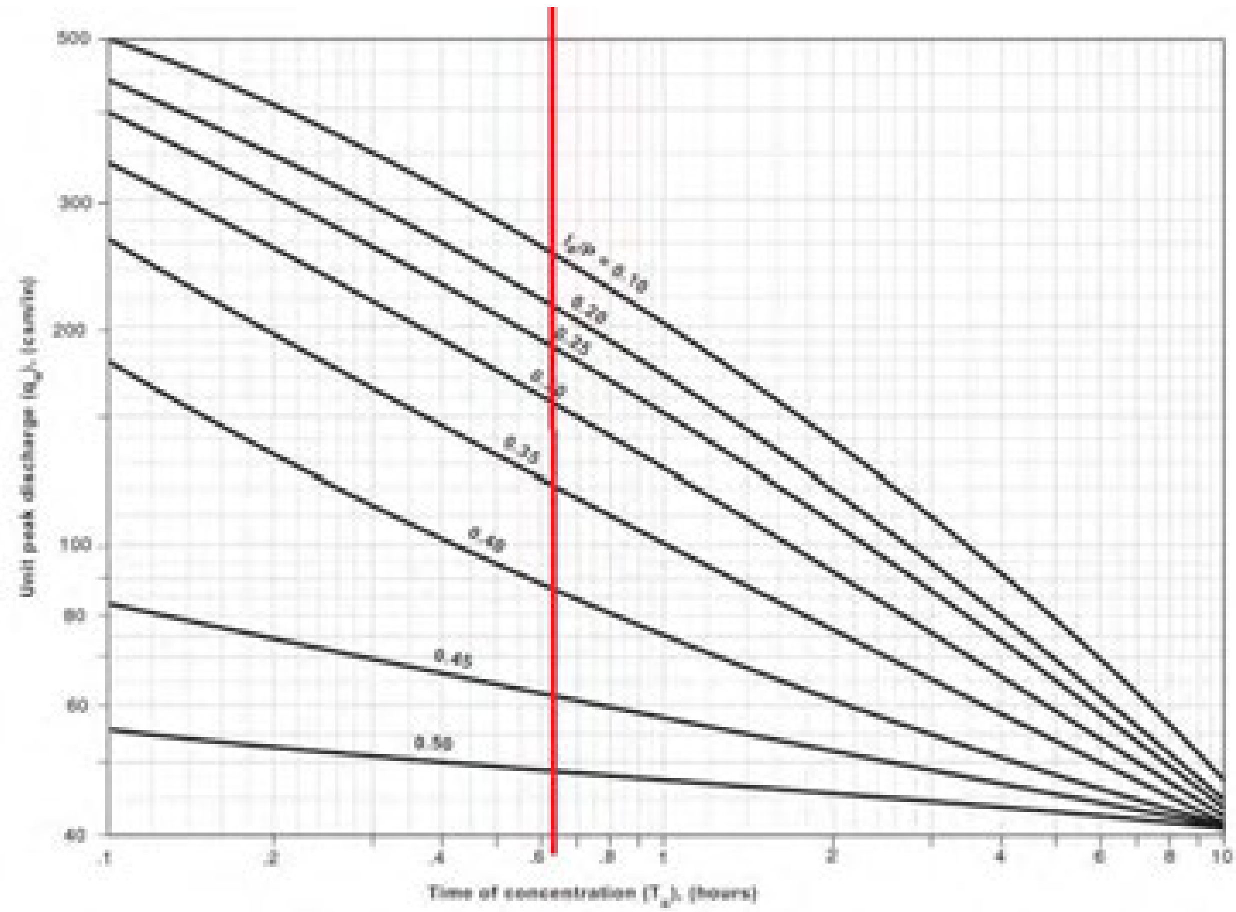


Figure 13 Unit Peak Discharge (q_u) for NRCS Type I Rainfall Distribution

Total runoff (Q_{in}) is calculated using the equation provided in the NRCS method:

$$Q_{in} = \frac{(P - 0.2S)^2}{P + 0.8S}$$

An estimated peak discharge, Q_p, is then calculated for each catchment area using the NCRS peak discharge equation.

3.4.5 Connected and Unconnected Impervious

An impervious area is considered unconnected if run-off from it flows into a pervious area as sheet flow before reaching the storm drain inlet. For analysis purposes impervious areas are assumed to be directly connected to the drainage system. Since the City has grass-lined ditches which convey run-off during major storm events, this assumption will tend to result in conservative flow estimates for the catchment areas.

3.4.6 Inlet Conditions

Storm drain inlets can often become clogged or blocked by debris such as trash or leaves after major storm events. If the inlet is not cleared before the next major storm event runoff cannot enter the drainage system and could result in flooding. A typical inlet spacing evaluation during system design considers the effects of 50% of the inlet opening being obstructed. The City's drainage system capacity assessment assumes inlets were designed with sufficient spacing and capacity even with 50%blockage, and are in good condition.

3.4.7 Cold Weather Considerations

Frozen pipes can restrict or in some cases completely block inflow and increase the potential for flooding. Freeze protection using insulation or heat tracing may be necessary under these circumstances. It is possible for a small winter storm to produce higher runoff than a larger summer storm when the ground is ice covered and additional flow is created through melting of ice and snow. Due to impermeable frozen ground, run-off can occur quickly in the winter months. Whereas in the summer months, run-off typically does not occur until the ground becomes saturated. Run-off volumes from a spring snowmelt event or a rain on snow event can be very large, often the largest volumes of the year. Increased volumes of sediment may also be directed to the drainage inlets during spring snowmelt. If the City's operation and maintenance (O&M) staff notice a build-up of sediment in the storm drain pipes, pre-treatment facilities designed for sediment removal may be necessary. Inspection and maintenance during spring run-off should be a consistent feature of any stormwater management plan.

NRCS specifically states that their peak flow methodology cannot estimate run-off from snowmelt or rain on frozen ground. Without an industry standard methodology for calculating these types of run-off, it is very difficult to know what the implications would be on the modeling results. Therefore, the drainage system capacity assessment ignores this issue. Additionally the system capacity assessment does not consider reduced capacity due to O&M problems such as frozen pipes or sediment loading.

3.5 Capacity Analysis

This section discusses the methods used to analyze run-off conveyance into the drainage system and identify potential conveyance deficiencies. Recommendations include system monitoring and flow data collection, condition assessment, line cleaning if necessary, maintaining the hydraulic model, and reviewing Municipality of Anchorage (Anchorage) stormwater design criteria for applicability to Soldotna's drainage system to address potential and current capacity issues.

3.5.1 System Capacity Modeling Methodology

Analysis of the stormwater system was performed using a hydraulic model developed by HDR. All of the information for the existing stormwater system came from either GIS data or record drawings provided by the City. The collection system was modeled using the InfoSewer modeling software developed by Innovyze. InfoSewer integrates advanced hydraulic and hydrologic modeling functionality in a GIS-based program used for planning, design, analysis, and expansion of sanitary, storm and combined sewer collection systems. InfoSewer performs comprehensive hydraulic calculations of steady-state analysis using various peaking factors.

Precipitation derived runoff rates were calculated for each catchment area using a spreadsheet and the NRCS peak flow methodology. Runoff from each sub-basin was assigned to a storm drain pipe manhole or cleanout. When basins were located between manholes, the upstream manhole or cleanout was chosen.

The InfoSewer model accumulates the load at each node, calculates flow depth and velocity for the pipe downstream of each loaded node and then sums the loads at downstream nodes before starting the calculation process again for the next downstream pipe.

Pump stations were modeled with the pump discharge curves and force main hydraulic considerations.

The drainage system model evaluated only a steady state flow condition. Under this condition flow attenuation from storage was not considered. Pump stations were assumed to be continuously operating creation the maximum downstream flow conditions at the discharge manhole. Steady state flow is a conservative assumption and is used to estimate maximum flows in the pipe for the assigned load condition.

Pipes were assumed to be sediment free and not deformed fro circular pipe.

The 2015 and 2035 flows were loaded into the model by catchment area. Runoff variation between these two years represented changes in land use from development.

Based on engineering judgment and recommended Manning's n values (roughness) from the American Society of Civil Engineers *Standard Guidelines for the Design of Urban Storm Sewer Systems*, all pipes in the system except for CMP use an n value of 0.013 in the model. The Manning's n value used for CMP is 0.024.

The hydraulic model is based on simplifying assumptions. For example the model does not have the ability to determine whether or not the manholes and inlets were designed with proper spacing and capacity, rather it assumes that each manhole and inlet has sufficient capacity to handle the allocated peak flow. All pipes were assumed to be clean and contain no sediment. Additionally, the pump station, located north of Riverside Drive along the Sterling Highway, is assumed to be properly sized to handle peak flows.

3.5.2 Flow Depth Limits

The maximum depth of flow for the design storm is the evaluation criterion for system capacity. Flow depth in pipes is typically expressed as a d/D ratio (the depth of flow in a pipe over the pipe diameter) or as the surcharge height over the pipe crown. Table 7 shows the d/D capacity criteria and corresponding designation. Maximum theoretical gravity flow capacity for a pipe typically assumes d/D is equal to 90%.

Table 7. Stormwater Pipe Capacity Designations

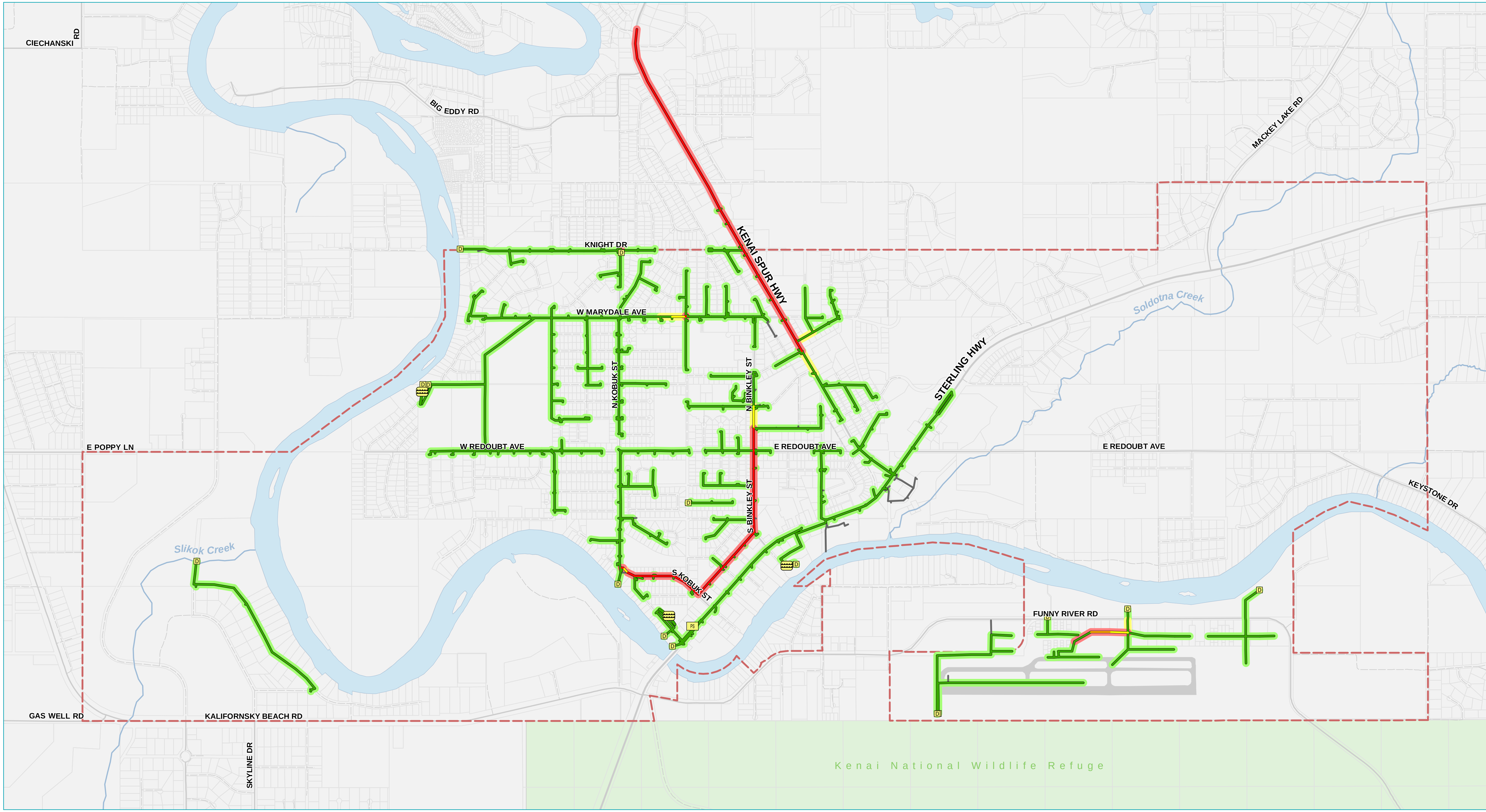
Capacity Designation	Numeric Criterion
No Issue	d/D ≤ 0.66
Medium Potential	0.67 ≤ d/D ≤ 0.80
High Potential	0.81 ≤ d/D ≤ 0.99
Over Capacity (Surcharging)	d/D ≥ 1

3.5.3 Capacity Analysis Results

System capacity conditions for 2015 and 2035 were analyzed with InfoSewer. Model results estimate water depths in each pipe during the peak hour of a 24-hour, 10-year rainfall event. Using the designations from Table 7, the results identified pipes with potential capacity issues. The model was then used to perform a GIS based analysis to understand the causes of capacity issues and prepare capacity management recommendations. The results of the analysis are described below and presented graphically in Figure 14.

The results show surcharging pipes and flooding occurs in two areas: the Kenai Spur Highway and around Wilson Street, Binkley Street, and Kobuk Street. Likely causes of inadequate capacity are flat pipe slopes and undersized pipes. Some sections of pipe in these sections have less than 0.3% slope, the minimum slope required by Anchorage’s drainage design criteria. According to model results, larger diameter smooth pipes could eliminate several problem areas where pipe slope cannot be adjusted. Any such pipe replacement project would have to involve further investigation.

If flooding occurs in areas of the City other than what is shown as problem areas on Figure 14, other factors such as sediment build-up, insufficient inlet capacity, or undersized pumps may be the cause.



SOLDOTNA
City of Soldotna, Alaska

Stormwater Mains - Capacity Status 2015
Peak hour depth over diameter of pipe

- No Issue (d/D) = 0 - 66%
- Medium Potential (d/D) = 67 - 80%
- High Potential (d/D) = 81 - 99%
- Over Capacity (d/D) = 100%
- Zero flow or not in model

Stormwater Mains - Capacity Status 2035
Peak hour depth over diameter of pipe

- No Issue (d/D) = 0 - 66%
- Medium Potential (d/D) = 67 - 80%
- High Potential (d/D) = 81 - 99%
- Over Capacity (d/D) = 100%

- D Discharge Structure
- PS Lift Station
- Storage Basin
- City Limits
- State Highway
- Town Major Collector
- Town Medium Volume
- Creek
- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

N

0 1,800
FEET

SOLDOTNA UTILITY MASTER PLAN

Stormwater Drainage System
2015 & 2035 Pipe Capacity
Figure 14

HDR

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3.6 Capacity Management Recommendations

Drainage system modeling requires engineering judgment to balance the uncertainties about system data with interpretation of model results. The model is a good tool for identifying pipes with potential capacity issues, but CIP decisions should not be based solely on model results. Pipes with capacity issues should be visually inspected and flow data collected to calibrate the model. Additionally, the use of low-impact development can minimize additional inflow and potentially defer pipe replacement projects.

Based on the model results and the capacity analysis methods outlined in this memorandum, the following recommendations are made:

- The City should continue to maintain an accurate representation of the stormwater system in GIS.
- The City should re-run the model when the next master plan is done or when significant property development impacts potential stormwater flows.
- The City should share the model results and coordinate with the State of Alaska DOT&PF to address potential capacity issues along state owned roads within the City boundary.
- The City should share model results with the Airport Advisory Board so that they can develop drainage management strategies as part of the *Airport Master Plan Update*. The expected apron, taxiway, and runway extensions provide an opportunity to incorporate LID techniques. In addition, the Airport Advisory Board may want to consider replacing the existing Oil/Grit Separators and open ditch near Patson Road with green infrastructure if further investigation of these facilities indicates inadequate water quality treatment.
- The City should review Anchorage drainage design criteria and adopt those criteria, which are applicable to the City.
- The City should implement LID to maximize water quality treatment and defer capital projects. The Anchorage design criteria require water quality treatment for the first 0.52 inches of rainfall from a 24-hour event. Installations of bioretention facilities, infiltration basins, and raingardens have been shown to reduce flows into stormwater catch basins, mitigate capacity issues, and improve water quality.

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4 Recommendations

4.1 Policy Recommendations

Soldotna's Comprehensive Plan, *Envision Soldotna 2030*, includes natural resource goals addressing stormwater. While comprehensive plan goals are not regulations, adoption of the comprehensive plan by the Soldotna City Council indicates the Council's support in achieving these goals. That support can be realized by updates to the municipal code and adoption of more robust design criteria for streets and drainage projects.

Natural Resource goals 5, 6 and 7 pertain to stormwater, as stated in *Envision Soldotna 2030* (PAGE):

> Goal 5: Evaluate the existing City stormwater system to identify and prioritize improvements to stormwater collection, detention and treatment.
>
> Goal 6: Increase stormwater design review standards for all nonresidential or multi-family residential development.
>
> Goal 7: Use public facility development and operations to model sustainable design techniques, such as using green areas along roads for stormwater detention and treatment, maximizing retention of native vegetation, reducing the impermeable footprint of new development, use of energy-efficient systems, and maximizing reuse and recycling of materials.

The system capacity model described in Section 3 addresses Goal 5, and in general Soldotna's drainage system is functioning well. Goals 6 and 7 can most effectively be implemented through municipal code revisions and adoption of more robust design criteria. As described in Section 1.6.2, Soldotna's municipal code and design criteria are insufficient to address drainage requirements necessary to reach the goals in the *Envision Soldotna 2030*.

4.1.1 Code of Ordinances

A critical element to any municipal code update is to not make property development so restrictive that it impairs economic growth or shifts development to surrounding areas. This could be the case if the City implemented system development charges, which applies to fees to developers connecting to the drainage system, however these infrastructure development costs should not benefit developers at the cost to the City. Design criteria and municipal code requirements can address this issue without the use of system development charges.

Anchorage has recently updated both their municipal code and *Design Criteria Manual*. Given the similarity in climate and weather patterns and density and types of development, it is recommended that the City of Soldotna review Anchorage's municipal code for guidance and work to adopt similar ordinances, which apply to Soldotna's service area. Since Anchorage is regulated under an Alaska Pollutant Discharge Elimination System MS4 discharge permit, not all components of the code may apply.

Title 21.07.040 of Anchorage's municipal code includes ordinances related to drainage, stormwater treatment, erosion control and prohibited discharges. Below is a summary of the contents of the Anchorage Title and is provided in its entirety as Appendix B:

- Purpose: The purpose of the chapter is to implement principles of drainage planning, including; not transferring drainage problems from one location to another; that good drainage design incorporates natural systems; drainage and stormwater management facilities are design for the sub-arctic climate , ease of maintenance, long term functionality and safety.
- Guidance Documents: The chapter directs the municipal engineer to develop and implement guidance manuals and standards.
- Emergencies: The chapter provides protocols in the event of an emergency.
- Drainage: The chapter requires the development of a drainage plan and specifies its components, including protocols in the event of exposure of subsurface flows.
- Stormwater treatment and erosion and sediment control: The chapter directs development of erosion control measures and post-development controls to protect stormwater quality.
- Snow storage and disposal: This section addresses seasonal storage and management of plowed snow from on-site parking lots and other motor vehicle areas. It requires developments to provide space to accommodate plowed snow, and also allows alternative and innovate solutions.
- Prohibited discharges, hazardous sites, violations and penalties and appeals: These sections of the title include a list of prohibited discharges into the storm sewer system, criteria on what constitutes a hazardous site, penalties for violations and appeals procedures.

In addition to Title 21.07.040, Anchorage municipal code includes numerous additional sections that apply to the management and development of stormwater. Many of these will not apply to Soldotna, but the municipal code provides a sound template that the City could use to develop code ordinances to meet the goals specified in *Envision Soldotna 2030*.

4.1.2 Design Criteria

The City of Soldotna has no adopted design criteria to direct how site and street designs address stormwater runoff and water quality treatment. Guidance is limited to Section 12.04.030 of the Soldotna municipal code, simply stating the drainage must convey the 10-year event and minimize the amount of paved area. To meet the natural resource goals in *Envision Soldotna 2030*, it is recommended that the City investigate more rigorous design criteria standards to guide developers to use LID approaches to stormwater treatment.

Anchorage has recently completed a multi-year effort to update their *Design Criteria Manual*; Chapter 2 addresses drainage and emphasizes LID approaches for storm water treatment. In developing the updated design criteria, Anchorage attempts to avoid an adverse business environment by allowing flexibility in design choices depending on the site conditions.

Section 3.2.2 of the *Anchorage Drainage Design Criteria Manual* presents management requirements for new development or redevelopment sites. A summary of these requirements and a list of applicability for each project type are provided in a table, recreated here as Table 8 and a summary of these requirements follows (Municipality of Anchorage 2015).

Requirement 1 – Water Quality Treatment

Stormwater management systems must be designed to provide water quality treatment through the use of Green Infrastructure LID. Treatment must be provided for runoff generated from the first 0.52 inches of rainfall from a 24-hour rainfall event preceded by 48 hours of no precipitation. Chapter 6 *of Anchorage Drainage Design Criteria Manual* includes methods such as retention, infiltration, bioretention, evaporation, rainfall harvesting, and/or any combination of these techniques.

The *Drainage Design Criteria* Manual also includes guidance when LID is infeasible due to site conditions.

Requirement 2 – Extended Detention

Extended detention is intended to protect streams and channels from erosion due to an increase in post-development flow. Extended detention requires that applicable projects detain post-development project runoff in excess of the pre-development project runoff for the 1-year, 24-hour storm for a period of 6 hours.

Requirement 3 -- Conveyance

Conveyance design is required for both small and large projects. Conveyance design is based on both project area flows and upstream and lateral inflows. If drainage is directed offsite, it must be directed into an established natural water course of an existing drainage facility. In cases where municipal drainage systems are not available or if the designer elects to keep project runoff onsite, the project must keep and manage onsite runoff generated form the required conveyance design storms.

Requirement 4 – Detention and Peak Flow Control

Site runoff, project flood bypass and downstream impacts must be managed under two different options. Each of these are designed to protect adjacent properties and natural water courses depending on the site situation

Requirement 5 – Downstream Impact Analysis

A downstream impact analysis is a hydrologic analysis of the drainage system that is receiving project discharge. The downstream impact analysis looks at changes in peak flow magnitude and overtopping duration at critical points downstream and the project must demonstrate that peak flow control thresholds are not exceeded.

Requirement 6 – Wetland Mitigation

The wetland mitigation requirement is intended to guide the designer in developing controls that are adequately sized to satisfy conditions in a U.S. Army Corps of Engineers Section 404 permit, if issued for the project.

Requirement 7 – Operation and Maintenance Plan

The stormwater management system, including all structural stormwater controls and conveyances, shall have an operation and maintenance plan to ensure that the system continues to function as designed.

Requirement 8 – Stormwater Management Report

The stormwater report is to provide details, including narrative, technical information, and analysis indicating how the proposed development meets Requirements 1 through 6. A final stormwater management report shall be submitted as part of the application for a Building Permit, Subdivision Agreement, or Improvement to Public Places Agreement.

Anchorage's *Drainage Design Criteria Manual* has yet to be formally adopted by the Municipal Assembly, and not all of the requirements would be applicable to Soldotna. A great deal of effort was put into its development, however, and it is recommended that City departments review the criteria and recommend for adoption those that pertain to Soldotna's drainage requirements. This effort should be lead by the City Engineer and the Public Works Department.

Table 8 Summary of Municipality of Anchorage Stormwater Standards and Requirements[1]

Project Classifications	Stormwater Management Requirements							
	Water Quality Treatment	Conveyance	Peak Flow Control	Downstream Impact Analysis	Project Flood Bypass	Operation and Maintenance Plan	Stormwater Management Report	Wetland Mitigation
	Using Relevant (LID) Tools form Chapter 6	10-year 24-hour event	Two options to meet these requirements. Designer can select preferred option		Safe Passage of the 100-yr event			
Exempt Projects								✓
Small Projects (<10,000 sf of land disturbance)		✓	✓		✓	✓	✓	✓
Large Projects (>10,000 sf of land disturbance)	✓	✓	✓	✓	✓	✓		✓

[1]Table 3.2.1 of the Anchorage Design Criteria Manual (Municipality of Anchorage 2015)

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5 Capital Improvement Program

5.1 Project Phasing and Priorities

The City of Soldotna uses a CIP as a basis for budgeting the planning, design, and construction of needed facilities. The projects recommended for the study areas were combined to create a 20-year list covering the period 2016-2035. These projects form the Soldotna Drainage System CIP.

5.2 Project Priority Criteria

Soldotna's drainage system is well maintained and performing as expected, with only a few problem areas on Wilson Road and at the airport. These problems increase at the end of the planning period in 2035 along South Binkley Street and South Kobuk Street, assuming no improvements to the system are performed. Additionally, there are drainage capacity issues along the state-owned Kenai Spur Highway that, while not under the City's jurisdiction, create flooding problems for City residents.

Capital drainage projects are best accomplished concurrently with transportation improvements, and it is recommended that the drainage projects be included as part of road projects. Additionally, future capital improvements due to capacity issues may be deferred with the implementation of LID requirements, which provides detention and attenuate runoff velocities.

5.3 Capital Improvement Schedule

5.3.1 2016 - 2035 Capital improvement Program

Projects are organized chronologically starting with projects to be built in 2016 and ending with those projects to be constructed prior to 2035. Estimated costs are also included. Feasibility studies and master plans represent the lowest level of effort in developing estimates of cost, and the American Association of Cost Engineers specifies that these types of planning level cost estimates have an anticipated accuracy of +50% to -30%.

Contingencies

Cost estimates presented in the 2015 DMP include a 25% contingency added to the construction cost estimates. This contingency is added to cover many construction unknowns, such as soil conditions, season of construction, bidding climate, unforeseen physical conflicts with other utilities, and various incidental costs for labor and materials not specifically included in the estimated construction quantities.

5.4 Project Recommendations

Recommended projects to address identified system needs and future service are compiled in Table 9. Table 9 presents the recommended project implementation schedule in the years 2016 to 2035. The schedule attempts to tie improvements to anticipated increases in development and associated increased flow into the drainage system. Revisions to the planned schedule will be necessary should growth patterns change.

Table 9. Capital Improvement Recommendations

Project #	Project Name	Implementation Year	Description	Estimated Cost (2015 Dollars)
D1	Wilson Road Drainage System Capacity Improvements	2016	The 24-inch corrugated metal pipe at Wilson St. surcharges under certain conditions, likely due to roughness and a flat slope of ~.03%. Recommended improvement includes replacing CMP with smooth-walled HDPE	$1,431,000
D2	Airport	2016	Capacity Expansion and treatment upgrades should be addressed in airport master plan.	$388,000

In addition to these capital projects, it is recommended that an analysis of the storm drain system be conducted whenever a road project is undertaken. The analysis would include a review of the capacity analysis presented in Section 4, a video inspection, and discussions with City maintenance staff for any known problems. Pipe data should be cataloged with the other GIS data developed for the drainage system.

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Appendix A

Alaska Department of Environmental Conservation Anti-Degradation Policy

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State Antidegradation Policy
18 AAC 70.015

The following regulation is an excerpt from 18 AAC 70 Alaska Water Quality Standards as adopted in 1997. This regulation can also be found in 18 AAC 70 as amended in 2003 and 2011.

18 AAC 70.015. Antidegradation policy. (a) It is the state's antidegradation policy that

(1) existing water uses and the level of water quality necessary to protect existing uses must be maintained and protected;

(2) if the quality of a water exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality must be maintained and protected unless the department, in its discretion, upon application, and after compliance with (b) of this section, allows the reduction of water quality for a short-term variance under 18 AAC 70.200, a zone of deposit under 18 AAC 70.210, a mixing zone under 18 AAC 70.240, or another purpose as authorized in a department permit, certification, or approval; the department will authorize a reduction in water quality only after the applicant submits evidence in support of the application and the department finds that

(A) allowing lower water quality is necessary to accommodate important economic or social development in the area where the water is located;

(B) except as allowed under this subsection, reducing water quality will not violate the applicable criteria of 18 AAC 70.020 or 18 AAC 70.235 or the whole effluent toxicity limit in 18 AAC 70.030;

(C) the resulting water quality will be adequate to fully protect existing uses of the water;

(D) the methods of pollution prevention, control, and treatment found by the department to be the most effective and reasonable will be applied to all wastes and other substances to be discharged; and

(E) all wastes and other substances discharged will be treated and controlled to achieve Register 186,

(i) for new and existing point sources, the highest statutory and regulatory requirements; and

(ii) for nonpoint sources, all cost-effective and reasonable best management practices;

State Antidegradation Policy, 18 AAC 70.015

(3) if a high quality water constitutes an outstanding national resource, such as a water of a national or state park or wildlife refuge or a water of exceptional recreational or ecological significance, the quality of that water must be maintained and protected; and

(4) if potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy described in this section is subject to 33 U.S.C. 1326 (commonly known as sec. 316 of the Clean Water Act).

(b) An applicant for a permit, certification, or approval who seeks to reduce water quality as described in (a) of this section shall provide to the department all information reasonably necessary for a decision on the application, including the information and demonstrations required in (a) of this section and other information that the department finds necessary to meet the requirements of this section.

(c) An application received under (a) of this section is subject to the public participation and intergovernmental review procedures applicable to the permit, certification, or approval sought, including procedures for applications subject to the Alaska Coastal Management Program in AS 46.40 and 6 AAC 50, and applications subject to 18 AAC 15. If the department certifies a federal permit, the public participation and intergovernmental review procedures followed by the federal agency issuing that permit will meet the requirements of this subsection. (Eff. 11/1/97, Register 143)

Appendix B

Municipality of Anchorage Title 21.07.040 – Drainage, Stormwater Treatment, Erosion Control, and Prohibited Discharges

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21.07.040 - Drainage, storm water treatment, erosion control, and prohibited discharges.

A. Purpose.

1. Drainage plans and the requirements of this section and the Design Criteria Manual are intended to implement the following principles of drainage planning:

a. The design of a drainage system shall not transfer a problem from one location to another.

b. Adequate space shall be provided for drainage conveyance and storage.

c. Good drainage design incorporates the effectiveness of the natural systems, rather than negating, replacing, redirecting, or ignoring them. The features, capacity, and function of the existing natural system shall be considered and utilized.

d. Drainage and storm water management facilities shall be designed with ease of maintenance, long-term function, sub-arctic climate function, protection of public safety, and accessibility as primary considerations.

2. Other purposes of this section include:

a. Regulating development preparation and land-disturbing activity in order to control erosion and sedimentation and accordingly to prevent water pollution from sedimentation, to prevent accelerated erosion and sedimentation of lakes and natural watercourses; and to prevent damage to public and private property by erosion and/or sedimentation during and after construction;

b. Regulating storm water discharge to improve the quality of the environment for residents of the municipality, administer the Municipal Separate Storm Sewer permit, and manage impacts to the watersheds in the municipality; and

c. Minimizing point and non-point source pollution into the water bodies of the municipality.

B. Guidance documents. The municipal engineer shall develop, implement, and maintain various guidance manuals which shall provide standards and guidelines for this Section 21.07.040. The Design Criteria Manual and the Storm Water Treatment Plan Review Guidance Manual are examples of such manuals.

C. Emergencies. Where site work deviates from approved plans due to an emergency, the municipal engineer shall be notified on the next business day. Changes to an approved plan shall be submitted within 14 days to the public works department. For the purposes of this section, an "emergency" is a situation which would result in an unacceptable hazard to life, a significant loss of property, or an immediate, unforeseen, and significant economic hardship if corrective action requiring a permit is not undertaken immediately.

D. Drainage.

1. Intent. A drainage plan shall show the post-development drainage patterns of the site.

2. Applicability. This section applies to all development within the municipality.

3. Drainage plan required.

a. Applications for the following entitlements shall include a drainage plan:

i. A permit from the development services department, for projects that include land disturbance;

ii. Subdivision plat (both preliminary and abbreviated plats);

iii. Site plan review (administrative and major); and

iv. Conditional use.

The drainage plan submittal requirement may be waived by the director and the municipal engineer if both agree that such a plan is not necessary.

b. The drainage plan shall show the area affected by the application, as well as watercourses, drainage and water quality easements, appropriate drainage outfall for surface water, roof drainage, and other impervious surfaces, and any other pertinent information, and shall address surface and subsurface drainage. The drainage plan shall also indicate impacts, if any, on adjacent, up-gradient, and down-gradient properties.

c. An approved drainage plan is required before any site work commences.

4. Standards. Drainage plans shall comply with the requirements of municipal code and the guidance of the Design Criteria Manual. Post-development drainage plans shall be designed in a manner such that there will be no adverse off-site impacts. Any net increase of water volumes shall be mitigated and/or directed to an adjacent drainage system or receiving water that has the demonstrated capability to handle the new flows. The municipality may require a dedicated drainage easement(s) to ensure the drainage is consistent and compatible with surrounding drainage patterns.

5. When no permit is required.

a. In situations where a building or land use permit is not required, all design and construction activities shall comply with municipal code.

b. If the municipal engineer reasonably believes that a project is significant in nature or that it will have negative impacts on surrounding property, water quality, drainage, or the roadways, the municipal engineer may require submittal of a drainage plan and a full review of the project. The applicant shall pay the appropriate review fees for the review. If the project is under construction, the municipal engineer may issue a stop work order until the project has been reviewed and approved.

c. If a project has been completed and there are negative impacts on surrounding property, water quality, drainage, or the roadways, the municipal engineer may pursue enforcement actions under Chapter 21.13.

6. Exposure of subsurface flows. If, during site work, unexpected subsurface flows are exposed, the municipality shall be informed immediately. If the subsurface flow cannot be contained within the site and has a significant off-site impact, work shall cease immediately and shall not be resumed until a temporary flow management plan has been submitted to and accepted by the municipality. In addition, the developer shall amend the drainage plan to address the exposed flows and potential for glaciation and shall submit it to the municipality and receive approval before resuming site work other than temporary flow management.

E. Storm water treatment and erosion and sediment control.

1. Intent. A storm water treatment plan shall show both the controls put in place during construction and any needed post-development controls to prevent erosion and protect water quality.

2. Applicability. Storm water treatment plan approval is required prior to commencement of land clearing or ground disturbing activities; the discharge of surface water (including from snow disposal sites); the construction, alteration, installation, modification, or operation of a storm water treatment or disposal system; demolition or utility work; connection to the municipal separate storm sewer system; work in water bodies, wetlands, or watercourses; or dewatering activities, except as listed in E.4. below. All construction, development, and maintenance activities shall be in accordance with the approved storm water treatment plan.

3. Nonconformities. No nonconforming rights are granted for this subsection 21.07.040 E.

4. Exceptions. A storm water treatment plan shall not be required for the following. An erosion control plan may still be required if the discharge is so concentrated as to cause soil

disturbance. The municipal engineer may waive the requirement for a storm water treatment plan for other activities that, in his or her judgment, will not create erosion or impair water quality.

a. Building improvements where no earth is disturbed;

b. Any earth disturbance that is less than 500 square feet in area;

c. Agricultural activities (not including site landscaping). Discharges from agricultural activities are still subject to water quality standards and potential enforcement for illicit discharges to watercourses or the storm sewer system;

d. Discharges of the following into the municipal separate storm sewer system:

   i. Uncontaminated water line flushing;

   ii. Residential irrigation water;

   iii. Rising ground waters;

   iv. Uncontaminated ground water infiltration;

   v. Uncontaminated discharges from potable water sources;

   vi. Foundation drains;

   vii. Air conditioning condensate;

   viii. Springs;

   ix. Uncontaminated water;

   x. Individual residential car washing;

   xi. Flows from riparian habitats and wetlands;

   xii. De-chlorinated swimming pool discharges;

   xiii. Street wash waters; or

   xiv. Flows from emergency fire fighting activity.

5. Submittal requirements and review procedure. Storm water treatment plans shall be submitted to the public works department on the form provided. The submittal shall include plans for both temporary (during construction) and permanent storm water treatment and erosion control, and any supplementary information required in the user's guide or the Design Criteria Manual.

   a. Storm water treatment plan review guidance manual. The Storm Water Treatment Plan Review Guidance Manual shall be used to develop, review, and approve storm water treatment plans. Applicants submitting plans under this subsection shall comply with the manual regarding plan requirements and reviews, and if necessary shall gather data to confirm storm water conditions.

   b. Changes to an approved storm water treatment plan. Any changes to permanent storm water controls from an approved storm water treatment plan require approval by the municipal engineer. Changes in temporary or construction storm water treatment controls or best management practices necessary to maintain effective storm water treatment do not require municipal approval but shall be documented.

   c. New application required. If dewatering, land clearing, construction, alteration, installation, modification, or operation has not begun within one year after issuance of a storm water treatment plan approval, the approval is void, and a new application shall be submitted to the public works department for review and approval.

   d. Project-wide approval. The municipal engineer may issue a project-wide approval to an applicant who plans to conduct an operation with the same runoff characteristics at various discharge locations. He or she may require the submittal of site-specific plans, including a schedule and description of all planned discharge activities, for approval, and may restrict that approval to certain proposed discharge activities.

6. Land clearing. Mechanized land clearing of one acre or greater requires an approved storm water treatment plan. Until a subsequent use is approved, a temporary native vegetation buffer shall be retained on the perimeter of the lot being cleared, equal to or greater than the specified minimum setback required in the zoning district. This buffer shall be at least 15 feet wide on the perimeter of lots in commercial and industrial zoning districts, except where these are adjacent to PLI and/or residential zoning districts, where the temporary buffer shall be a minimum of 30 feet wide. Those areas of native vegetation in commercial and industrial zoning districts not essential to the parcel's development and situated on the perimeter of the site shall be retained and protected from disturbance as specified in subsection 21.07.080 F.3.

7. Erosion and sediment control administrator. A qualified erosion and sediment control administrator, who shall be responsible for the erosion, sedimentation, and best management practices during construction, shall be identified in each storm water treatment plan submitted for approval, except for storm water treatment plans for owner-built single- and two-family dwellings. Evidence of contractual liability shall be provided when requested.

   a. In order to be identified as a qualified administrator, a person shall successfully complete a training course and associated test for certification from a training program approved by the public works department.

   b. The qualified administrator shall maintain their certification in active status throughout the length of the project. In the case where the qualified administrator's certification becomes expired or revoked, a new qualified person shall be selected to be the erosion and sediment control administrator and shall be identified on the storm water treatment plan.

8. Alternate materials, design, and method of construction.

   a. The provisions of this section are not intended to prevent the use of any alternate material, design, or method of construction not specifically prohibited by this code, provided any alternate has been approved and its use authorized by the municipal engineer.

   b. The municipal engineer may approve any such alternate, provided that he or she finds that the proposed design complies with the intent and purpose of this code, and that the material, method, or work offered is, for the purpose intended, at least the equivalent of that required in this code in suitability, effectiveness, durability, safety, sanitation, and degree of structural integrity. The details of any action granting modifications or the acceptance of a compliance alternative shall be recorded and entered in the public works department's files.

   c. Whenever there is insufficient evidence of compliance with any of the provisions of this code or evidence that any material or construction does not conform to the requirements of this code, the municipal engineer may require tests as proof of compliance to be made at no expense to the municipality. Test methods shall be as specified by this code or by other recognized test standards. If there are no recognized and accepted test methods for the proposed alternative, the municipal engineer shall determine test procedures. All tests shall be made by an approved agency. Reports of such tests shall be retained by the municipal engineer for the period required for the retention of public records.

9. Inspections.

   a. Required inspections. Prior to the commencement of or during land clearing or ground disturbing activities of one acre or greater, the discharge of surface water, or dewatering activities subject to this section, an inspection of approved best management practices associated with the storm water treatment plan shall be conducted. Prior to the issuance of a certificate of zoning compliance, permanent site controls shall be verified by inspection or other means, as determined by the municipal engineer. The owner or contractor of record is responsible for requesting the required inspections at the appropriate times.

b. Other inspections authorized.

i. A municipal official, upon presentation of proper identification, may enter the premises at reasonable times to inspect or perform duties imposed by this code, for the purpose of determining whether the owner or operator thereof is in compliance with the specific requirements of this section. If such premises are unoccupied, the official shall first make a reasonable effort to locate the owner or other person having charge or control of the premises and request entry. If entry is refused, any approvals issued under this section may be immediately suspended until an inspection is conducted, and the official shall have recourse to the remedies provided by law to secure entry. Permittees, owners, or operators shall immediately stop all work upon the site being posted with a stop work order for failure to allow inspection.

ii. A municipal official may inspect any property or facility suspected as the source of illicit discharges in violation of 33 USC 1342 (1987) as amended.

iii. No inspection for which a warrant would be required under the constitution of this state or the United States may be conducted under this section without the proper warrant.

c. Availability and production of plans and records. Approved plans and specifications shall be available on site for review by municipal inspectors at the time of requested inspections. At the request of municipal officials and during normal working hours, owners or operators of facilities, construction sites, premises, or areas shall produce and make available for inspection or copying all records or information required to be maintained or reported under the provisions of this section.

F. Snow storage and disposal.

1. Intent. This section addresses seasonal storage and management of plowed snow from on-site parking lots and other motor vehicle areas. It requires developments to provide space to accommodate plowed snow, and also allows alternative and innovate solutions. This section is not designed to increase the amount of area already used for snow storage by existing developed residential and commercial property; instead it is intended to clarify applicable regulations and encourage thoughtful site planning and snow management with respect to adjacent property and other requirements of this title. Its objectives are:

a. Ensure water quality treatment and drainage control of snow melt;

b. Maintain safe and convenient access and circulation; and

c. Protect adjacent landscaping, walkways, streets, and property.

2. Applicability. Except where stated otherwise, all existing and new uses with on-site surface areas to be plowed for motorized vehicle access or parking shall comply with this section. For example, this includes surface areas such as parking spaces, circulation and parking aisles, associated driveways, queuing lanes, emergency vehicle access lanes, loading areas, tractor trailer areas, and vehicle sales and display areas. The following uses and surfaces are exempt:

a. Single-family, two-family, three-unit multifamily, townhouse, and mobile home dwellings on individual lots;

b. Snow disposal sites subject to subsection 21.05.060 E.8.; and

c. Ice-free (snow-melting) surfaces and/or covered surfaces.

3. Operational standards. For all applicable uses (including existing uses and new development):

a. Plowed snow shall not interfere with required pedestrian or vehicle circulation or sight distance.

b. Snow storage shall not interfere with access to utility equipment or create a hazard around utility equipment, in accordance with utility tariffs. For example, snow piles shall not be placed underneath an overhead utility line such that the snow pile reduces clearances to less than National Electrical Safety Code (NESC) ground clearance requirements.

c. Plowed snow may be removed to an approved snow disposal site, or shared among abutting or contiguous lots jointly managed for snow storage and disposal purposes. Plowed snow shall not be otherwise removed from the property. Snow shall not be moved to a right-of-way or other public place without a valid right-of-way permit pursuant to Title 24.

d. Snow piles stored longer than on a 72-hour temporary basis shall not result in direct offsite drainage such as onto neighboring properties or public rights-of-way, except for snow melt drainage directed into an approved drainage facility.

e. Winter trash accumulation from plowed snow shall be removed and paved snow storage areas swept by June 1 (or as soon as snowmelt conditions permit).

4. Snow storage areas on new development sites. Developments involving the construction of new principal buildings, the removal and replacement of existing principal buildings, and/or the expansion or redevelopment of on-site surface areas to be plowed for motorized vehicle access and parking shall provide for snow storage and disposal on the site plan, as provided below. Tenant improvements, renovations, alterations, and enlargements of existing developments are exempt, except that the addition or expansion of parking lots or other areas for motorized vehicle parking and access by the greater of either 10 parking spaces or 10 percent of the existing area shall comply.

a. If snow will be stored on-site, snow storage areas shall be designated on the site plan as provided in 4.b. through 4.g. below. If snow will be removed off-site to a snow disposal facility or another alternative snow management strategy is used as provided in subsection F.5. below, then the snow storage areas may be reduced or eliminated from the site plan.

b. For residential uses, an area equal to at least ten percent of the surface area on the site to be plowed for motorized vehicle parking and access (as identified in subsection F.2.) shall be designated for snow storage. For nonresidential uses, this area requirement shall be five percent.

c. As an alternative to 4.b. above, the applicant shall provide a calculation stamped by a professional registered with the Alaska State Board of Registration for Architects, Engineers, and Land Surveyors, that indicates the proposed snow storage and disposal strategy will be adequate to accommodate the plowed snow in an average snow year, considering the site plan layout, the amount of surface area to be plowed for motorized vehicles (as identified in subsection F.2.), and the proposed method(s) of snow storage and disposal.

d. Snow storage areas shall be located to comply with the operation standards of subsection F.3. above, and shall abut the surface area to be plowed.

e. Snow storage areas shall have a minimum dimension of eight feet to accommodate snow piling from a plow blade.

f. The site plan shall not, unless allowed through an administrative site plan review, designate snow storage areas in required perimeter landscaping, required residential private open space, or on required trees. Designation of required residential private open space for snow storage shall be permitted only on the condition that the snow pile and trash accumulation from plowed snow be removed and the space made usable by May 1.

g. Snow storage areas shall be planted with ground-cover (such as grass), or paved subject to subsection 21.07.090 H.12., paving.

5. Alternative snow management strategies. Alternative snow management strategies such as snow melters, underground storage, or removal to an approved snow disposal site, may be approved by the municipal engineer in lieu of a required snow storage area, subject to the following:

   a. The owner shall either set aside the area that would otherwise be needed to provide the required snow storage area on the site, or enter into an agreement with the municipality, in conformance with the Title 21 User's Guide, which is recorded, runs with the use of the land, and ensures continuation of the alternative strategy and the future implementation of contingency measures if such contingency measures are ordered by the municipal engineer.

   b. Areas to be used for temporary storage of plowed snow awaiting removal or disposal shall be depicted on the site plan.

   c. The method of treatment and disposal shall comply with subsection F.8. below.

6. Setbacks. Plowed snow shall be set back from streams, watercourses, wetlands, and water bodies as specified in Section 21.07.020, and is prohibited within ten feet of storm water outfalls and discharge points.

7. Snow melt drainage. Developments shall comply with subsection 21.07.040 D., drainage, to address drainage of snow melt in areas of the site affected by the development.

8. Snow melt treatment. Detention and treatment practices and/or facilities for chloride, particulates, and other pollutants shall be provided prior to discharge of snow melt from a site sufficient to comply with subsection 21.07.040 E., and shall be subject to review and approval by the municipal engineer.

G. Prohibited discharges.

1. Applicability. This section applies throughout the municipality.

2. Prohibited discharges or acts. No person shall cause or permit illicit discharges:

   a. Into any waters of the state, or waters of the United States, unless such is first treated in a manner approved by the federal, state, or other agencies having jurisdiction; or

   b. Into a storm sewer of the municipality, other than pursuant to a dewatering permit, an approved storm water treatment plan, a national pollutant discharge elimination system permit, or a permit issued by a local, state, or other agency having jurisdiction. Examples of discharges that are prohibited include:

      i. Grease, fatty materials, offal, or garbage;

      ii. Sand, sand dust, dirt, gravel, sawdust, metal filings, broken glass, or any material which may cause or create an obstruction in the sewer;

      iii. Gasoline, benzene, fuel oil, or a petroleum product or volatile liquid;

      iv. Milk or any liquid milk waste product in quantities in excess of ten gallons during any 24-hour period;

      v. Wax, cyanide, phenols, or other chemical or substance that may cause damage to materials of which the sewer system is constructed; or

      vi. Wastewater, as defined in AMC Section 15.20.010.

   For the purposes of this section, "illicit discharges" means pollutants or any materials other than storm water.

3. Dumping in watercourses and water bodies. No person shall deposit, dump, abandon, throw, scatter, or transport solid waste, garbage, rubbish, junk, fill, soil, dirt, snow, ice, vegetation, or other material in such a manner as to obstruct, impound, or cause siltation of any river, stream,

creek, watercourse, water body, stream or water body or wetland setback, water quality easement, storm sewer, ditch, drain, or gutter except as otherwise allowed by valid federal, state, and other permits or licenses relative to water pollution, water impoundment, or water quality control.

H. Hazardous sites.

1. For the purposes of this section, any site meeting any or all of the conditions and defects described below shall be deemed to be hazardous, provided that such conditions or defects exist to the extent that the health of the watershed, the requirements of the municipal separate storm sewer system permit, or the safety of the public are endangered, as determined by the municipal engineer.

   a. Any site that causes sediment to be discharged in such a way that it may be delivered directly or indirectly to the storm sewer or receiving waters;

   b. Any site that causes pollution to be discharged in such a way that they may be delivered to the watershed;

   c. Any property for which the owner, manager, or tenant fails to install and/or maintain properly permitted BMPs; or

   d. Any site where actions are causing soil masses to be in danger of sloughing, destabilizing, failing, or collapsing as a mass wasting event.

2. All sites which are determined after inspection by the municipal engineer to be a hazardous shall be abated as determined by the municipal engineer.

I. Violations and penalties.

1. Violations.

   a. Any person who violates any provisions of this section shall report such violation to the project management and engineering department and shall make available any information or records related to the contents of the substance discharged.

   b. In addition to any other remedy or penalty provided by this title, any person who violates any provision of this title or regulations adopted there under shall be subject to the civil penalties or injunctive relief, or both, as provided by AMC subsection 1.45.010 B.

   c. In any action under this section, the municipality, if not a party, may intervene as a matter of right.

2. Penalties.

   a. All sites operating without approval under this section may be immediately posted with a stop work order and shall pay double fees for all required permits or inspections under this section, as well as any fines which may be assessed. In addition to any other remedy permitted by law, fines may be assessed for failure to have a permit or approved plan, failure to allow inspections, or failure to obey a properly issued stop work order. Violators of this section may also be charged $1,000.00 per day until the violation(s) is corrected.

   b. Any person who negligently or intentionally permits or causes a discharge in violation of this section shall, upon conviction, be subject to a civil fine penalty of $5,000.00 to $10,000.00 per day, or injunctive relief to cease the violation, or both. In addition to any fine assessed under this section, any person who violates any provision of this section or any rule or regulation adopted pursuant to this section shall be subject to a further civil penalty of up to double the cleanup and remediation costs incurred as a result of the violation.

   c. Any person who permits or causes a discharge in violation of this section shall be strictly liable, regardless of intent, for the full amount of any fines or other liquidated penalties incurred by the municipality for any violations of federal law which are caused by the discharge.

d. No certificate of zoning compliance shall be issued until all fines levied under this section have been paid.

J. Appeals.

1. Appeals of orders, decisions, or determinations made by the municipal engineer shall be heard by the zoning board of examiners and appeals, pursuant to subsection 21.03.050 B.

2. The zoning board of examiners and appeals shall have no authority over the interpretation of the administrative provisions of this section, nor shall the board be empowered to waive requirements of this section.

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SOLDOTNA

City of Soldotna, Alaska

City of Soldotna

Wastewater Facilities Master Plan

2015 Update

City of Soldotna, Alaska
February 15, 2016

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List of Acronyms

The following is a list of acronyms and short forms used in this plan.

AACE	American Association of Cost Engineers
AD	Anaerobic Digester
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADMM	Average Day Maximum Month
AER	Aerobic
ANX	Anoxic
APDES	Alaska Pollutant Discharge Elimination System
ASP	Aerated Static Pile
Ave	Average
BFP	Belt Filter Press
BNR	Biological Nutrient Removal
BOD	Biological Oxygen Demand
BTUH	British Thermal Units per Hour
CDP	Census Designated Place
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
CMP	Corrugated Metal Pipe
CMU	Concrete Masonry Unit
COD	Chemical Oxygen Demand
DAFT	Dissolved Air Flotation Thickener
dBA	Decibel
DF	Digester Feed
DLWD	Alaska Department of Labor and Workforce Development
DO	Dissolved Oxygen
DOE	Department of Ecology
DS	Digested Sludge
EDU	Equivalent Dwelling Unit
EFF	Effluent
EPA	Environmental Protection Agency
F/M	Food-to-microorgansim ratio
GBT	Gravity Belt Thickener
GHG	Greenhouse Gases
gpd	gallons per day
gpm	gallons per minute
HVAC	Heating, Ventilating, and Air Conditioning
HP	Horsepower
HRT	Hydraulic Retention Time
HST	high speed turbo

IFAS	Integrated Fixed Film Activated Sludge
IN	Inch
INF	Influent
lbs	pounds
MBR	Membrane Bioreactor
MCC	Motor Control Center
MD	Maximum Day
MGD	Million Gallons per Day
mg/L	milligram per liter
MLE	Modified Ludzack-Ettinger
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MM	Maximum Month
MPN	Most Probably Number
MW	Maximum Week
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
NPW	Net Present Worth
O&M	Operation and Maintenance
PCL	Primary Clarifier
PD	Positive Displacement
PE	Primary Effluent
PE	Population Equivalent
PFRP	Process of Further Reduction of Pathogens
ppd	Pounds Per Day
PSL	Primary Sludge
psig	pounds per square inch gage
RAS	Return Activated Sludge
RST	Rotating Drum Thickener
sBOD	soluble (filtered) BOD
SCADA	Supervisory Control and Data Acquisition
SCL	Secondary Clarifier
SE	Secondary Effluent
SF	Square Feet
SNDN	Simultaneous Nitrification and Denitrification
SOTE	Standard Oxygen Transfer Efficiency
SRF	State Revolving Fund
SRT	Solids Retention Time
SVI	Sludge Volume Index
TKN	Total Kjehldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus

TSS	Total Suspended Solids
TWAS	Thickened WAS
μg/L	Microgram per liter
US	United States
UV	Ultra Violet
VFA	Volatile Fatty Acids
VFD	Variable Frequency Drive
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WWTP	Wastewater Treatment Plant

1 Introduction

The purpose of this Wastewater Facilities Plan Update is to outline the recommended improvements and upgrades for the Soldotna Wastewater Treatment Plant (WWTP) in order to meet future flow demands through 2035 and prepare an associated Capital Improvement Program (CIP) to implement the plan's recommendations. The plan will evaluate a projected 20 year time horizon (i.e., 2016– 2035) for the facility and develop capital and operational improvements to the plant to accommodate increased flows and loads, meet applicable regulatory requirements, and optimize operation and maintenance activities. This plan provides a description and justification for each plan recommendation, as well as the recommended implementation sequence and year.

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

1. An estimate of existing and projected flows and loads.
2. Review of regulatory requirements.
3. Evaluating process alternatives for meeting future flow demands.
4. Developing potential site layouts to accommodate future expansion.
5. Developing planning-level cost estimates for recommended alternatives.
6. Preparing a Facilities Plan consistent with Alaska Department of Environmental Conservation (ADEC) and Environmental Protection Act (EPA) requirements.

1.1 Background

The project planning area includes the City of Soldotna (City) and surrounding area. Wastewater is collected and conveyed to the wastewater treatment plant. A separate master plan covers the operation of the collection system. Treatment of wastewater occurs at a single facility located north of the Kenai River on S. Kobuk Drive. Existing infrastructure will be utilized to the extent possible to reduce capital costs.

The existing Soldotna WWTP, an activated sludge system, treats wastewater for the residents and businesses of Soldotna. The treated effluent from the Soldotna WWTP is discharged into the Kenai River; which has been designated by the Alaska Department of Fish and Game (ADF&G) as an anadromous (Chinook salmon specifically) spawning stream. The WWTP has been operating and discharging at its current location since the early 1970s. As the community and businesses have grown, Soldotna has upgraded the WWTP to meet its needs.

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

1.2 Previous Wastewater Treatment Plant Studies

In 1998, the City hired HDR to perform a feasibility study to evaluate effluent disposal options. HDR performed the project in three phases. The first phase consisted of water quality sampling and data collection to determine if WWTP outfall effluent was impacting the Kenai River. Results showed that the river was not being harmed by the effluent. In phase two, HDR evaluated WWTP processes to determine improvements needed to meet future requirements and wastewater flows. During phase three, HDR evaluated nine different ways the City of Soldotna could dispose of wastewater other than in the river, and prepared construction cost estimates for each alternative. Phase three of the study concluded that the City should maintain its existing outfall in the Kenai River and upgrade the treatment plant to process increased flows and loads.

In 2001, the City commissioned the update of the “City of Soldotna Wastewater Facilities Master Plan”, which outlined the existing conditions and proposed upgrades for the WWTP. Select recommended alternatives from the 2001 plan were designed and installed by 2006. These upgrades included adding a third secondary clarifier, a return activated sludge (RAS) and waste activated sludge (WAS) pumps, scum pumping for the third clarifier, Ultra Violet (UV) disinfection, effluent flow measurement, and various associated piping and site changes. These upgrades are incorporated into the existing facilities discussion of this Plan.

2 Basis of Planning

This chapter discusses factors affecting the design criteria for the WWTP evaluation and basis of planning for this Facility Plan Update including; water quality, current and future regulatory requirements, and the basis for project cost evaluation.

2.1 Water Quality and Regulatory Requirements

The City of Soldotna currently operates their WWTP under ADEC Alaska Pollutant Discharge Elimination System (APDES) Permit No. AK-0020036. The discharge permit was last renewed on July 25, 2000. The City was granted an extension by the EPA and is in the process of negotiating a new effluent permit with the ADEC. The current Soldotna WWTP effluent limits are shown in Table 1 and the proposed DRAFT permit limits for the next permit renewal are shown in Table 2. The current treatment requirements are typical for a secondary wastewater treatment plant. The current National Pollutant Discharge Elimination System (NPDES) permit is included as Appendix A of this Plan.

Table 1. Current Soldotna WWTP NPDES Permit Effluent Limits

Parameter (Units)	Limitation at Discharge Point (monthly/weekly/daily)	Limitation at Mixing Zone Edge (monthly/weekly/daily)
BOD (mg/L)	30/45/60[1]	Not applicable
TSS (mg/L)	30/45/60[1]	Not applicable
pH	6.5 - 8.5	6.5 - 8.5
Fecal Coliform Bacteria (#/100/ mL)	100/---/200	20/20/40
Residual Chlorine (mg/L)	---/---/0.002	---/---/0.002
Flow (MGD)	---/---/1.02	Not applicable
Other Wastewater Constituents	---	State Water Quality Standards
[1] 85% minimum removal		

Table 2. Preliminary DRAFT Soldotna WWTP NPDES Permit Effluent Limits

Parameter (Units)	Limitation at Discharge Point (monthly/weekly/daily)
BOD (mg/L)	30 / 45 / 60
TSS (mg/L)	30 / 45 / 60
pH	6.5 (daily minimum) 8.5 (daily maximum)
Fecal Coliform Bacteria (#/100/ mL)	20 / -- / 40[1]
Residual Chlorine (mg/L)	-- / -- / 0.002[2]
Flow (MGD)	-- / -- / 1.08
Copper[3] (µg/L)	3.1 / -- / 4.1
Zinc[3] (µg/L)	40.1 / -- / 40.1
Total Ammonia as Nitrogen (mg/L)	2.8 / -- / --

[1] Not more than 10% of the samples may exceed 40 FC/100mL.
[2] ADEC will use the minimum detection limit of 0.1 mg/L as the compliance limit for this parameter.
[3] Analyzed as total recoverable.

The current NPDES permit includes a mixing zone in the Kenai River for the treated effluent. The mixing zone is an area of 152 feet long by 16 feet wide downstream from the outfall. The assumed minimum dilution of the treated effluent in the mixing zone is 30:1. In order to verify the WWTP is meeting State Water Quality Standards, sampling takes place on both sides of the river and downstream of the WWTP outfall. Fecal coliform monitoring takes place upstream and downstream of the outfall. All other parameters are monitored upstream of the outfall.

The analyses in this report are based on meeting the current effluent discharge permit conditions and also to consider potential future permit limits. The City has begun negotiations and discussions with ADEC regarding renewal of Soldotna's WWTP APDES permit, with new effluent criteria, in the near future. New discharge limits for ammonia, copper, and zinc were developed by ADEC in a pre-draft permit dated December 9, 2010 and the City and ADEC have had correspondence on the preliminary draft permit since 2010. Issues currently being discussed include:

- Ammonia – The preliminary draft permit eliminates the existing mixing zone in the Kenai River and establishes an end-of-pipe limit for ammonia (2.8 milligram per liter (mg/L) monthly average). The current permit has no ammonia requirements. The City does not consistently monitor for effluent ammonia but has monitored for ammonia in the effluent several times in the past and results indicate that the plant achieves full nitrification on a consistent basis.
- Copper and Zinc - Potential WWTP discharge limits for copper and zinc (3.1 microgram per liter (µg/L, monthly average) and 40.1 µg/L (monthly average), respectively) were developed by ADEC in a pre-draft permit and are of particular importance to the City. The relatively low copper and zinc effluent limits would be difficult to treat within the WWTP (high capital cost for enhanced clarification and filtration equipment, long-term operational costs for chemical addition, and overall operational complexity of metals removal) and the recommended approach for compliance is a two-pronged approach to address the metals issue outside of the WWTP. This approach addresses the metals in the drinking water system (prior

to entering the sanitary sewer system and ultimately the plant) and at the WWTP discharge point in the Kenai River (after the treatment processes). The WWTP effluent option would involve the development of site-specific metals criteria for determining the effluent permit limits.

Results of discussions with ADEC regarding potential future permit limits will be incorporated by amendment into the Final Facility Plan Update. The alternatives analyses performed for this Draft Plan have been developed based on meeting the current effluent discharge permit conditions as well as the potential discharge limits developed by ADEC in the 2010 pre-draft permit.

Biosolids disposal requirements remain the same for current and preliminary draft permit. Title 40 of the Code of Federal Regulations (CFR) Part 503 defines the current federal biosolids requirements, which were enacted in 1993 and updated in 2011. These regulations govern the treatment, use, and disposal of biosolids for land application (not including disposal to landfills). Part 503 differentiates between Class A and Class B biosolids. The designation refers to the reduction of pathogens. Class A biosolids are treated to reduce pathogens below detectable levels. Biosolids are designated as Class B if pathogens are detectable but have been reduced to levels that do not impact public health. Class B biosolids are also required to prevent exposure after biosolids use or disposal to disease vectors. Alaska adopted, by reference in 18 AAC 60.505, 40 CFR 503.15, which defines operational standards for processing and disposing of biosolids. These regulations and guidelines are incorporated into the existing NPDES permit, but currently do not apply as the biosolids are landfilled with daily cover. Future disposal alternatives may necessitate compliance with 40 CFR Part 503.

2.2 Basis for Cost Estimates

Estimates of the project and operation and maintenance (O&M) costs associated with the preferred treatment alternatives were prepared and used during the evaluation process. All cost estimates prepared as part of the Facilities Plan are order-of-magnitude estimates, as defined by the American Association of Cost Engineers (AACE). An order of magnitude estimate is one that is made without detailed engineering data, and uses techniques such as cost curves and scaling factors from similar projects. The overall expected level of accuracy of the cost estimates presented is +50 percent (%) to -30(%). This is consistent with the guidelines established by the AACE for planning level studies.

2.2.1 Project Costs

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

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

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

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

2.2.2 Operation and Maintenance Costs

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

2.2.3 Net Present Worth Methodology

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

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

NPW = PWp + PWO&M

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

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

The factors used are:

- Planning period: 20 years (2015 to 2035)
- Interest rate (assumes ADEC State Revolving Fund (SRF) loan): 1.5%
- General inflation: 2.0%

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

3 Wastewater Treatment Facilities

3.1 Service Area Description and Land Use

The City of Soldotna is certificated to provide sanitary sewer collection services to the entire City and an area surrounding the City. The 2015 Soldotna Wastewater Master Plan, prepared concurrently with this Plan, evaluates the sewage collection system in detail. The following section summarizes portions of the wastewater master plan.

3.1.1 Existing Sewer Collection System

The City operates the public sewer system serving a portion of the City of Soldotna and several individual parcels adjacent to the City sewer pipe network but outside the city limits. The City also provides sewer service to the Kenai National Wildlife Refuge visitor's center on Ski Hill Road through a private sewer lateral from the visitor center to the City system on Funny River Road. The sewer system is shown in Figure 1.

The existing sanitary sewer collection system has 1,271 connections, which represents a population of approximately 3,380 people, or approximately 77% of the current City population. The parcels connected to the sewer collection system are shown in Figure 1.

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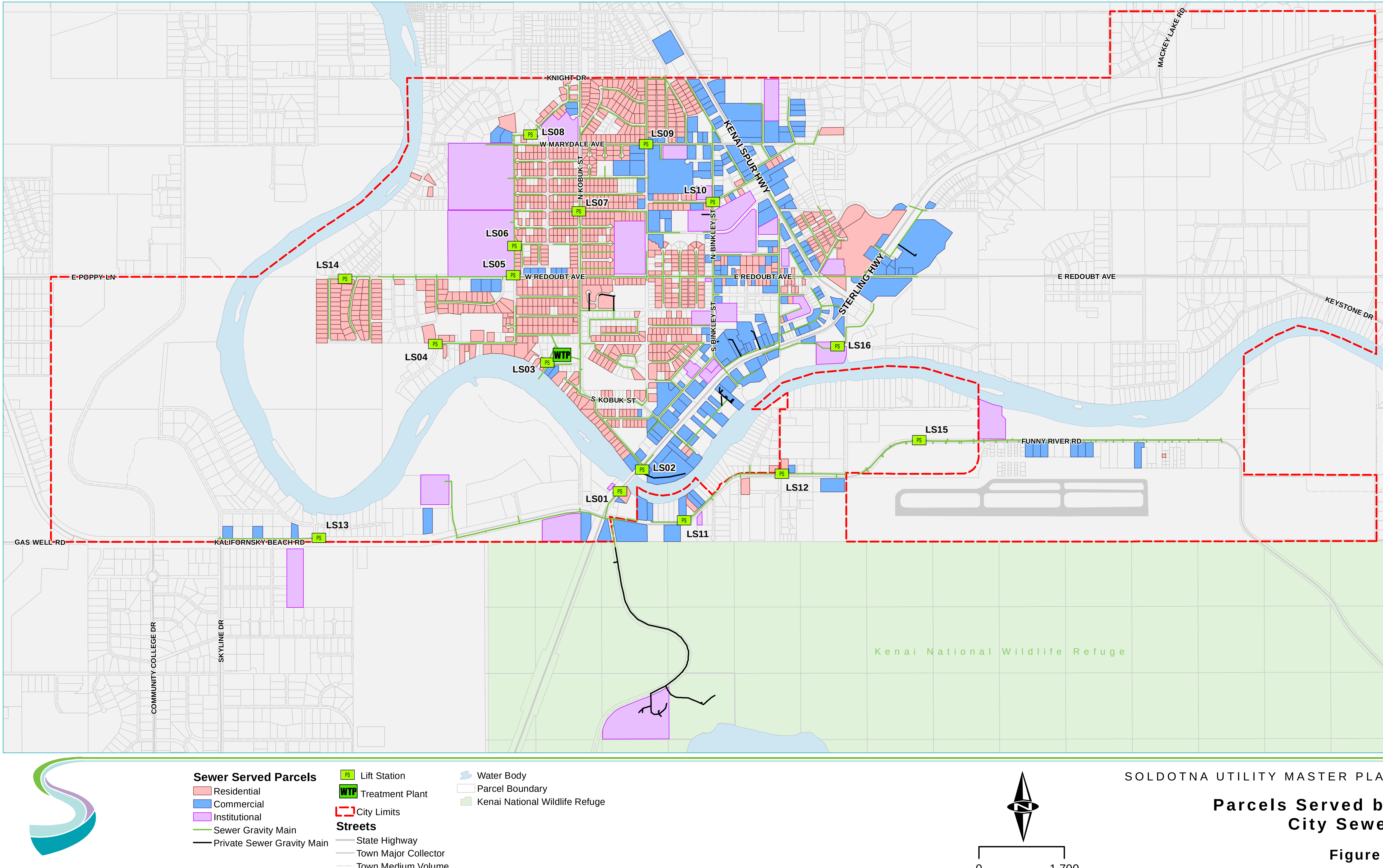

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Parcels Served by City Sewer

Figure 1

HDR

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3.1.2 Land Use

Land use for the years 2015 through 2035 was analyzed for the planning period. The City and Kenai Peninsula Borough (KPB) comprehensive planning process establish land use policies in the City and adjacent KPB lands. These policies were used as the basis for the 2015 WWMP and this Facility Plan Update and are summarized below.

City of Soldotna

The plan *Envision Soldotna 2030 Comprehensive Plan* provides for further development of commercial properties on the Sterling and Kenai Spur Highway corridors with additional mixed use development around the hospital. Higher density single and multi-family residential areas will generally remain the same and will infill the remaining parcels with development. These areas will connect to the sewage collection system. Rural residential areas to the east of the city center are assumed to not require City sewer in the planning period.

Ridgeway Census Designated Places

Bordering the City limits to the north is the Ridgeway Census Designated Place (CDP). This area contains the Kenai Spur Highway commercial corridor and a higher density residential area. Adjacent to the northern City limit and beyond this are rural residential areas and vacant land. Commercial and residential growth in this area is projected to continue through the planning period. Because of the adjacent commercial district of the City, commercial growth will likely be greater nearer to the City limit. Residential growth will be slower than the Kalifornsky CDP because there is less available land for such development. Rural residential areas are assumed to not require City sewer in the planning period.

Kalifornsky Census Designated Places

Bordering the City limits on the west and south is the Kalifornsky CDP. This area contains Kalifornsky Beach Road commercial corridor and a small area of higher density residential area near the western City limit. Beyond these are rural residential areas and vacant land. This was the fastest growing area in the KPB in the past decade and is projected to continue to grow rapidly through the planning period. Residential growth will be greater than the Ridgway CDP because there is more available land for such development. Rural residential areas are assumed to not require City sewer in the planning period.

3.2 Population and Population Served Forecasts

Population projections, and corresponding flows and loads, presented in this Facility Plan are largely based on the findings documented in the 2015 Wastewater Master Plan (HDR Alaska, Inc.).

The Soldotna Planning Department made future population estimates for the City in the *Envision Soldotna* 2030 Soldotna Bowl Comprehensive Plan. The comprehensive plan estimates were completed in 2009. These projections were based on growth of 7% per decade, or 0.70% per year, through 2030.

The Alaska Department of Labor and Workforce Development (DLWD) Research and Analysis Section prepared populations projections for Alaska and Boroughs. Most recently updated in 2012 this data projects population from 2012 through 2042. DLWD population projections only cover the State of Alaska and KPB. DLWD does not prepare projections for areas smaller than boroughs. The portion of the DLWD projected growth rates applicable to this plan's planning period are shown in Table 3. These projections show a declining growth rate through the planning period.

Table 3. DLWD Estimated Annual Population Growth Rates 2012-2037

Year	Alaska	KPB
2012-2016	1.01%	0.85%
2017-2021	0.91%	0.72%
2022-2026	0.80%	0.55%
2027-2031	0.70%	0.38%
2032-2037	0.64%	0.24%

To evaluate issues related to wastewater planning population projections for the City and adjacent Ridgeway CDP and Kalifornsky CDP are needed. However, because of the differences between the Soldotna Comprehensive Plan and DLWD population projections, neither of these is directly applicable for this plan. To prepare population estimates for this plan the following assumptions were made.

- The City of Soldotna will continue to grow at a greater rate than the KPB as a whole, as has been the case for the past decade.
- The Kalifornsky CDP will continue to grow at a faster rate than the City of Soldotna, as has been the case for the past decade.
- The Ridgeway CDP will continue to grow at a similar rate as the City of Soldotna, as has been the case for the past decade.
- Growth rates over the planning period will slow at the rate indicated for KPB by DLWD projections.
- The City of Soldotna, Ridgeway CDP, and Kalifornsky CDP will continue to be the fastest growing areas in the KPB and will receive a greater proportion of the total projected KPB population growth during the planning period.
- The total population growth projected by DLWD for the KBP will hold for the planning period. That is to say, the growth rates selected for the City, Ridgeway CDP and Kalifornsky CDP could not result in a larger KPB population than estimated by the DLWD. Adopting this criterion allowed for higher growth rates in the planning area but maintained the total KPB population equivalent to DLWD projections.

These criteria were used to develop growth rates and population estimates for use in this plan. The selected growth rates that provided the best fit estimate to the available data are shown in Table 4.

Table 4. Estimated Annual Population Growth Rates 2012 – 2037

Year	KPB	City of Soldotna	Ridgeway CDP	Kalifornsky CDP
2012-2016	0.85%	1.00%	1.00%	1.20%
2017-2021	0.72%	0.87%	0.87%	1.07%
2022-2026	0.55%	0.70%	0.70%	0.90%
2027-2031	0.38%	0.53%	0.53%	0.73%
2032-2035	0.24%	0.39%	0.39%	0.59%

The selected growth rates in Table 5 were used to prepare population estimate for the planning area through the planning period. These are presented in Table 5. The selected growth rates project a slightly greater population in the City in 2030 than is projected in the comprehensive plan, 4,881 versus 4,674.

Table 5. Estimated Planning Area Population 2016 – 2035

Year	KPB	City of Soldotna	Ridgeway CDP	Kalifornsky CDP
2016	58,721	4,419	2,146	8,432
2020	60,508	4,575	2,222	8,799
2025	62,401	4,745	2,305	9,218
2030	63,811	4,881	2,371	9,575
2035	64,761	4,983	2,421	9,875

The number of people connected to the sewer system in 2015 is estimated to be approximately 77% of the total City population. Some portion of the future development and population growth within the City limits will be in areas outside the sewer service areas. For planning purposes, it is assumed that 75% of population growth in the City will be in areas currently serviced by water and sewer. The remaining 25% of the City's growth in the planning period will use private on-site septic systems.

Not all buildings adjacent to the City sewer system are connected to it. Analysis of KPB parcel data and City sewer service data shows that approximately 80 parcels with buildings, either residences or other properties, are adjacent to the wastewater system but not connected to it. Owners of these buildings can connect to the wastewater system and do, for various reasons. It is assumed that this will continue during the planning period. For planning purposes it is assumed that those properties that currently front sewer laterals but do not have a service connection will become connected sometime over the next 20 years. It is assumed that the same number of people will be added to the system each year and all parcel residents will be connected by the end of the planning period.

The served population growth from population increase was added to the additions to the system from parcel connections. Served population will include customers within and outside the city boundary, as is does now. Table 6 shows the projected population served by wastewater in the City through 2035.

Table 6. Project City of Soldotna Population Served by Sewer, 2016 to 2035

Year	Projected Population Served (number)	Projected Population Served (percentage)
2016	3,417	77%
2020	3,550	78%
2025	3,698	78%
2030	3,819	78%
2035	3,915	79%

3.3 Wastewater Flow and Loading Projections

As discussed, population projections and flows and loads presented in this Facility Plan are largely based on the findings documented in the 2015 Wastewater Master Plan (HDR Alaska, Inc.). However, this facilities plan included a review of historical plant flow and loads dating from 2005 to present.

Wastewater flow projections are the fundamental criteria on which the sizing and design of collection and treatment facilities are based. To identify and characterize future wastewater flows for the planning period of this Facility Plan Update, historical flow data and treatment plant records have been evaluated. This chapter presents results of an analysis of wastewater flow data and establishes annual average and peak variations in flow and loads. This chapter also includes projections of future wastewater collection and treatment requirements based on served population estimates presented in Section 3.2.

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

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

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

3.3.1 Existing Wastewater Flows and Waste Loads

Available data was obtained from the City staff for current wastewater flow rates and loadings. The historical records from 2005 to 2014 provided an extensive record of the quantity and quality of wastewater collected, treated, and released. Combined with population data and commercial/industrial flow assumptions, per capita flow and load contributions were determined for projected flows and loads.

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

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

A detailed analysis of I&I into the system has not been conducted for the Soldotna sanitary sewer system. For this plan, influent raw wastewater flow data for the past three years was compared with rainfall data to identify correlations between high influent flows and weather events that contribute to I&I. Review of this data found that typical I&I events (such as high rainfall events or high snowmelt events) can significantly increase peak flows to the WWTP. Maximum day and peak hour flows generally correspond to significant rain events in the area; the peak hour flows can also be exaggerated by multiple pump station discharges combining at the WWTP. The peak flow seen at the plant in 2015 was approximately 3.16 million gallons per day (MGD), which exceeds the hydraulic capacity of several treatment plant processes, as discussed in the following sections.

The Soldotna WWTP currently accepts no hauled wastes. Hauled wastes typically include septage, leachate, and sewer vacuum truck contents. Trucks containing these materials currently haul the waste to disposal facilities in KPB.

Wastewater Flow and Load Data Analysis

An analysis of the existing flow and load data offers insight into the raw wastewater characteristics seen at the plant and provides a general operational understanding. As illustrated in Figure 2 and Figure 3 below, WWTP influent flows follow a fairly typical pattern seen in Anchorage and throughout the United States – they are decreasing relative to the loads as a result of water conservation as a whole (i.e. increasing saturation with more efficient fixtures and appliances). Also shown in Figure 2 and Figure 3 is the influent wastewater strength. As shown, since 2010 the influent biological oxygen demand (BOD) concentrations have been increasing which correlates to the decrease in flow.

While the influent strength is increasing, Figure 4 and Figure 5 illustrate that the influent loads have remained relatively constant over a 10-year period. The graph shows slightly increasing seasonal peaks since 2010, which is likely due to tourism picking back up following the economic downturn.

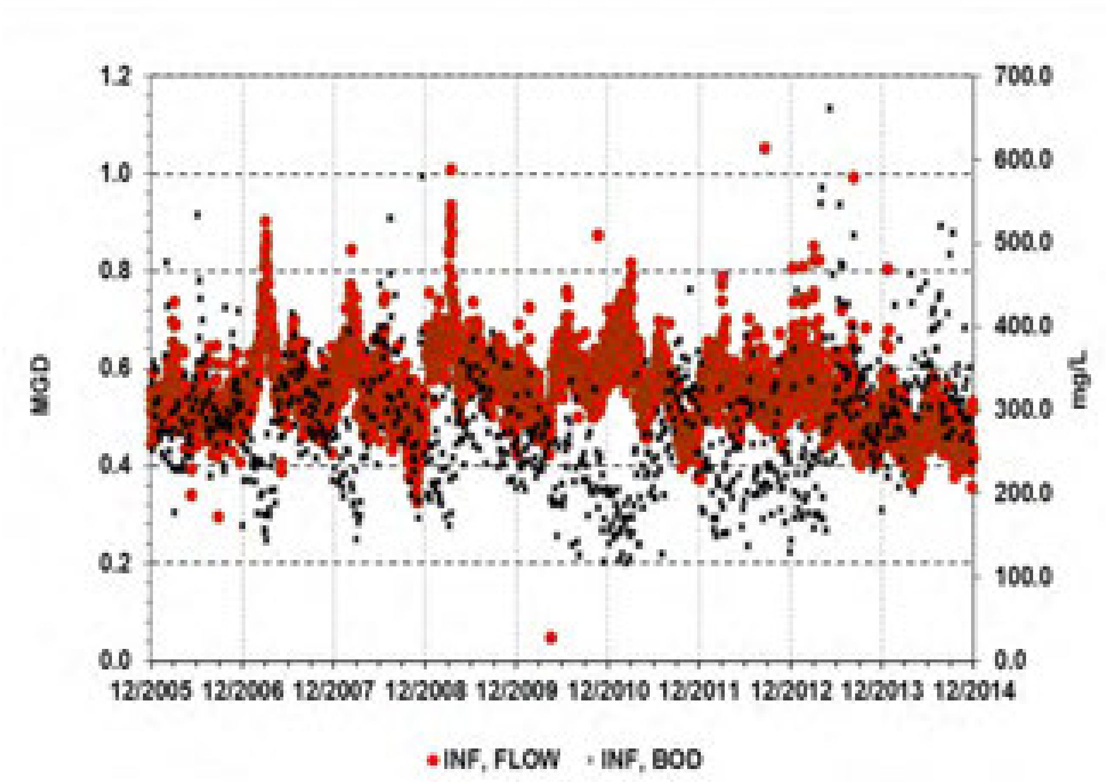

Figure 2. Existing WWTP Influent Flows and BOD, 2005 – 2014

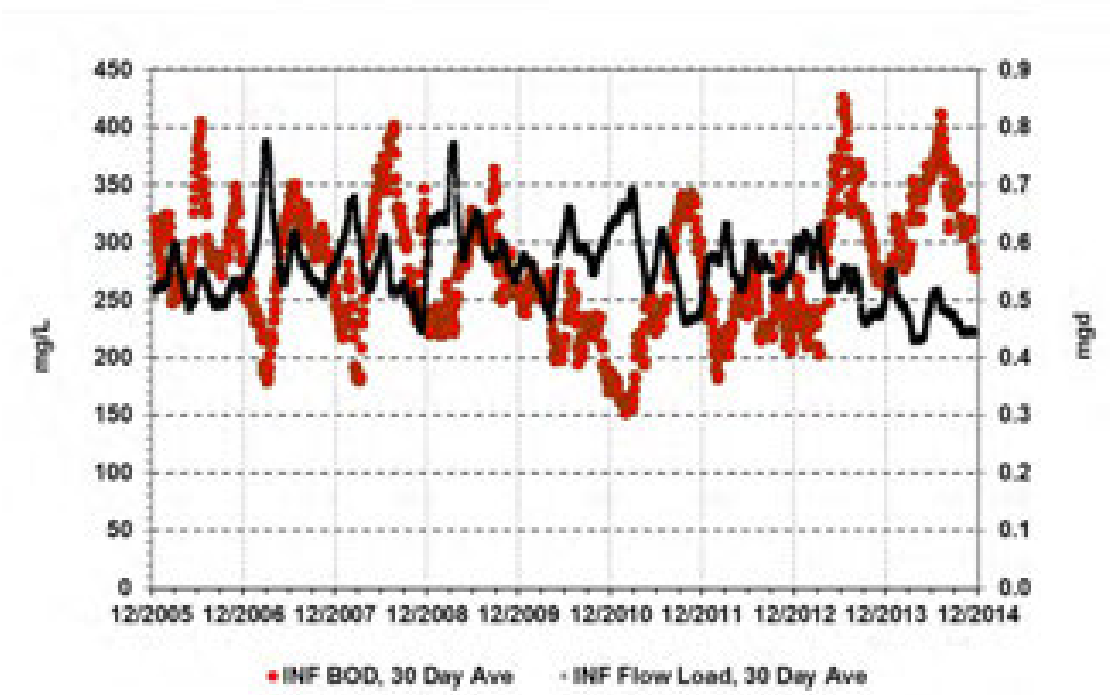

Figure 3. Existing WWTP Influent 30-Day Avg. BOD and Flow, 2005 – 2014

As discussed, the WWTP shows typical influent patterns for plants with I&I issues: large influent flow peaks and substantial influent total suspended solid (TSS) spikes without corresponding BOD peaks, which suggests the spikes are largely inert solids. This is typical of a system that receives large inflows due to significant rain events and breakup each spring. Figure 4 and Figure 5 show influent TSS levels compared to influent BOD levels.

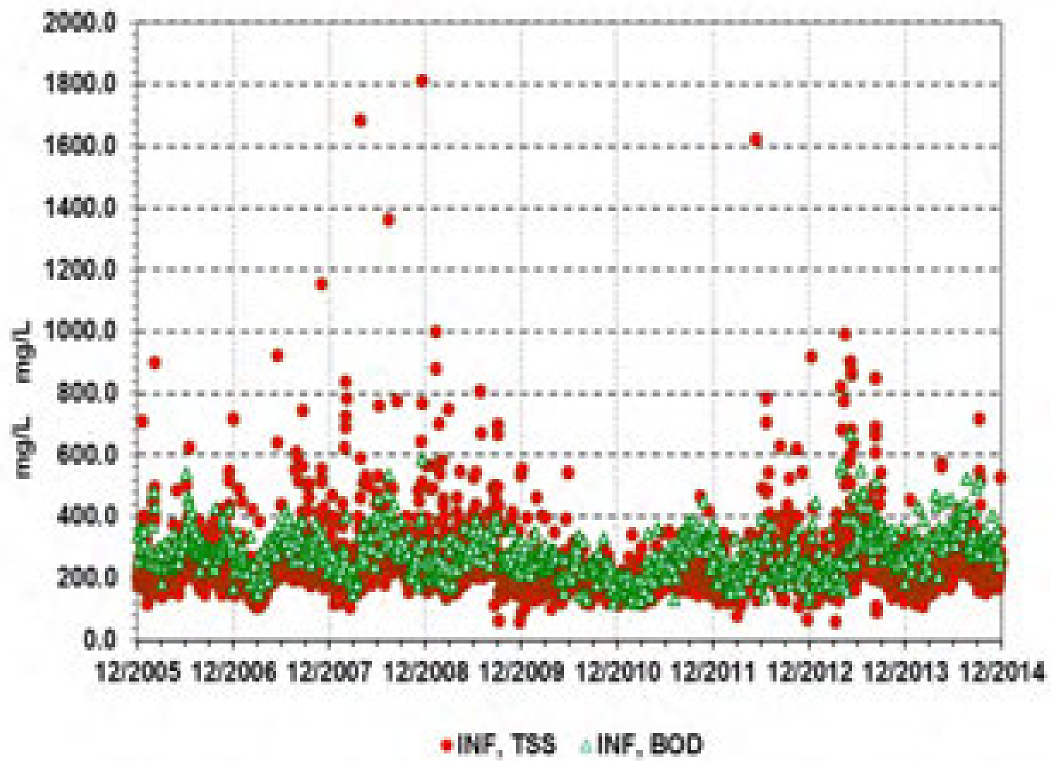

Figure 4. Existing WWTP Influent TSS and BOD, 2005 – 2014

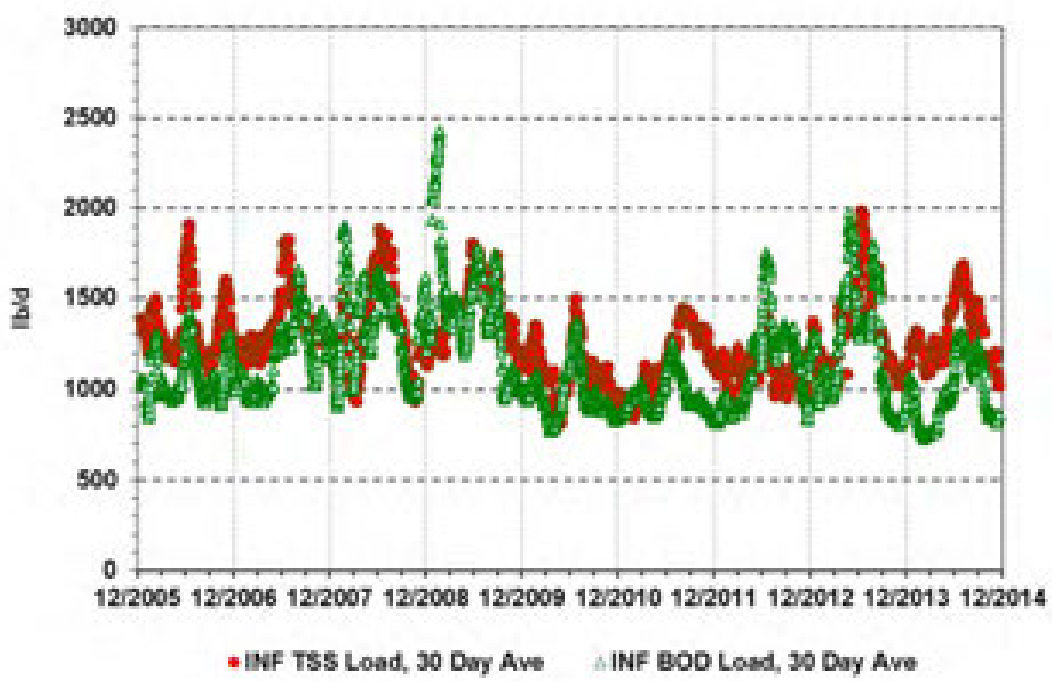

Figure 5. Existing WWTP Influent 30-Day Avg. TSS and BOD Loads, 2005 – 2014

The flows and loads used for design assumptions in the Plan evaluation were determined using statistical analysis (log normal percentiles). Both flows and loads were determined to distributed log normal, which is typical for municipal wastewater. An analysis of summer and winter conditions indicated that the plant sees distinct seasonal fluctuations driven largely by summer tourism and winter bleeding practices. Given the variation in conditions, design criteria were developed for both summer and winter influent flows and loads. The winter loads were determined by averaging the three months that historically have the lowest temperatures (January – March) and applying the same maximum to average and maximum day to average ratio calculated from the annual flows and loads. The results from the statistical analysis of the past three years are summarized in Table 7.

Table 7. 2012 – 2014 WWTP Flows and Loads (Rounded)

Parameter	Unit	Average	Maximum Month	Maximum Day
Summer				
Flow	mgd	0.52	0.63	0.73
TSS	lb/d	1,125	1,900	3,625
BOD	lb/d	1,250	1,800	2,700
Temperature	°C	13	13	13
Winter				
Flow	mgd	0.56	0.68	0.78
TSS	lb/d	950	1,604	3,061
BOD	lb/d	1,150	1,656	2,484
Temperature	°C	6	6	6

3.3.2 Projected Wastewater Flows and Waste Loads

The future flows and loads have been projected linearly at an annual growth rate of 1.0%. This growth rate is slightly higher than that derived for population growth and is used to provide a conservative approach to facility planning because plant improvements take multiple years to construct and are generally large expenses for a utility.

Even though the influent flows are trending down, it was assumed that the wastewater composition remains the same, meaning flows and loads increase at the same rate. All biological unit processes are sized based on load thus the long-term effect of water conservation can be neglected in the context of the 20-year planning horizon.

The projected influent wastewater composition for 2035 is provided in Table 8 for summer conditions and Table 9 for winter flows and loads.

Table 8. 2035 Summer Wastewater Composition

Parameter	Unit	Average	Maximum Month	Maximum Day
Flow	mgd	0.64	0.77	0.89
TSS	lb/d	1,345	2,301	4,411
BOD	lb/d	1,513	2,175	3,277
TSS	mg/L	253	358	592
VSS*	mg/L	227	322	533
COD*	mg/L	284	339	440
sCOD*	mg/L	114	135	176
ffCOD*	mg/L	597	711	924
BOD	mg/L	179	213	277
sBOD*	mg/L	89	107	139
VFA*	mg/L	8.9	10.7	13.9
TKN*	mg/L	48	58	75
NH_4-N*	mg/L	32	39	50
TP*	mg/L	5.7	6.8	8.8
PO_4-P*	mg/L	2.8	3.4	4.4
ALK	mg/L	250	250	250
* assumed values using typical ratios relative to BOD				

Table 9. 2035 Winter Wastewater Composition

Parameter	Unit	Average	Maximum Month	Maximum Day
Flow	mgd	0.68	0.82	0.96
TSS	lb/d	1,159	1,958	3,735
BOD	lb/d	1,403	2,021	3,031
TSS	mg/L	203	285	469
VSS*	mg/L	183	256	422
COD*	mg/L	246	294	380
sCOD*	mg/L	98	118	152
ffCOD*	mg/L	517	617	798
BOD	mg/L	155	185	240
sBOD*	mg/L	78	93	120
VFA*	mg/L	7.8	9.3	12.0
TKN*	mg/L	42	50	65
NH_4-N*	mg/L	28	33	43
TP*	mg/L	4.9	5.9	7.6
PO_4-P*	mg/L	2.5	2.9	3.8
ALK	mg/L	250	250	250
* assumed values using typical ratios relative to BOD				

3.4 Existing Wastewater Treatment Facilities

The following section identifies the existing unit processes at the Soldotna WWTP and provides plant performance history.

The existing Soldotna WWTP provides preliminary and secondary treatment. Influent flow is screened and de-gritted before entering the activated sludge process. Secondary effluent is disinfected with UV before discharge to the Kenai River. Waste active sludge from the secondary treatment process is pumped to the aerobic digester. Periodic decanting is employed to thicken the digester content and extent the solids retention time. Before dewatering and disposal at a local landfill the (partially) digested solids are stabilized via inline lime addition. Figure 6 shows the process schematic and Figure 7 provides an existing site plan for the facility.

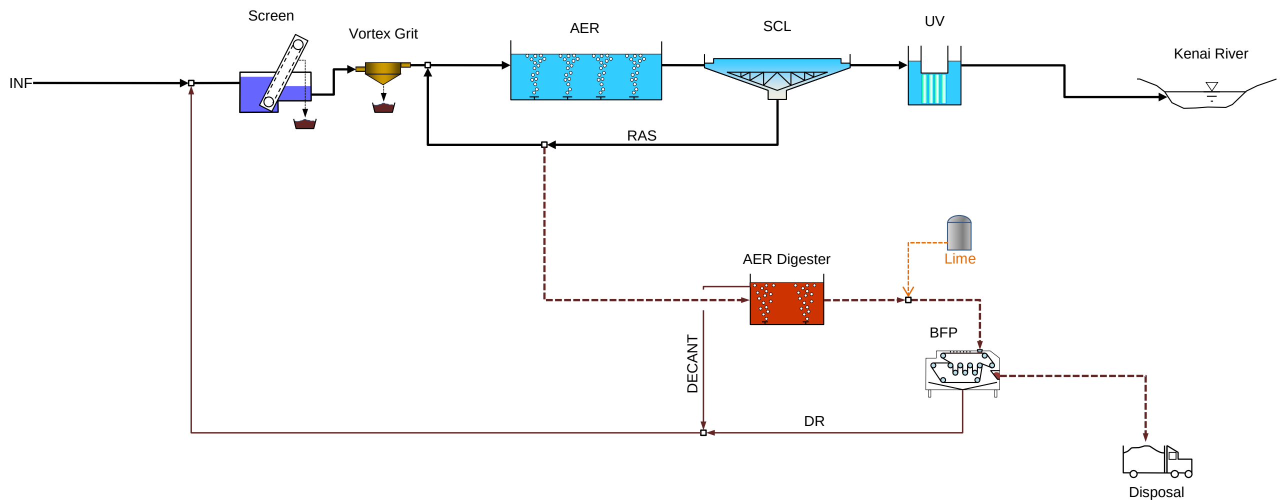

Figure 6. Schematic Representation of the Existing Soldotna WWTP

3.4.1 Unit Process Review and Evaluation

The Soldotna WWTP is a secondary treatment plant using an extended aeration process followed by disinfection. The following sections describe each of the existing unit processes and include the results of a facility condition assessment and known deficiencies. Figure 8 represents the existing Soldotna WWTP process flow diagram

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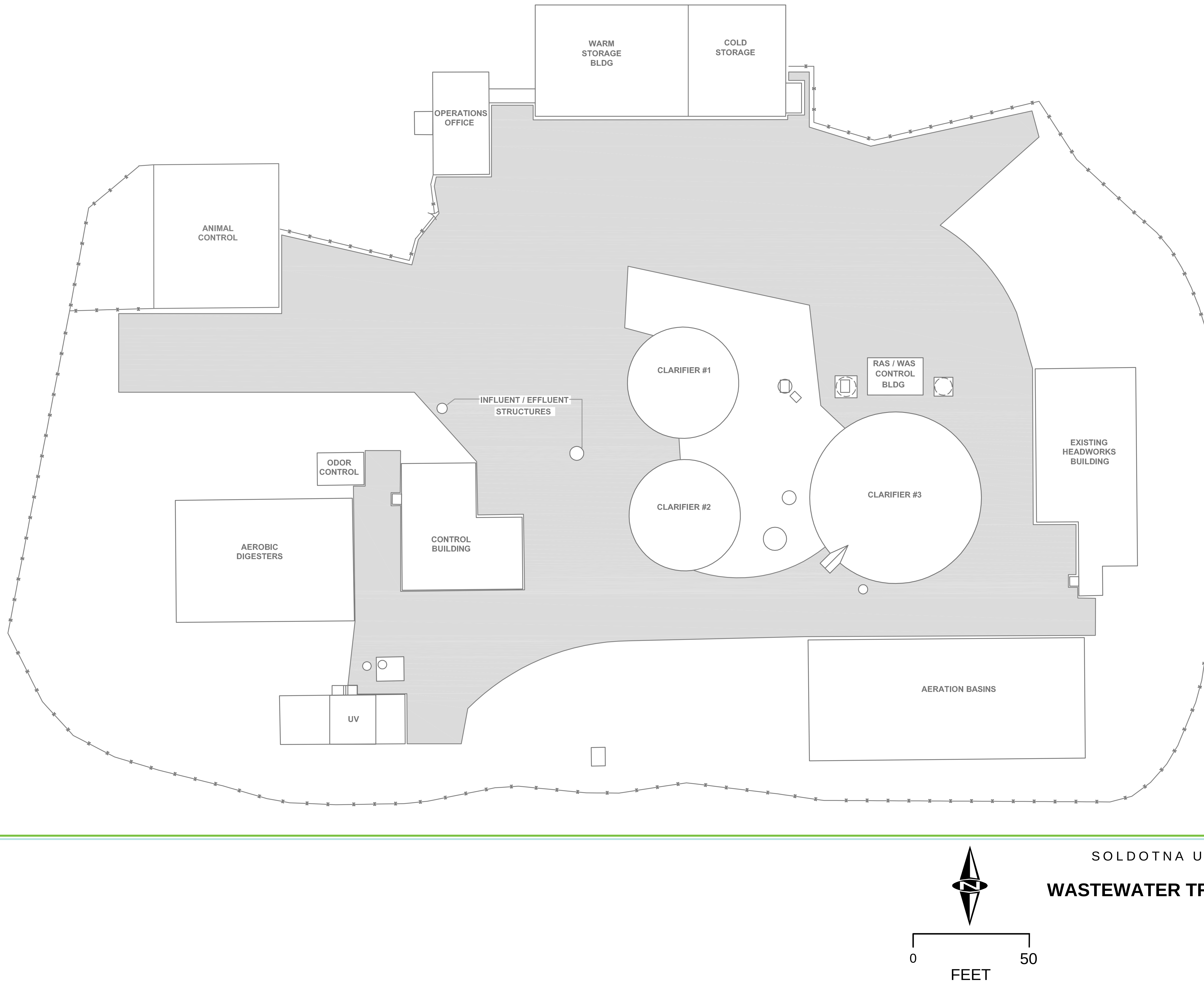

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

WASTEWATER TREATMENT FACILITY

EXISTING SITE PLAN

FIGURE NUMBER 7

HDR

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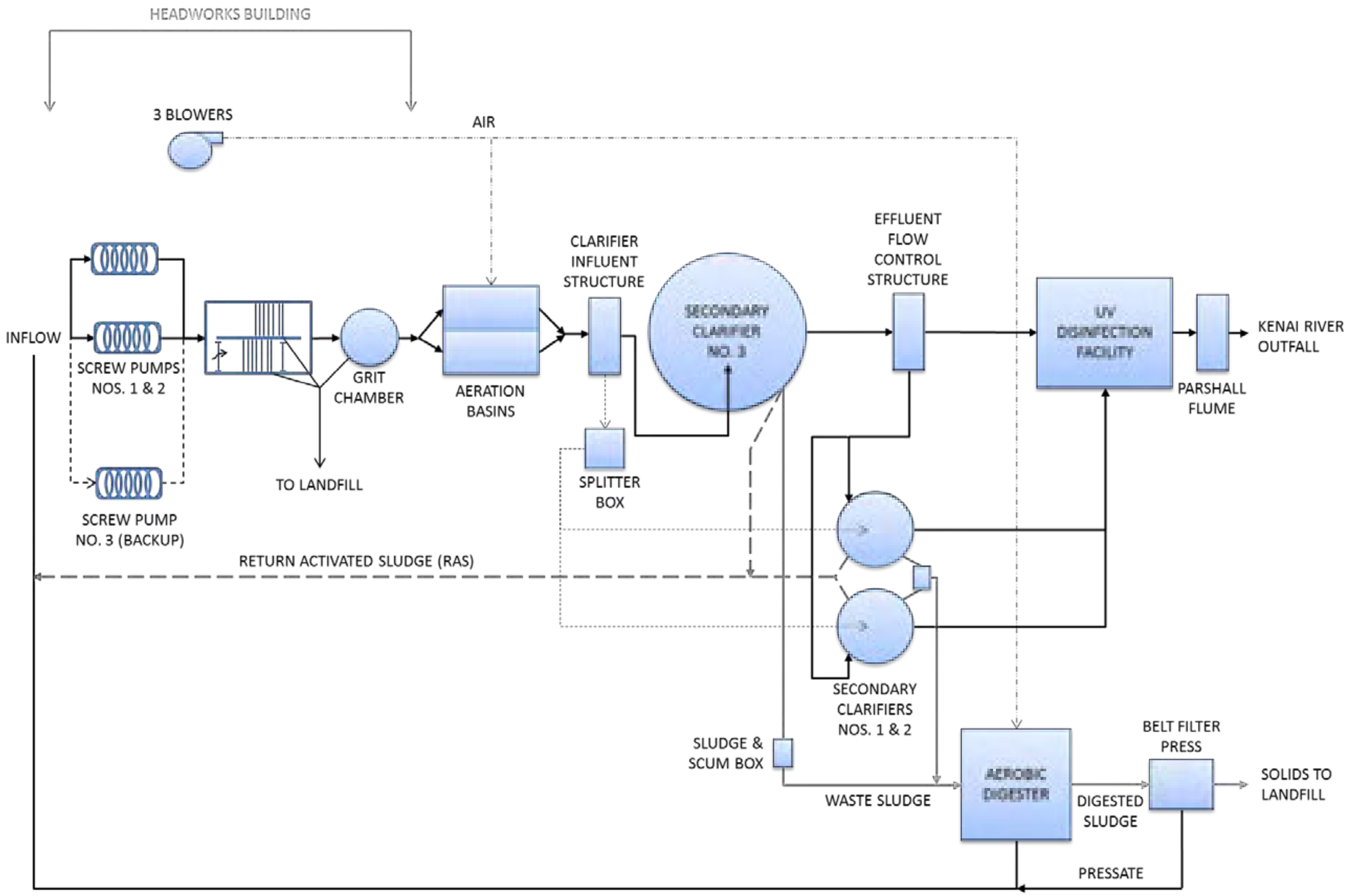

Figure 8. Soldotna WWTP Process Flow Diagram

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Headworks

The Headworks Building, Figure 9, houses the influent screw pumps, influent sampler, screens, grit chamber, and a Parshall flume for influent flow measurement. The facility also houses an abandoned standby generator, aeration blowers and controls, and odor control components that are no longer in use. The building's existing heating, ventilating, and air conditioning (HVAC) had a history of maintenance problems due to corrosion, which required a replacement of the system in 2006. The following sections discuss the Headworks Building, electrical service, equipment, and treatment processes inside of the Headworks Building.

Figure 9. Soldotna WWTP Existing Headworks Building

Headworks Building Evaluation

The Headworks Building was designed in 1979 and built in 1980 with additions in later years to include a storage area and boiler room. The roof was replaced, except over the screw pump area, and rooftop ventilation equipment was removed during a 1994 project.

The existing Headworks Building was designed and constructed prior to the adoption of the "National Fire Protection Association (NFPA) 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities" in 1990. Previous additions of this code required that all electrical components within 36 inches of the floor be rated "Class I, Division1, Group D" and the design complied with the code at the time. The significance of this rating is that all electrical components and equipment are to be rated for explosion proof service. The current edition of the code requires that all components in the presence of raw wastewater (Headworks Building) be rated for Class I, Division 1, Group D service. At this time, there are no components in the Headworks Building that have the explosion proof rating. In addition, there is no separation between the treatment area and the blower room, and blower intake air is drawn from the whole building. The blower room contains the building electrical service, Motor Control Center (MCC), distribution switchgear and a nonfunctioning standby generator. The electrical switchgear and generator are not allowed in a room connected to the screw pump and grit separation area, which would be classified as a hazardous location per NFPA 820.

Currently, the roof of the Headworks Building (Figure 10) over the screw pump area has significant leaks and is at the end of its useful life. It should be replaced as soon as possible if the existing Headworks Building is maintained with future upgrades or the City intends to keep the building for future use of any kind.

Figure 10. Soldotna WWTP Headworks Leaking Roof over Screw Pumps

Open water in the building results in high humidity in the building and a corrosive environment, Figure 11. This situation is exacerbated during cold winter conditions when condensation becomes a significant problem since the Headworks Building is a CMU block building structure with insulation on only one wall. The uninsulated walls and high humidity environment has lead to additional maintenance costs in the building. For example, unit heaters are changed frequently due to corrosion.

Building ventilation is non-existent, and the heating system is inadequate to maintain reasonable temperatures within the building. The boiler that was recently installed is rated at 153,000 BTUH output, and serves hydronic unit heaters in the process and storage areas. The unit heater coils foul rapidly and require frequent cleaning, but are not capable of maintaining reasonable temperatures. Corrosion of piping and supports has occurred with exposed copper severely affected.

Figure 11. Examples of High Humidity and Poor Building Ventilation Causing Highly Corrosive Environment

As part of any preliminary design or full design involving the Headworks Building should include a structural analysis. There is concern that the structural reinforcing on the CMU superstructure may be limited and not meet design standards. The City should proceed with field verification with nondestructive testing to confirm the adequacy of the reinforcing, if the Headworks Building is to remain in the future.

Electrical Service and Standby Generator

The electrical service is provided by Homer Electric Association. It is a 400 amp, 480 volt, three-phase service. In 2001, the City added a multiple feed to improve reliability. In the event one of the two power transmission systems experiences difficulties, the redundant feed should be available. In addition, transformers provide power for low voltage equipment (for example: 240, 208, and 120 volt) through distribution panels.

A 50 kilowatt emergency generator with an automatic transfer switch is located in the Blower Room and is currently not in use. The Back-up power served select lighting panels, RAS pump 1, influent pumps 1 and 2, conveyor 1, clarifier drives 1 and 2, bar screens and chemical pumps.

Headworks Equipment

The influent flow to the Soldotna WWTP first enters the Headworks Building through a 24-inch line flowing by gravity into the influent pumping station, which consists of three screw pumps located side-by-side, Figure 12. A weir plate separates the wet well for each pump. Two of the pumps are used for influent pumping and the third pump can be used as a backup to increase forward flow through the WWTP, which can be accomplished by removing the weir plate between the wet well sections. Each pump is equipped with a 10 horsepower (HP) V-belt motor. Screw pumps 1 and 3 were rebuilt in 2007 and 2009, respectively. Screw Pump 2 has not been rebuilt. Table 10 shows the screw pumps' manufacturer, size, capacity and motor power.

Table 10. Influent Pumping Information

Description	Value
Manufacturer	CPC Engineering
Number of Pumps	3
Type	Screw pump
Size	30 inch
Capacity	1,215 gpm (1.75 MGD) each
	1,215 (1.75 MGD) firm
	2,430 gpm (3.50 MGD) total
Motor power	10 hp

Figure 12. Influent Screw Pumps

Figure 12 shows the influent wet well and pumping area. The plant staff indicates that the screw pumps have been reliable and they like the current influent pumping system. With all three pumps operating, the influent pump station has the capacity to handle the peak flows currently seen at the plant as well as projected future flows, assuming I&I flows do not increase significantly. Reducing I&I peak flows to the facility would help insure the current pumps could meet all peak hour flow events during the planning period.

Screening

Flow from the screw pumps continues through a mechanical filter screen consisting of 5/8-inch openings with a backup 1-inch opening bar screen. The primary screen, the mechanical screen, deposits screenings into a chute for collection and disposal at the landfill. The backup screen, the bar screen, is located in a bypass channel parallel to the mechanical screen.

The mechanical screen is a Parkson Aquaguard installed around 1993. Table 11 shows the screen manufacturer and Figure 13 shows the existing screening equipment. Plant staff indicated that they are satisfied with the equipment. From visual inspection of the equipment there did not appear to be any broken teeth on the screen. There is currently no washer or compactor for the screenings and this should be considered in any facility upgrade. Although, the plant staff indicated they do not mind the current disposal method for the screenings and grit with a wheel barrow and skid loader. Accumulated screenings and grit quantities are approximately 20 cubic feet every two days.

Table 11. Mechanical Bar Screen Information

Description	Manufacturer
Mechanical Barscreen	Parkson Aquaguard

Figure 13. Existing Mechanical Bar Screen and Screenings Disposal

The rated capacity of the current screen appears to be satisfactory. The screen has a reported rated capacity of 3.5 MGD and should be adequate for most flows seen at the plant. The equipment is old, however, and may not provide the removal efficiency it once did. Based on information obtained from plant staff regarding the accumulation of solids in downstream unit processes, it is likely that the screening equipment is not adequate for peak hour flows. Screening capacity should be verified to ensure adequate capacity exists.

Grit Removal

A single 10’x10’ Deritus™-type horizontal grit chamber is used for grit removal, Figure 14. Wastewater enters the grit chamber through an influent box with flow-straightening vanes. The vanes promote uniform flow across the chamber. Inside the grit chamber, a rotating rake moves grit to a collection area. A grit screw conveys grit out of the chamber, where it is deposited in a wheelbarrow and manually loaded onto a conveyor belt, covered with lime, and then hauled to the landfill for disposal. The original screw conveyor was modified by plant staff shortly after installation. Grit quantity is about 1 full wheel barrow a day. The bucket is dumped every other day. Table 12 shows the manufacturer and other parameters of the grit chamber and Figure 14 shows the existing grit equipment and conveyor.

Table 12. Grit Removal Information

Description	Value
Manufacturer	Peabody Wells
Number of Units	1
Area	100 SF
Capacity	2.8 MGD
Overflow rate at peak	17,000 gpd/SF

Figure 14. Existing Grit Removal Equipment and Screw Conveyor

The grit chamber performance is primarily dependent on flow rates. The theoretical capacity of the unit for 50 degrees (°) F liquid temperature, the normal temperature of the sewage in the Soldotna WWTP, is 2.8 MGD. The theoretical required capacity, with consideration for future maximum daily flow rates of the grit system for 2035, is 0.89 MGD. The capacity is adequate for maximum daily flows at this time; however, the system may be inadequate for peak hour events. As peak hour flows exceed 2.8 MGD, it is likely the grit removal system is not effectively removing grit from the wastewater stream and allowing solids to accumulate in downstream unit processes (the aeration basins).

The age of the grit system is beyond its expected useful life with over 30 years in operation. Replacement of the grit system would reduce its risk of failure. The grit removal screw pump is now 25 years old and is also at the end of its expected useful life. Its original design was immediately modified due to bearing failure problems. It has performed well since the initial modifications were made. This system should be considered for replacement due to its service age.

3.5 Biological Treatment Process

The biological treatment process is composed of two components: aeration basins and secondary clarifiers. Aeration basins were designed to provide an environment to oxidize BOD and ammonia in the wastewater. The secondary clarifiers were designed to separate solids from the treated wastewater to permit return of the biological components to the aeration basins.

3.5.1 Activated Sludge System – Aeration Basins

The activated sludge system consists of two parallel aeration basin trains each 115 feet long, 23 feet wide, and a wastewater depth of 16 feet. Both basins are located under an aluminum cover with a walkway in the center. Typically, one basin is operated until the influent flow reaches 0.60 MGD then the second basin is brought into service.

In the fall, one basin is taken off-line to be drained and cleaned. During this time, maintenance is also performed on the diffusers. During the winter time, air is continually blown through the diffusers in the empty basin to reduce condensation in the Aeration Basin Building. In 2006, the original coarse bubble diffusers were replaced with new fine bubble diffusers to improve oxygen transfer and efficiency in the basins. The existing diffusers are Sanitaire 9” membrane disc diffusers with 468 diffusers installed per tank; or a total of 936 aeration basin diffusers.

Dissolved oxygen (DO) probes are located at the head of the basins. The plant staff should consider relocating the probes to approximately one third of the way down the tanks to optimize operation. The air rate is controlled based on set oxygen levels at the DO probes with a control valve on each of the supply lines to the basins. There are no other zone controls for the basins. Typically, the DO target level is 2 to 3 mg/L. The addition of more controls over the DO in the basins would provide better operational flexibility.

Current Basin Operation

DO has been increasing in the aeration basins over the years. Operators indicate this is to manage growth of filamentous organisms in the aeration basins. Figure 15 presents aeration basin DO between 2005 and 2014.

The Mixed Liquor Suspended Solids (MLSS) maintained in the aeration basins appears to vary significantly, as illustrated in Figure 16. Operators cite lack of control of the RAS/WAS pumps as a reason for varying MLSS. Concentrations can reach 4,000-5,000 mg/L, which is not necessarily problematic, but the operational goal for the facility is approximately 3,200 mg/L. While higher MLSS concentrations aren’t necessarily problematic, the rapid changes in MLSS can be problematic – no bioreactor performs well under rapidly changing conditions. Variations can occur when trying operational changes in the RAS/WAS, or when basins are taken offline for winter operation.

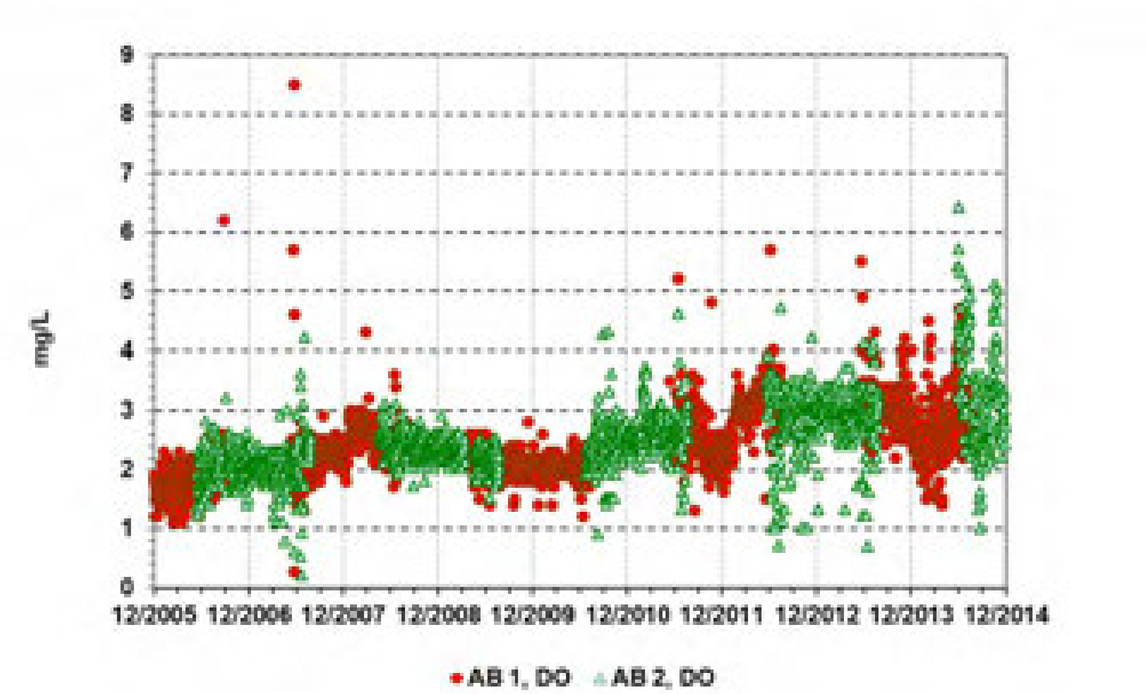

Figure 15. Aeration Basin Dissolved Oxygen, 2005 – 2014

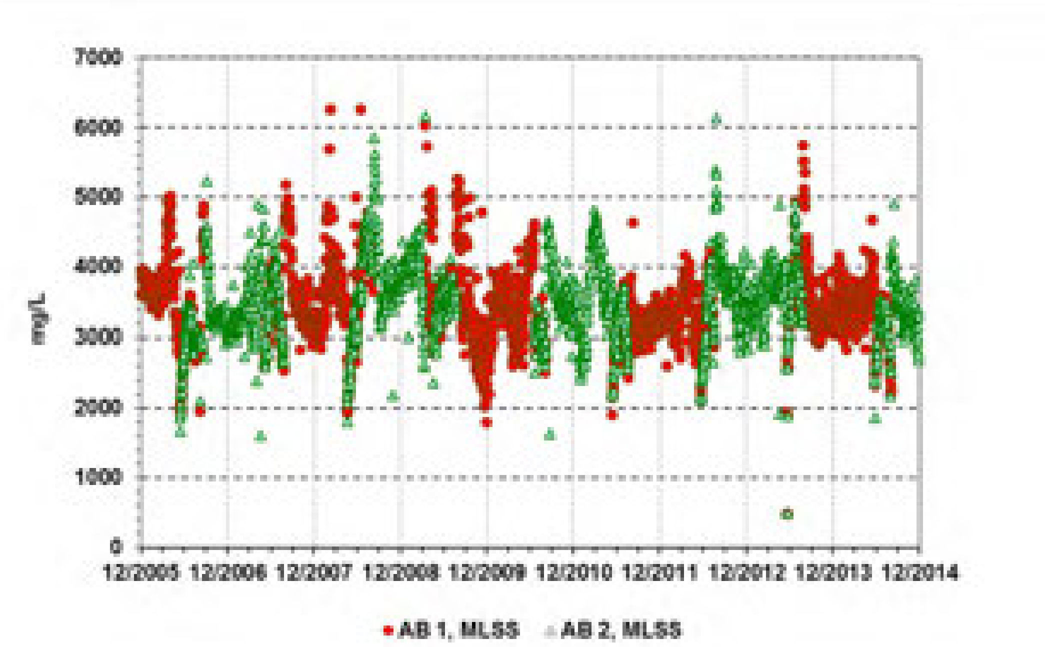

Figure 16. Aeration Basin Mixed Liquor Suspended Solids, 2005 – 2014

There appears to be no relationship apparent between the Food-to-microorganism ratio (F/M) and Sludge Volume Index (SVI) at the facility, as illustrated in

Figure **17**. Problems were encountered with SVI from 2010 to 2011 timeframe but were believed to be impacted by filamentous organisms. Operators report SVI has been much better since that time.

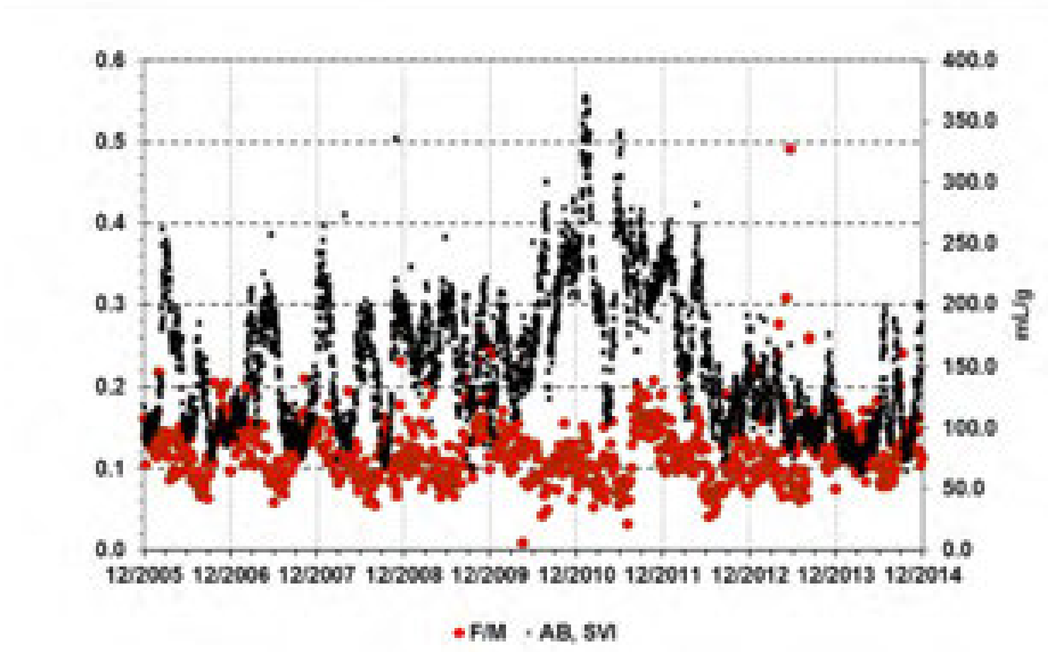

Figure 17. Aeration Basin F/M and SVI, 2005 – 2014

3.5.2 Activated Sludge System – Aeration System

Three 75 HP centrifugal blowers (Lamson Model 857-0-0-7-0-0AD), located in a separate room of the Headworks Building, provide air to the aeration basins and aerobic digesters. The blowers take inside air directly from the Blower Room. Air is supplied for both the aeration basins and the aerobic digesters through one main air supply line. The blower operating condition is approximately 1,600 SCFM at 9.0 pounds per square inch gage (psig).

Typically, one aeration blower is operated at all times whether one or two aeration basins are in operation. At times, peak flow periods require two blowers to be in service. DO in the aeration basins is controlled with one probe at the beginning of each basin. Table 13 presents a summary of the components in the aeration system.

Table 13. Aeration System Information

Description	Value
Aeration Basin	
Number of Units	2
Size (L x W x D)	115 FT x 23 FT x 16 FT
Volume	0.317 MG Each
	0.633 MG Total
Aeration System	
Type	Fine Bubble
Diffuser Manufacturer	Sanitare
Number of Diffusers per Basin	468
Number of Blowers	3
Blower Type	Centrifugal
Capacity	1,600 scfm each
	3,200 scfm each
Motor Size	75 hp each

The three existing centrifugal blowers, Figure 18, that serve the WWTP are approaching the end of their useful lives (approximately 20-30 years), and represent an older, less efficient means to supply the air flows needed at the facility. Preliminary evaluation suggests the installation of high speed turbo (HST) blowers at the plant to replace the existing blowers could result in considerable energy savings and long-term operational savings for the City.

Figure 18. Existing 75 hp Lamson Blowers

Activated Sludge System – Secondary Clarifiers

The Soldotna WWTP operates three secondary clarifiers. Two smaller secondary clarifiers (clarifiers 1 and 2) were included in the original plant and are relatively shallow based on current design standards, with a 10-foot side water depth. A third, larger clarifier (clarifier 3) was added with the 2006 plant upgrades. Under normal operation, the larger clarifier provides the required process clarification, one of the smaller clarifiers provides additional polishing, and the other smaller clarifier functions as a surge tank.

The two small clarifiers that were constructed in the 1970s have not been refurbished. All internal mechanical components and gear boxes are worn and in need of replacement.

One of the original clarifiers is used for additional polishing. Using the clarifier decreases effluent turbidity which decreases UV bulb maintenance, saving operating costs.

The second smaller clarifier is used as an equalization basin for sludge decanting and belt filter press pressate. Using the clarifier allows these two high strength liquid streams to be metered into the influent stream over 12 to 36 hours. This decreases the chance of upsetting the treatment process and lowers O&M costs associated with these disruptions.

Using the clarifiers for these purposes helps lower O&M costs and levels manpower needs.

Table 14 provides details of the secondary clarifiers. The staff has indicated that stray current occurs from the secondary clarifier 3 that was installed in 2006. The clarifier has zinc anode. These were replaced after 8 years of use. The rapid usage of the anodes has been linked to stray currents.

During the winter, snow accumulates between the old clarifier doors and the scum box. In addition, the opening between the scum box and the door entrance is too narrow for the skid loader. A recommended upgrade is to cover this area to avoid snow accumulation in the future.

Table 14. Secondary Clarifier Information

Description	Value
Clarifier 3	
Number of Units	1
Diameter	60 FT
Depth	15 FT
Surface Area	2,375 SF
Clarifiers 1 & 2	
Number of Units	2
Diameter	30 FT
Depth	10 FT
Surface Area	1,413 SF (Total)

Activated Sludge System – RAS System

A RAS/WAS pump station was installed at the plant as part of the 2006 modifications. The design included separate RAS and WAS wet wells and a Control Building. Due to design and construction issues with the pump station, the operators have struggled to keep pumps in operation and maintain process control. In 2015, modifications were made to the RAS/WAS system that addressed and alleviated these problems.

RAS flow is controlled manually with a valve at the pump wet well. The flow is adjusted to maintain approximately 6,200 mg/L RAS TSS concentration. Table 15 provides a summary of the RAS system.

Table 15. RAS Pumping Information

Description	Value
RAS Pumping	
Manufacturer	Flygt
Number of Pumps	2
Type	Submersible Pump
Size	30 Inch
Capacity	1,215 gpm (1.75 MGD)
Motor Size	10 hp

Disinfection

In 2006, a new UV disinfection system was installed to replace the previous chlorine disinfection system. UV disinfection utilizes UV light to prevent *microorganisms* from reproducing (called “inactivation”). The UV lamps emit a minimum of 40 mJ/cm^2 of light energy at the specific wavelength of 254 nm. The Soldotna WWTP UV disinfection system is a vertical bulb arrangement. Maintaining an even water control through the bulbs is essential and a weir is used to maintain level control through the system. Over time, algae and other organics can build up on the bulbs. The typical bulb cleaning frequency for the WWTP is every six weeks during the winter and every three weeks during the summer. Overall, the WWTP does not have significant algae issues for the UV system and the system has performed well. No chemicals are needed in this process normally, although they could be used to clean the bulbs on an as-needed basis. The UV system Programmable Logic Controller (PLC) needs to be upgraded and integrated into the overall WWTP Supervisory Control and Data Acquisition (SCADA) system. Table 16 shows basic information for this system.

Table 16. UV Disinfection Information

Description	Value
Manufacturer	Inflico/AquaRay 40
Type	Vertical Tube
Number of Modules	3
Number of Bulbs per Module	40
Watts per Module	3,000

Description	Value
Type of Level Control	Weir
Bulb Life (approximate)	10,000 hours
Bulb Cleaning Frequency	Winter: Every 6 weeks Summer: Every 3 weeks

Effluent Disposal

Treated effluent is discharged to the Kenai River through an outfall consisting of a 21-inch diameter corrugated metal pipe (CMP). There are conflicting records on the outfall, which indicate it could be a reinforced concrete cylinder pipe rather than CMP. The pipe extends 150 feet out into the Kenai River channel and ends in a headwall. A channel was constructed between the headwall and the river, approximately 50 feet beyond the headwall. The outfall has an open-ended diffuser. Floods have filled the channel with cobles and plugged the diffuser. The outfall operates effectively.

3.5.3 Biosolids Treatment and Disposal

Activated sludge is wasted daily to the aerobic digesters. This has provided additional stabilization of the biosolids. Prior to dewatering in the belt filter press, lime is added to the biosolids, and ultimately the biosolids are disposed at the landfill. The belt filter press is capable of dewatering to approximately 17 to 21% solids.

3.5.4 Aerobic Digestion

Waste activated sludge and scum from the secondary clarifiers is pumped to two aerobic digesters using a submersible pump. Biosolids are fed to either or both digesters. The digesters are normally operated in parallel and fed almost continuously, with 0.5 to 1.0% solids. WWTP staff has indicated that the digesters achieve about a 40 to 50% volatile solids (VSS) reduction; however, a recalculation of the VSS destruction indicates that the average reduction is typically around 12%.

On an average Soldotna adds 200 lbs. per week of lime to the digesters to maintain a pH between 6 and 7. Staff report that if the pH drops below 6 it is difficult to decant the digesters before the sludge blanket rises.

Air is supplied to the digesters by the main centrifugal blowers in the Headworks Building. Prior to 2006, there were two separate digester blowers located in the Control Building that served only the digesters. An evaluation of the old blowers performed in 2003 found that the aging equipment was inefficient and nearing the end of its useful life. As part of the 2006 upgrades, the old blowers were removed and all process air was supplied by the Headworks blowers.

Control of air to the digesters is hard to manage because aeration is not periodically stopped to allow the digesters to settle. Quiescent conditions while the air is off will allow better settling and better liquid decanting.

During the site visit and evaluation it was noted that the digester building was extremely warm, due largely to the abundance of air supplied by the aeration system. It was also noted during the site visit that the handrail which were not previously replaced around the digesters is deteriorating and may require replacement.

The supernatant is decanted and pumped to the headworks. An average of 1,930 gallons per day (gpd; 13,500 gallons per week) is returned to the headworks over a 6-hour period (an equivalent flow rate of 7,320 gpd). This number may be increased, depending on operational procedures and if the decanting of the digesters and recycling pressate from the belt press coincide. These operational values should be revisited during any design phase of this system. Table 17 presents the aerobic digestion components and information.

Table 17. Aerobic Digestion Information

Description	Value
Aerobic Digesters	
Number of Units	2
Size (L x W x D)	75 FT x 21 FT x ~12.5FT
Volume	0.258 MG (34,500 CF) total
Sludge Feed Pump	
Number of Pumps	1
Capacity	50 gpm
Sludge Digester Decant Pump	
Number of Pumps	1
Capacity	150 gpm
Total Head	11 FT
Aeration System	
Type	Coarse Bubble
Number of Diffusers	73 per Basin
Blowers	
Manufacturer	See Aeration Basin Blowers

3.5.5 Dewatering

One belt filter press is used to dewater the digested biosolids prior to final disposal at the landfill. The belt filter press is currently operated for eight hours every other day. No backup dewatering system is available. A progressive cavity pump is used to feed the belt press with approximately 0.75 to 1.00% solids. Polymer is added to the incoming digested biosolids to aid in the dewatering process. Polymer addition requires a mixture of approximately 500 gallons of water with 6 lbs. of dry polymer for every 22,000 lbs. of sludge. Biosolids are dewatered to approximately 17 to21% solids.

The belt filter press is designed for 25 to 75 gallons per minute (gpm) of feed biosolids. The total capacity of the belt filter press is a function of the operating time. Table 18 provides the details of the belt filter press system.

Table 18. Belt Filter Press Information

Description	Value
Belt Filter Press	
Manufacturer	Roedinger
Number of Units	1
Effective Width	4 FT
Capacity	25 to 75 gpm
Solids Concentration	
Feed	0.75% to 1.00%
Dewatered	17-21%
Wash Water Required	Estimated ~30 gpm at 85 psi

The liquid from the dewatering process and belt filter press wash water is returned to the headworks, resulting in an additional 58,000 gpd of flow from the dewatering process and 100,000 gpd from the wash water flow.

3.5.6 Solids Disposal

Ultimately, the final disposal of the biosolids is in the KPB Landfill. Lime is currently added to the sludge cake at the discharge of the belt press and is mixed as it is conveyed to the truck, then hauled to the landfill. On average, for every 22,000 pounds (lbs) of sludge about 100 lbs of lime is added. The landfill requires that lime be added to the dewatered biosolids prior to disposal to achieve a pH of 12.0 to 12.5. The addition of lime is not a requirement of the current APDES permit. Lime addition is a requirement from the Landfill's Solid Waste Division and is not a CFR Part 503 requirement.

3.5.7 Plant Performance

The plant discharges disinfected effluent into the Kenai River. The average effluent quality has not changed much from 2005 to the present and does not show much seasonal variability. As previously discussed, the plant does on occasion have spikes in effluent TSS but these are relatively infrequent and do not exceed the effluent limits for the facility. Plant staff indicates that the effluent TSS spikes are typically seen when the plant is having problems with filamentous growth. These spikes could also be attributed to internal recycle flows in the plant (RAS/WAS, belt press pressate, etc.).

Effluent data from 2005 through 2014 show average BOD concentrations of less then 5 mg/L (less than 7 mg/L ninety percent of the time), as well as average effluent TSS of 4.4 mg/L (less than 7 mg/L ninety percent of the time). Maximum values for both BOD and TSS over the time period are well below the permitted limits. Figure 19 shows the effluent TSS and BOD concentrations for the period between 2005 and 2014.

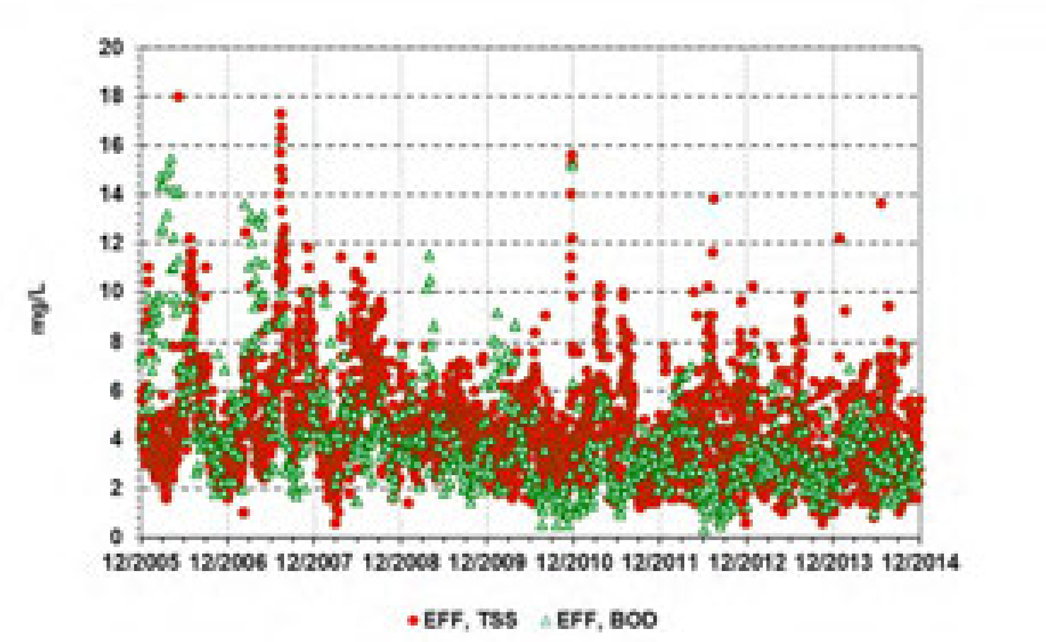

Figure 19. Effluent BOD and TSS, 2009 – 2014

Historically, the plant has met the effluent requirements of the current APDES permit without issue; which presently are 30 mg/L monthly average, 45 mg/L weekly average, and 60 mg/L maximum daily BOD and TSS. While the plant does not yet monitor effluent ammonia consistently, the longer Solids Retention Times (SRTs) and low effluent BOD suggest that the plant achieves full nitrification on a consistent basis. If the plant was not fully nitrifying it could be expected that at least occasionally the nitrogenous oxygen demand would result in elevated effluent BOD.

4 Alternatives Analysis

Selecting the right alternative requires a solid understanding about the economic and regulatory environment for the planning horizon of 20 years and sound estimates of population growth, energy cost, and regulatory requirements. Due to uncertainties in many of these factors, this alternative analysis must focus on near-term improvements that ensure compatibility and expandability for a variety of long-term scenarios. As part of the alternative analysis, the various facility components were evaluated as to their current condition, capacity, and adequacy for compatibility with future conditions.

4.1 Model Development

The wastewater process simulator BioWin 4.1 was used for the calibration and unit process, capacity, and alternative evaluation. The simulator uses mathematical models that describe key biological, chemical, and physical reactions that occur in a wastewater treatment plant. The model does not however represent reality and was developed around a typical municipal wastewater environment. To insure the validity of the model and its applicability to this facility and its specific wastewater the first step is to calibrate the model to conditions at the Soldotna WWTP.

In addition to the model calibration effort itself the process of calibrating the model requires a thorough familiarization with the existing facility, its process design, and how it is operated. Completing the calibration process thus assures the validity of the model as well as insuring sufficient understanding of design and operation of the facility.

The calibration goal is not to achieve an exact match for every single measured parameter, but rather to find an overall good fit between the data and the simulated results. This subsequently requires prioritizing the more critical parameters with respect to facility planning, such as biological yield or effluent nutrients over other less critical parameters, such as effluent TSS or aeration basin DO.

Models are typically calibrated to a period of time that showed reasonably consistent operation conditions and performance, encompasses enough data points to average the natural variability in wastewater treatment but not too long to limit the range of conditions (i.e. temperature range, flow range).

The combined variability of influent flows and loads and unit process operation did not suggest any particular time period over the past two years that would be particularly well suited for the model calibration. For the summer steady state whole plant model calibration the period of July through August of 2014 was selected. The influent composition for the calibration period is summarized in Table 19. Limited influent characterization data was available and assumptions were required to generate a wastewater characterization typical of a predominantly municipal service area. The majority of missing parameters were calculated based on typical municipal wastewater ratios relative to BOD. For instance, the typical ratio of Total Kjehldahl Nitrogen (TKN) to BOD is 0.17 and two-thirds of influent TKN is ammonia. Schematic diagrams of the treatment process input and output parameters are shown in Figure 20 to Figure 23.

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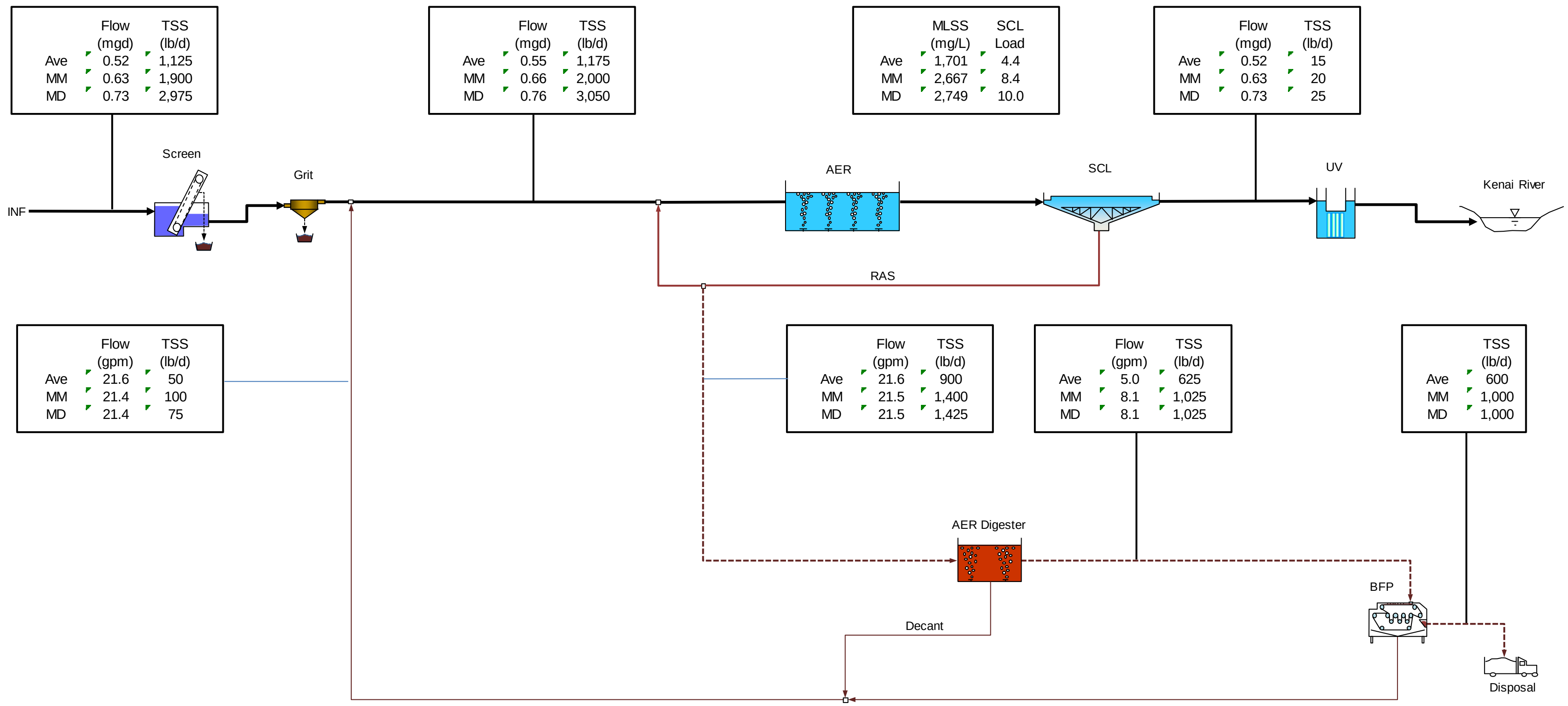

Figure 20. 2014 Summer Mass Loadings Schematic

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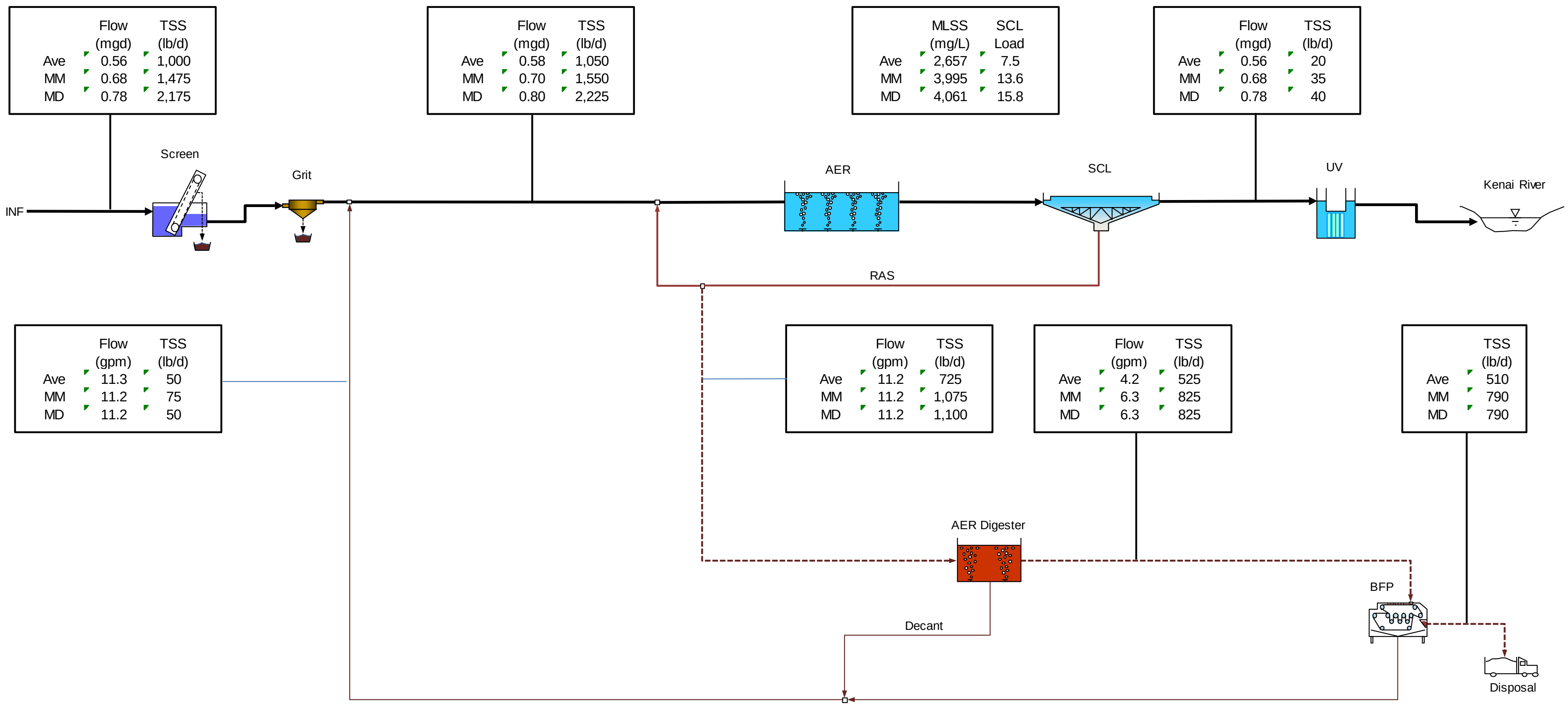

Figure 21. 2014 Winter Mass Loadings Schematic

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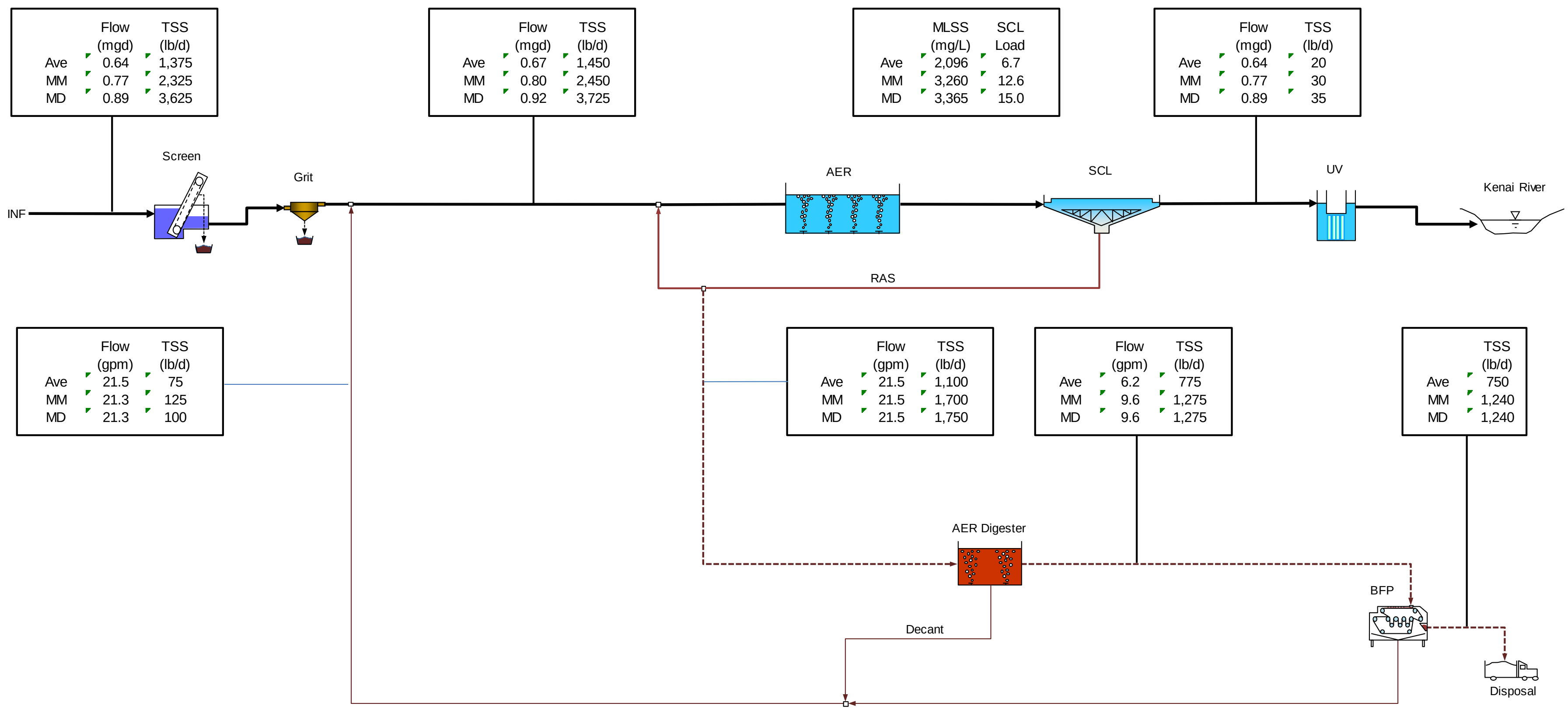

Figure 22. 2035 Summer Mass Loadings Schematic

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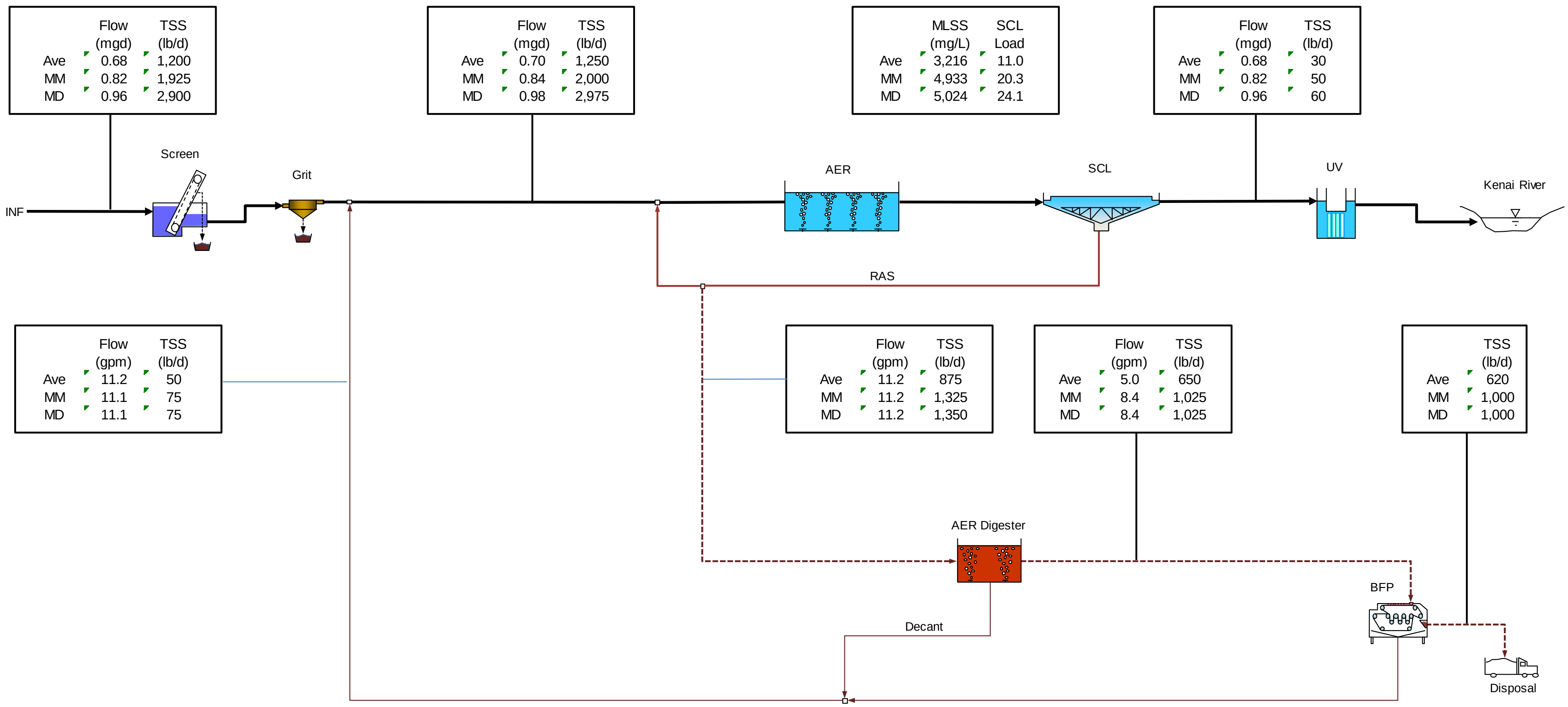

Figure 23. 2035 Winter Mass Loadings Schematic

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4.2 Headworks

The Existing Headworks Building requires a new roof over the influent pump area in the near future to help extend its useful life, but it is not recommended to do large scale equipment replacement or building renovation on the existing building to maintain its operation as a headworks. It is recommended that a new Headworks Building (with screening and grit facilities) be constructed while the existing building remains operational. The following proposed modifications are represented in the Figure 24 and Figure 25.

The existing building was constructed around 1980 timeframe with additions in later years to include a storage area and boiler room. Building ventilation is non-existent, and the heating system is inadequate to maintain reasonable temperatures within the building. The boiler that was recently installed is rated at 153,000 BTUH output, and serves hydronic unit heaters in the process and storage areas. The unit heater coils foul rapidly and require frequent cleaning, but are not capable of maintaining reasonable temperatures. Corrosion of piping and supports has occurred with exposed copper severely affected.

There is no separation between the treatment area and the blower room, and blower intake air is drawn from the whole building. The blower room contains the building electrical service, MCC, distribution switchgear and a nonfunctioning standby generator. The electrical switchgear and generator are not allowed in a room connected to the screw pump and grit separation area, which would be classified a hazardous location per NFPA 820, which came into existence in 1990.

It would be possible to isolate the blower room from the rest of the building. Given the extent of the renovation (and cost) that would need to take place to utilize the current structure as a headworks it would be much simpler, cleaner, and cost effective to construct a new Headworks facility.

The existing screening and grit removal equipment is at the end of its useful life and should be replaced with new, more efficient equipment as the old equipment fails and requires more operational attention. The new screening equipment would be capable of removing solids as well as washing, compacting, and dewatering all in a single unit. Wastewater flows would be pumped from the influent wet well to the screens. Operation of the screens involves:

- Wastewater flows from an influent channel (within a concrete channel or stand-alone tank) into the screening basket which retains the solids. When the wastewater rises to a predetermined level, the screening basket rotates and lifts the screened material out of the influent flow stream.
- As the material reaches the top of the screening basket, it drops into a screw conveyor/compactor. Any material still in the screening basket is removed by a spray wash system. This system also flushes organic materials back into the influent channel.
- The central screw conveyor/compactor transports screened material to a discharge chute and storage container.

The solids are compacted and dewatered up to a 40% dry solids content. Several manufactures, including Lakeside, Huber, and Parkson, make reliable screening equipment for this type of application. Manufacture cut sheets for the screening/grit equipment have been included in Appendix B.

As an option for the headworks upgrade, a grit system could be incorporated into the screening design. The manufacturers listed above can provide a “headworks complete plant,” which performs all of the screening operations described above (solids removal, compacting, dewatering) as well as remove and dewater grit from the influent wastewater.

The plant does not currently accept septage or other hauled wastes. Septic tanks in the service area are pumped and disposed of by private companies. As an option for a new headworks, the City has asked to evaluate the ability to accept septage at the WWTP. The “complete plants” described above are often used to accept and provide preliminary treatment for septage loads. In addition to a dedicated screening/grit unit, other facilities that would be required to accept septage at the plant include a septage holding tank and pump to meter the high strength flow into the influent flows to the aeration basins. With a relatively small plant like Soldotna it is imperative to be careful with septage to ensure that it does not negatively impact treatment in downstream processes. The septage loads would definitely need to be equalized and metered back. Adding all the particulates in typical septage to the secondary plant will push out active biomass if the SRT is kept constant. Also, feeding too much of the high strength waste could effectively “kill” the biological reactors in the plant. Incorporating septage handling at the WWTP would be a relatively involved and costly process that would need to include the following elements:

Receiving station

- Hard surfaced, truck unloading ramp sloped to a drain to allow ready cleaning of any spillage and washing of the haul tank, connector hoses, and fittings. The ramp drainage must be tributary to treatment facilities and should exclude excessive stormwater.
- A flexible hose fitted with easy connect coupling to provide for direct connection from the haul truck outlet to minimize spillage and help control odors
- Washdown water with ample pressure, hose, and spray nozzle for convenient cleaning of the septage receiving station and haul trucks.
- The receiving station would need to be covered and heated for winter months but still allow excellent ventilation and access for vehicles.

Storage/equalization

- An adequate off-line septage receiving tank should be provided. Capability to collect a representative sample of any truckload of waste accepted for discharge at the plant should be provided. The receiving tank should be designed to provide complete draining and cleaning by means of a sloped bottom equipped with a drain sump. The design should give consideration to adequate mixing, for testing, uniformity of septage strength, and chemical addition, if necessary, for treatability and odor control.

Screening and grit removal

- Screening, and grease removal of the septage as appropriate to protect the treatment units.

Pumps and valving

- Pumps provided for handling the septage should be of the nonclogging design and capable of passing 3-inch diameter solids.

Valving and piping

- Valving and piping for operational flexibility to allow the control of the flow rate and point of septage discharge to the plant.

Safety and Security features – to protect the operational personnel as well as provide security features to address haulers entering the WWTP site and dumping waste into the system.

Staffing

- Laboratory and staffing capability to determine the septage strength and/or toxicity to the treatment processes.

Odor control

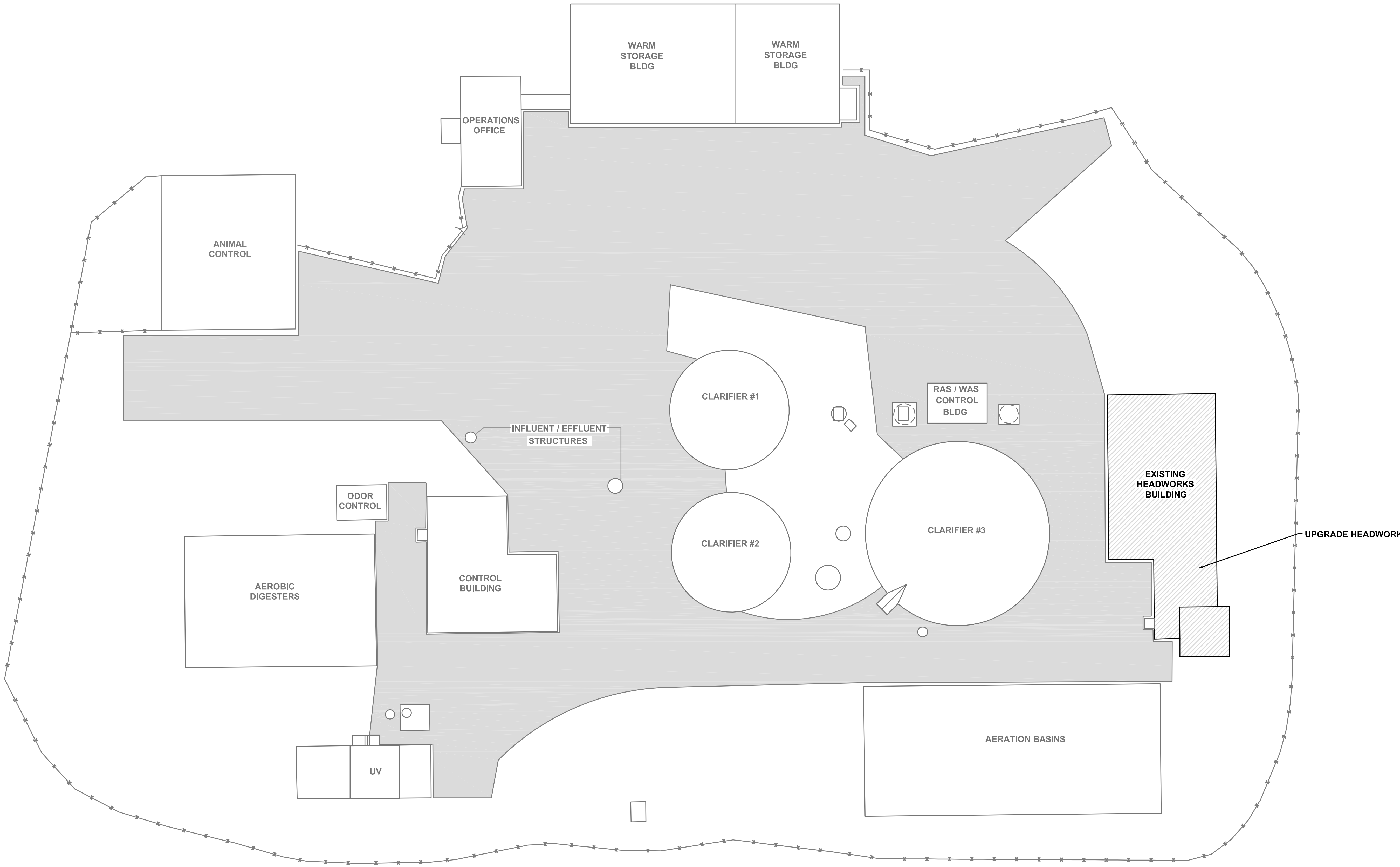
- Odor control is essential for any waste handling operation, especially in the case of septage. Septage processing can result in the release of odors causing complaints from local residents. For septage receiving units, the best approach to control odors is to cover the sources of odor emissions and to exhaust this air to a suitable control system. Due to the concern of odor problems associated with septage receiving, only septage receiving units that provide a completely enclosed system should be investigated.

Based on the capital investments that would be required to incorporate septage acceptance at the WWTP, the long-term operational and managerial work that would be required to maintain a septage receiving station, and the potential for negative impacts to biological processes downstream of the septage facility, it is not recommended that septage acceptance be incorporated into the WWTP design at this time.

In addition to the new building, a new influent pump station would be required and the screw pumps would be taken out of service. Preliminary evaluation of the new headworks building assumes a new submersible pump station would be located near the influent to the existing headworks building.

The new headworks facility will include grit removal and screening. The facility will be designed to have a two channel screening/grit facility with one screen installed and a bypass channel with a 1-inch coarse screen. A second mechanical screen could be installed in a future phase. The new headworks building and pump station could be constructed without disruption to the existing headworks. Once the new headworks is brought on-line, the existing building could be refurbished or demolished based on City needs.

In the interim the blowers should be replaced and installed in a new building, which is discussed later in this Plan. Also, the roof on the existing headworks building should be repaired to help extend its useful life and allow operating of the headworks processes until a replacement headworks building is constructed.



SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

WASTEWATER TREATMENT FACILITY
PROPOSED ALTERNATIVES SITE PLAN

Figure 24

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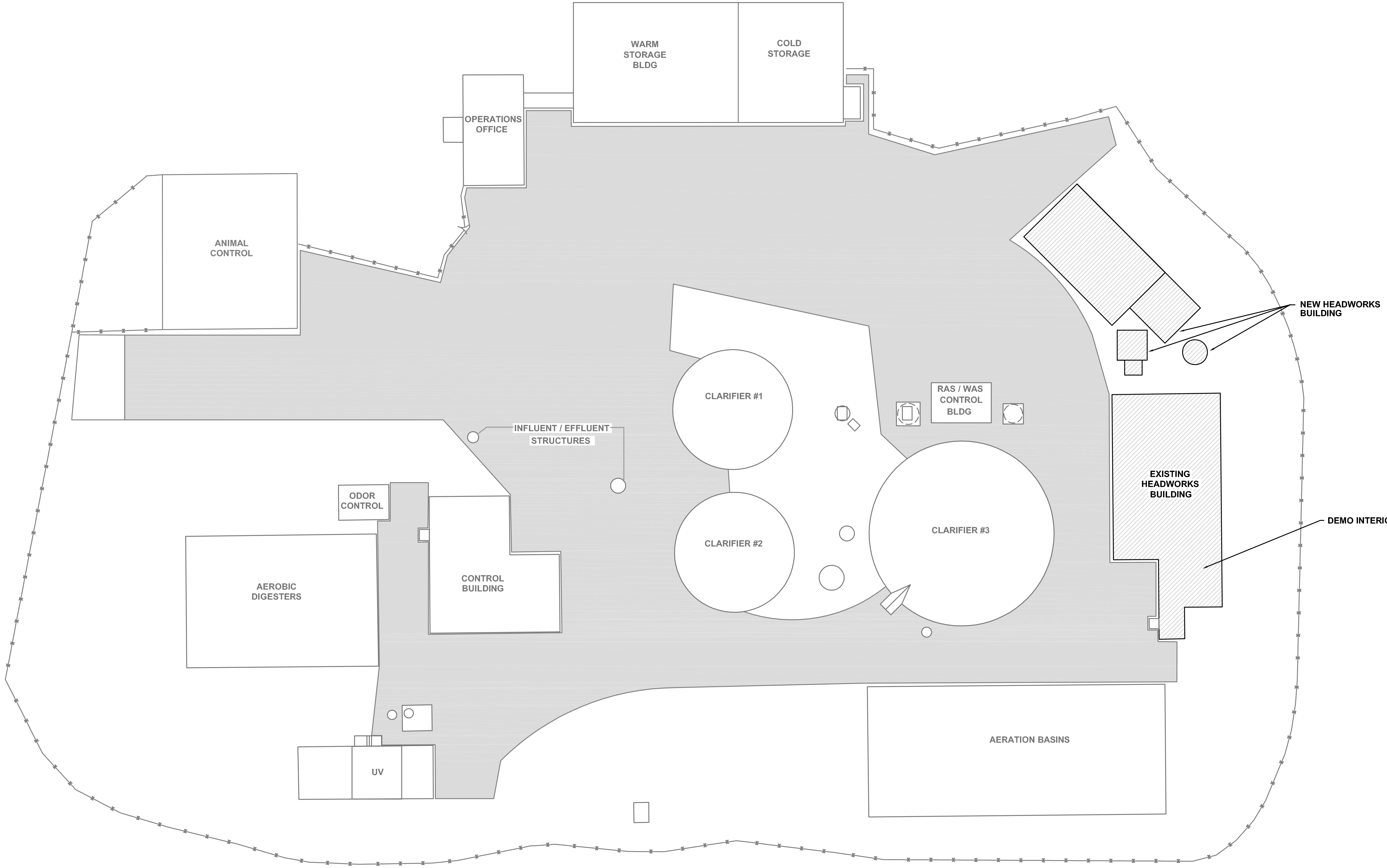

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

WASTEWATER TREATMENT FACILITY
PROPOSED ALTERNATIVES SITE PLAN

Figure 25

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4.3 Biological Treatment Process

4.3.1 Activated Sludge System – Aeration Basins

The mass balances for both current and future flows and loads were generated using the calibrated Biowin model. The results for summer and winter conditions are summarized in Table 19 for 2015 and Table 20 for 2035. The MLSS and secondary clarifier load projections throughout the planning period are based on the assumption that the process does not change and the operation strategy remains the same.

The parameter that has the greatest impact on the biological treatment capacity of the plant is the nitrification safety factor. For this analysis a typical conservative safety factor of 2.0 was utilized. Figure 26 shows the relationship of temperature and minimum SRT for stable nitrification (nitrite < 0.1 mg/L). Because the basin geometries are plug flow at Soldotna the minimum SRTs are 5.1 days for the summer design temperature of 13°C and 9.5 days for the winter temperature of 5.1°C. After applying the safety factor of 2.0 these results in design SRTs of 10 days (summer) and 19 days (winter). For the clarifier loading a RAS rate of 50% was assumed.

It should be noted that it is possible to operate the facility with a much lower factor of safety for nitrification. As a general rule, decreasing the factor of safety increases the required level of automation and monitoring and operator attention and time.

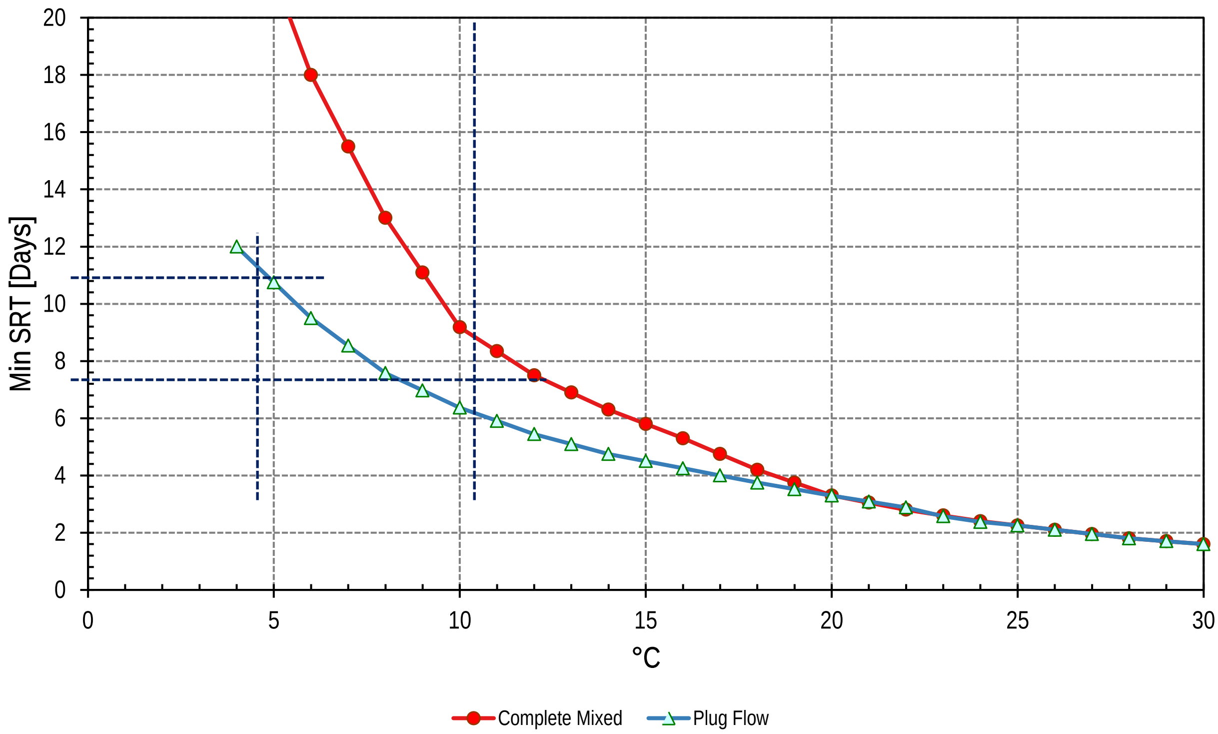


Figure 26. Relationship of Minimum SRT and Temperature

Table 19. Mass Balance Summary for 2015 Flows and Loads

Parameter	Unit	Summer			Winter		
		Ave	MM	MD	Ave	MM	MD
INF TSS	lb/d	1,125	1,900	2,975	1,000	1,475	2,175
ABI	lb/d	1,175	2,000	3,050	1,050	1,550	2,225
SE	lb/d	15	20	25	20	35	40
WAS	lb/d	900	1,400	1,425	725	1,075	1,100
DS	lb/d	625	1,025	1,025	525	825	825
Cake	lb/d	600	1,000	1,000	510	790	790
MLSS	mg/L	1,700	2,670	2,740	2,660	4,000	4,060
Yield	lb/lb	0.71	0.77	0.53	0.62	0.64	0.44
SCL Load	lb/ft²/d	4.4	8.4	10.0	7.5	13.6	15.8

Table 20. Mass Balance Summary for 2035 Flows and Loads

		Summer			Winter		
Parameter	Unit	Ave	MM	MD	Ave	MM	MD
INF	lb/d	1,375	2,325	3,625	1,200	1,925	2,900
ABI	lb/d	1,450	2,450	3,725	1,250	2,000	2,975
SE	lb/d	20	30	35	30	50	60
WAS	lb/d	1,100	1,700	1,750	875	1,325	1,350
DS	mlb/d	775	1,275	1,275	650	1,025	1,025
Cake	lb/d	750	1,240	1,240	620	1,000	1,000
MLSS	mg/L	2,100	3,260	3,360	3,220	4,930	5,020
Yield	lb/lb	0.71	0.77	0.53	0.62	0.66	0.44
SCL Load	lb/ft²/d	6.7	12.6	15.0	11.0	20.3	24.1

The MLSS projections (maximum month) show values between 4,000 and 5,000 mg/L (Figure 27 and Figure 28) for winter loading conditions in 2035 but the secondary clarifier loadings are well below the typical maximum design value of 25 pounds per square feet per day (lb/ft^2/d). MLSS concentration even as high as 6,000 mg/L are not inherently problematic as long as they are matched up with sufficient clarifier capacity. In addition these are winter maximum month conditions with a conservative safety factor for nitrification. Meaning, there is sufficient redundancy and flexibility in the system to allow operators sufficient room to navigate any events out of the ordinary.

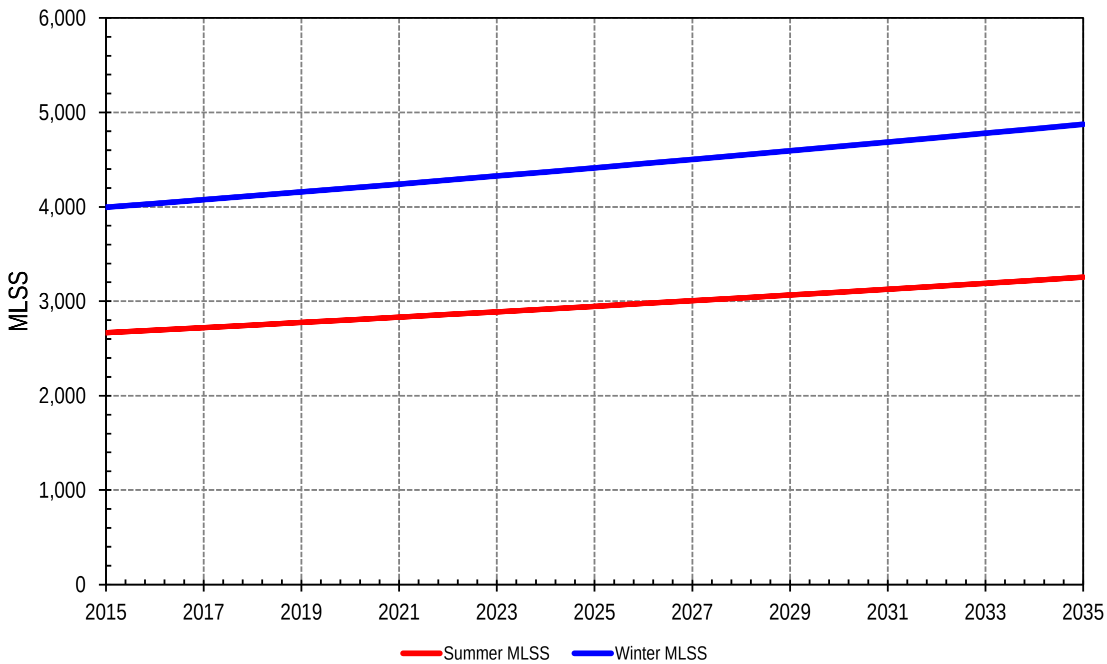


Figure 27. Projected Maximum Month MLSS from 2015 through 2035

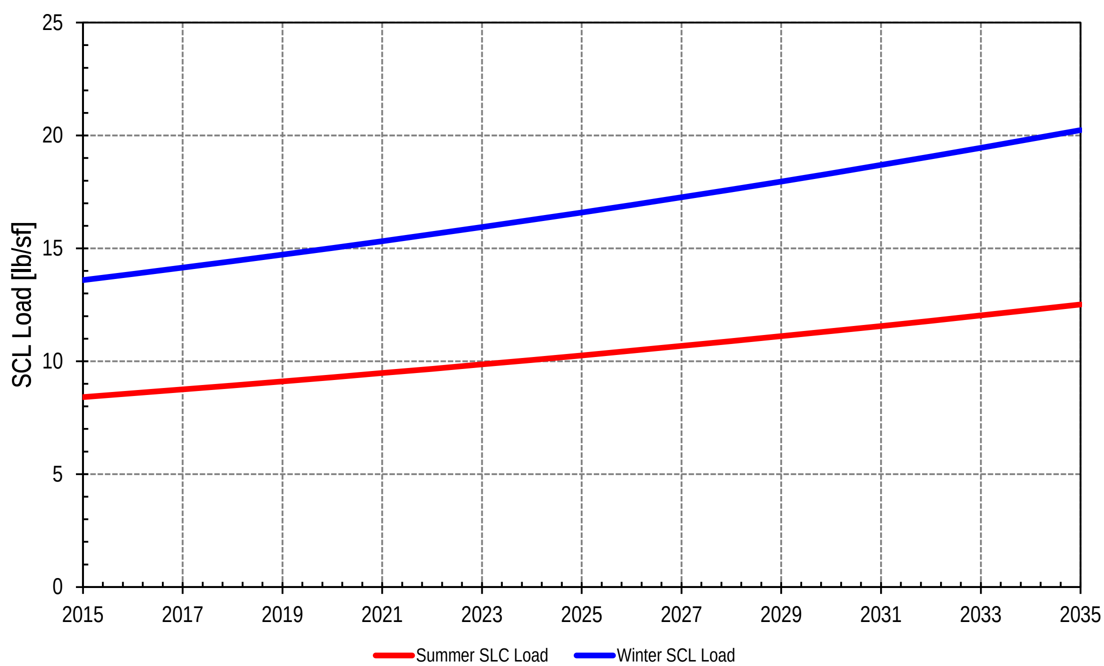


Figure 28. Projected Maximum Month SCL Load (50% RAS) from 2015 through 2035

Preliminary process calculations indicate that near the end of the planning horizon (2035), the existing number of diffusers in the aeration basins may be insufficient to meet projected air demands. It is likely, however, that the City will need to replace the existing diffusers before the end of the planning horizon. It is recommended that the City plan on adding more diffusers with the next diffuser replacement – which would be approximately 10 years out given the typical life span of diffusers.

The City may want to consider several other process modifications at the time of diffuser replacement to enhance nutrient removal capabilities and improve overall efficiency of the treatment system. The current aeration basins consist of two plug flow trains with fine bubble aeration that have the ability to fully nitrify throughout the planning horizon but no ability to denitrify. Denitrification is not a process requirement as there is no proposed effluent limit for Total Nitrogen (TN). However, adding the ability to denitrify would provide a number of benefits including improving oxygen recovery, alkalinity recovery, improved transfer efficiency, and potentially better settling sludge. The impact of the sludge settling (selector effect) depends on the denitrification process.

The simple rule of thumb is that nitrification accounts for roughly 50% of the oxygen demand and denitrification recovers 50% of the oxygen required for nitrification. By denitrifying 80% of the generated nitrate the overall oxygen demand decreases by 20%. The savings in aeration requirements (energy) may significantly exceed 20% since the oxygen transfer efficiency improves due to either an upstream anoxic (ANX) zone or lower DO values in SNDN mode (simultaneous nitrification and denitrification).

The existing aeration diffuser grid only has a single control valve; therefore, the entire aeration grid would have to be modified to accommodate a pre-anoxic zone or independent aeration of the front quarter to one third of the plug flow basins. For a Modified Ludzack-Ettinger (MLE) option, the entire aeration grid may simply be shortened at the end and then moved towards the end. In addition a nonstructural baffle wall and submerged 3Q constant speed internal recycle pump and piping would be required (Figure 29).

The second option is to equip the aeration system with the ability to control for SNDN with a package controller (Figure 30 and Figure 31) that monitors DO, ammonia, and NOx-N to control the air supply based on operator defined setpoints (DO, effluent ammonia, fail-safe settings, etc.). Alternatively, The City of Soldotna can purchase and integrate the required elements in-house.

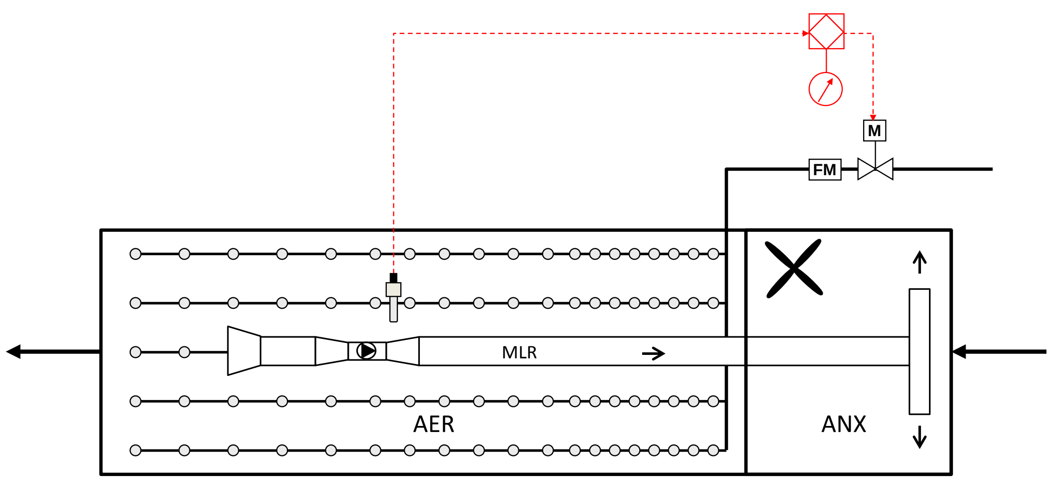


Figure 29. Example MLE Implementation

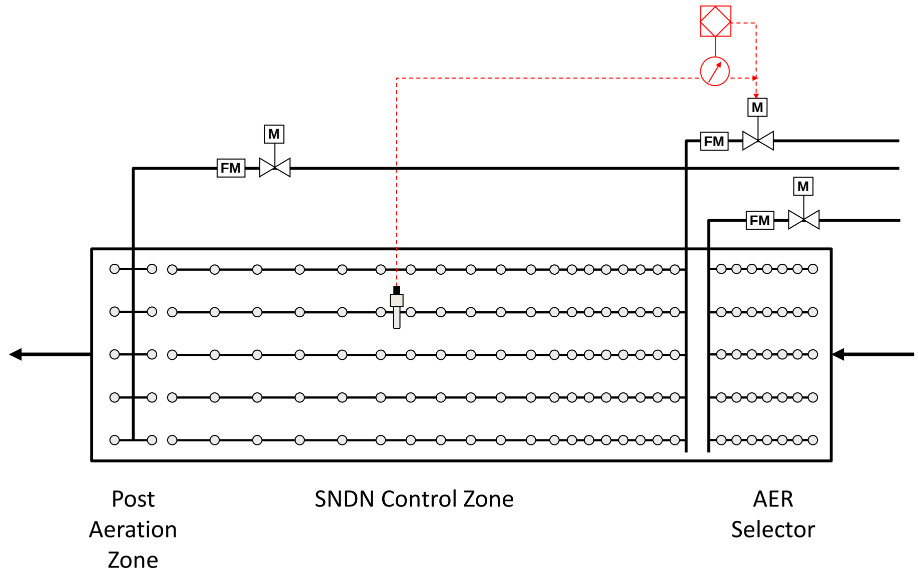


Figure 30. Example of SNDN Configuration at Soldotna WWTP

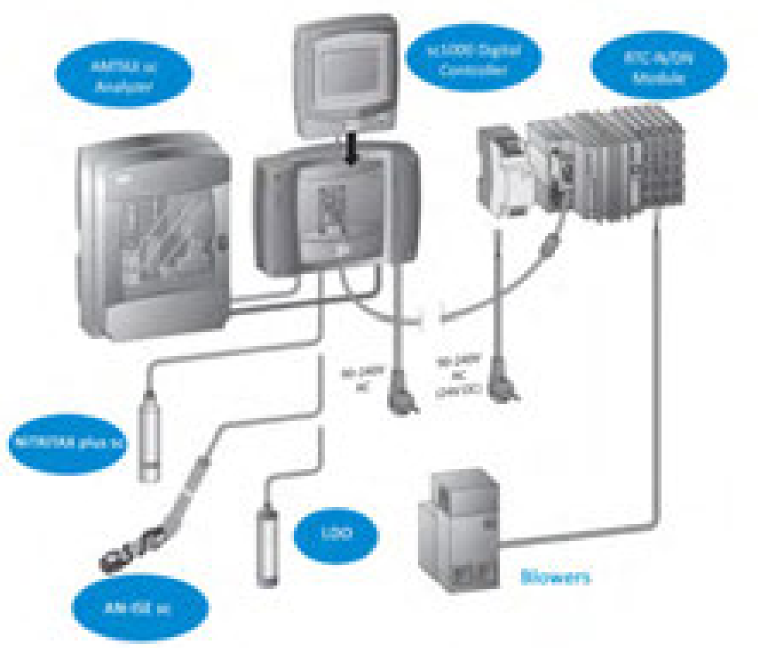


Figure 31. HACH RTC105 N/DN-Module (Example)

As previously discussed in the model calibration section, the model for the facility has been developed based on typical municipal wastewater characteristics for several influent and process parameters, not specific data for the Soldotna plant. It is recommended that the City develop a routine sampling plan as well as an influent characterization sampling plan to gather the necessary data for future designs, capacity evaluations, or planning efforts. In addition to the current sampling at the facility, it is suggested that the WWTP staff begin testing for alkalinity (influent and aeration basins), ammonia (influent and through the aeration basins), and TKN (influent).

4.3.2 Activated Sludge System – Aeration System

Based on current average air flows and anticipated future operation of the plant, the installation of new high–efficiency blowers would result in significant energy savings and pay for itself within several years of operation. The three existing centrifugal blowers that serve the WWTP are approaching the end of their useful lives (approximately 20-30 years), and represent an older, less efficient means to supply the air flows needed at the facility.

Energy and sustainability strategies continue to become increasingly important to publicly owned treatment works) and the communities they serve. Many facilities are looking for opportunities to achieve energy-efficient and sustainable design for new construction as well as long-term operation of existing facilities. One area within wastewater treatment plants that can provide significant energy savings is the blower design.

Approximately fifty percent (50%) of energy usage at a typical WWTP is associated with the aeration system and its related blowers. For decades, the workhorses of the industry have been the multistage centrifugal blower and positive displacement (PD) blower. In the last few years, however, the HST blower has become increasingly popular as facilities look for ways to become more energy efficient and reduce power costs. The HST units have a wider operating range than the traditional centrifugal or PD blower and better efficiency across the entire range of operation. As such, many WWTPs are replacing some or all of their multistage centrifugal blowers with HST units.

Preliminary evaluation suggests the installation of HST blowers at the plant to replace the existing blowers could result in considerable energy savings and long-term operational savings for the City. In addition to higher efficiency, the HST blowers offer a high turndown ratio (>50% turndown), lower HP, no vibration and very little noise (80 A-weighted decibels [dBA]), very low maintenance, and typically a smaller footprint than the older centrifugal or PD blowers. Additionally, the use of the HST blowers with variable frequency drives (VFDs) and the existing DO monitors in the aeration basins provide for direct loop control of blower speeds, which is more efficient than the current mode of operation of throttling the inlet air to the constant speed motors.

Blower efficiencies vary considerably. The new HST blowers have a wider operating range and better efficiency across the entire range of operation when compared to the multi-stage centrifugal blower. The efficiency of a variety of blower systems is shown in Figure 32 below.

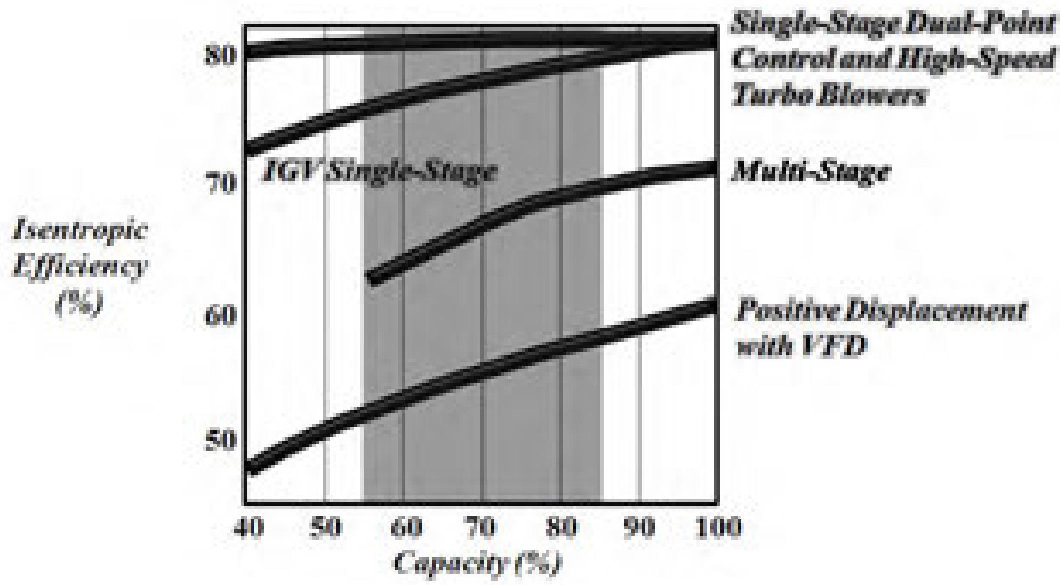


Figure 32. Blower Efficiency Comparison

As the figure illustrates, it is no surprise that HST blowers have become so popular. They are very efficient throughout the typical operating range of 50 to 100 percent of capacity.

It is recommended that the new blowers be installed in a new building located between the existing headworks and aeration basins. The projected (2035) average day maximum month (ADMM) air demand for the aeration basins is approximately 1,780 pounds per day (lbs/day) of oxygen for nitrification and a maximum amount of air required under nitrification mode is approximately 3,300 lbs/day. Additionally, it is anticipated that approximately 1,040 scfm would need to be delivered to the aerobic digesters for adequate mixing. The design of the new HST blowers should consider dual blowers for the aeration basins and the aerobic digesters. The current system supplies air to both unit processes and the result is a lack of control of mainly the digesters. As new blowers are sized and designed, dedicated blowers for the aeration basins and digesters should be evaluated for process efficiencies and improved control of both systems.

Activated Sludge System – Secondary Clarifiers

The capacity of the existing three clarifiers was reviewed for both hydraulic and solids loading conditions. Based on the review, the existing clarifiers have adequate capacity and meet hydraulic and solids loading criteria for future flows and loads within the 20-year planning horizon.

Activated Sludge System – RAS System

In 2015, modifications were made to the RAS/WAS system that addressed and alleviated previous design and operational problems experienced with the system. The RAS/WAS system installed in 2006 made it difficult for the operators to vary the RAS flow rate back to the aeration basins and typically a constant rate exceeding 100% of the design influent flow rate was maintained. The improvements made to the system in 2015 should allow operators to specify a return flow rate more in an optimal range of approximately 40 to

100% of the actual influent flows to the facility. The treatment analysis performed for current and future conditions assumes a RAS rate of 50%.

The existing RAS rate of over 100% (design flows) causes higher solids loading on the secondary clarifiers. A RAS rate reduction would increase the clarifier capacity. More appropriately, this concept should be viewed as secondary clarifier optimization through adjustment of the RAS rate. The RAS rate is important because the hydraulics of a secondary clarifier are complex and changes in the RAS return rate have a number of impacts on the capacity of the clarifier. The list below contains some of the key relationships with a higher RAS rate and a positive and negative correlation regarding the impact on the capacity of the secondary clarifier.

Positive aspects of a relatively high RAS flow rate include:

- increased downward solids transport
- produce a lower clarifier sludge blanket
- lower the potential for floating sludge through denitrification
- reduced solids retention time in clarifier

Negative aspects of a relatively high RAS flow rate include:

- increase the turbulence in the clarifier
- higher potential for flow breakup
- increased solids loading

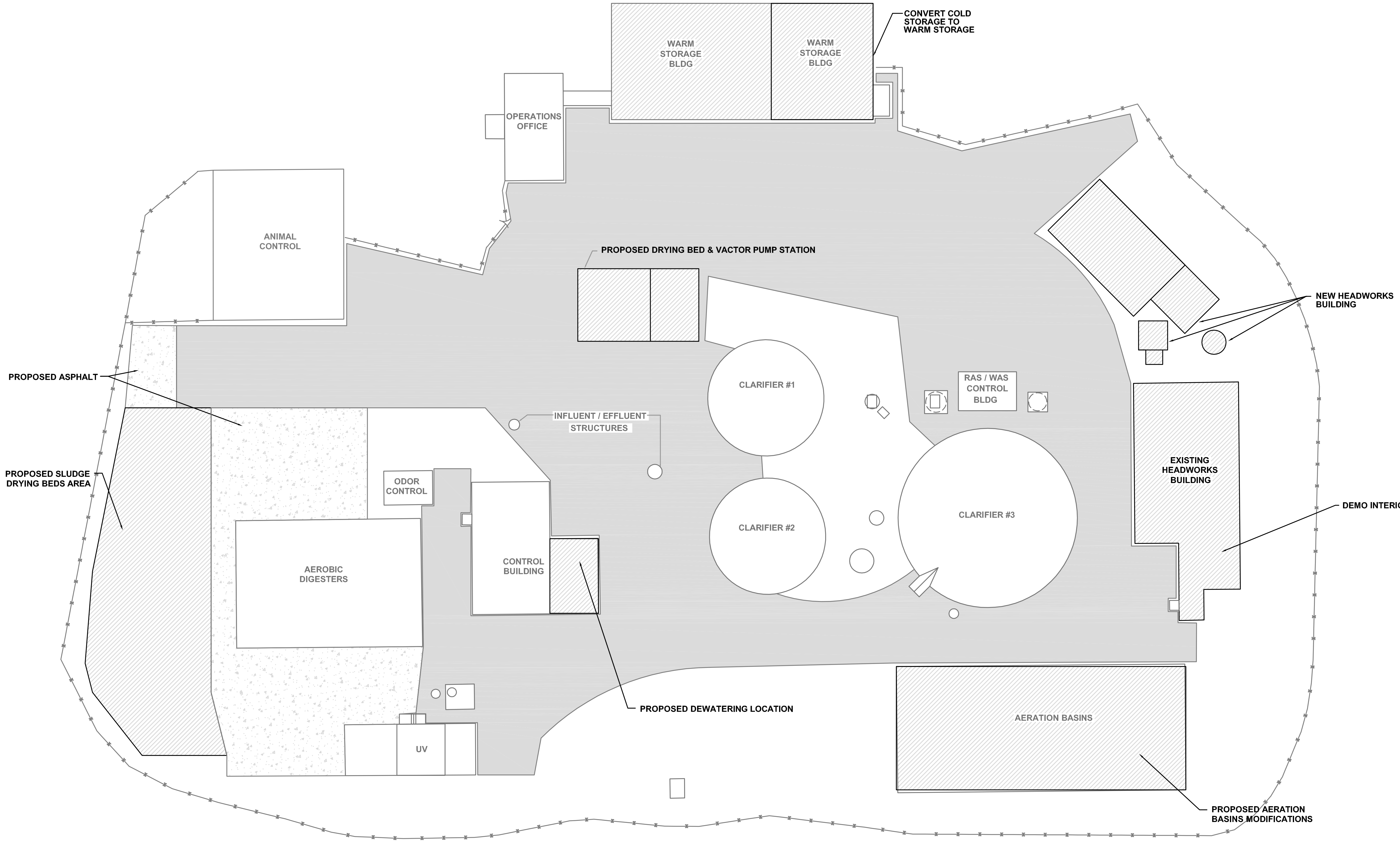
Disinfection

The existing UV system has adequate treatment and hydraulic capacity for future flows and loads within the 20-year planning horizon.

One recommended improvement to the UV system is to upgrade the control panel/PLC to allow the unit to be incorporated into the plant SCADA system.

4.4 Biosolids Treatment and Disposal

The City of Soldotna disposes of biosolids at the KPB landfill, which annually costs approximately $30,000 for disposal and $13,000 for hauling. More efficient dewatering equipment or drying beds would reduce these costs due to lower water content and fewer trips to the landfill would be required. The following alternatives are related to solids handling on site and are represented in Figure 33 and Figure 34.



SOLDOTNA UTILITY MASTER PLAN

WASTEWATER TREATMENT FACILITY

PROPOSED ALTERNATIVES SITE PLAN

Figure 33

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City of Soldotna, Alaska

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SOLDOTNA UTILITY MASTER PLAN

WASTEWATER TREATMENT FACILITY
PROPOSED ALTERNATIVES AERIAL VIEW

Figure 34

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4.5 Aerobic Digestion

The existing aerobic digester is undersized to achieve significant VSS reductions or to comply with pathogen reduction requirements, although neither are required since the dewatered biosolids are further treated with lime and disposed of in a landfill. Additional aerobic digester capacity for more stabilization is not required. Current regulations for disposal in a landfill only require that biosolids pass a paint filter liquids test to determine the presence of free liquids in the waste. Therefore, the lime is not a regulatory requirement. It is recommended that the City negotiate with the landfill to reduce or eliminate the use of lime for biosolids disposal.

The overall digester operational cost could be minimized, however, by running the digester as a simple sludge storage tank followed by mechanical thickening upstream of dewatering. The existing belt filter press is nearing the end of its useful life and will require replacement within the planning horizon. The lime volume required to raise the pH to 12 is dependent on the amount of water in the sludge. Prethickening the sludge between 5% and 7% would reduce the water in the sludge before lime addition by up to 80%. The existing digester could be functionally subdivided into aerated WAS storage and mechanically mixed thickened WAS storage to which the lime would be added. Alternatively, a small drum thickener could be added after the digester and upstream of the dewatering unit. Using a small drum thickener and screw press, thickening and dewatering can be designed for 24/7 operation, which reduces equipment size and cost as well as the internal loads returned to the head of the plant.

4.6 Dewatering

The existing belt filter press is nearing the end of its useful life and will require replacement in the next few years as parts are becoming more expensive and difficult to acquire. Replacement of the existing belt press with another dewatering option should be considered. A replacement belt press or dewatering equipment should be considered as operational times begin to exceed five days per week, eight hours per day.

A belt filter press represents an older, less efficient technology to compact and dewater biosolids. One option for improving the efficiency of the dewatering system is a small drum thickener followed by a screw press. A screw press is generally a contained unit where sludge that has been conditioned with a polymer is fed onto a screw-like drum that spins and transports sludge towards a discharge point. While the screw conveyor slowly turns, the screw pitch and drum diameter are decreased, which increases pressure on the sludge. The increased pressure forces water from the sludge, which is then filtered through small wire screening. A screw press can generally achieve solids concentrations of 30 to40% when dealing with aerobically digested primary sludge and offers very low maintenance and simple operation. A skid-mounted system is available that includes the screw press, flocculation tank, sludge pump, control panel, and polymer system. A rotary drum thickener with polymer addition can be used prior to a screw press for more efficient thickening and better dewatering in the screw press. Figure 35 shows a flow diagram of a typical screw press dewatering process. Figure 36 and Figure 37 are examples of a small drum thickener and screw press.

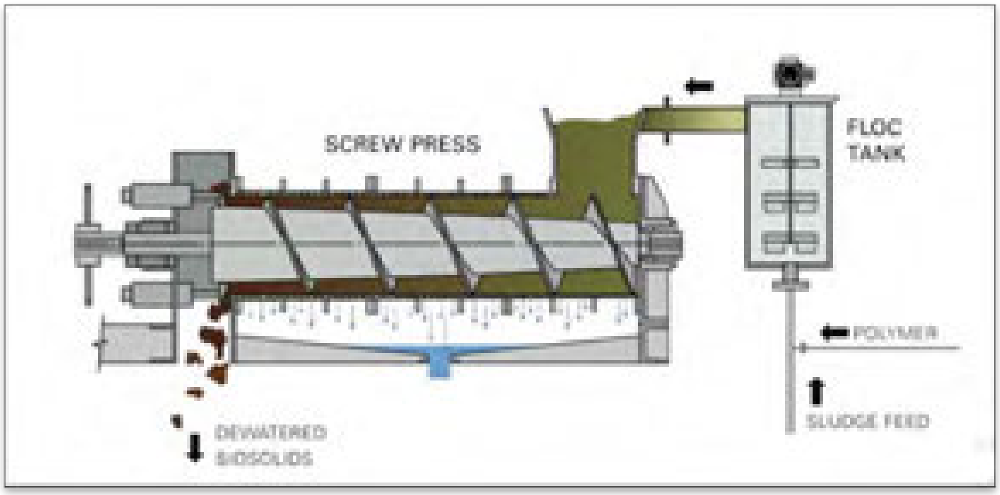

Figure 35. Typical Screw Press Dewatering Process Flow Diagram

Figure 36. Example for Small Drum Thickener

Figure 37. Example for Small Screw Press

Several manufacturers, including FKC and Huber, make reliable skid-mounted screw press equipment for this type of application. Figure 38 below shows the FKC screw press and conveyor from a recent installed in Skagway, AK. The equipment shown in the photos is similar size to what would be required at the Soldotna WWTP.

New dewatering equipment would offer improved performance, reliability, and efficiency over the older, existing equipment.

Significant operation and maintenance savings could be realized with an equipment replacement based on factors including:

- Lower operating costs associated with disposal of screenings and dewatered sludge with a lower water content,
- Lower operating costs associated with the less time spent by treatment plant staff handling/transporting wetter solids, and
- Incremental decrease in O&M costs by replacing existing equipment nearing the end of its useful life.

Figure 38. Screw Press Installation in Skagway, AK

More significant annual savings could be realized based on disposal of dewatered sludge from the plant with a new rotary drum thickener and screw press. However, when the City is ready to replace its dewatering equipment, the best available technology should be re-evaluated.

4.7 Drying Beds

Another alternative to mechanical dewatering is a sludge drying bed. It is a common method utilized to dewater sludge via filtration and evaporation. Perforated pipes situated at the bottom of the bed are used to drain seepage water or filtrate. A reduction of 35% or less in moisture content is expected after drying. The drying bed consists of a concrete structure for the bed and walls, an optional filter media, an underdrain, and inlet.

The WWTP has limited space behind the digesters and would only be capable of handling two to three months of biosolids. The City could purchase land to the west to have the capacity to hold biosolids for one year; however, the property is close to homes and a drying bed is prone to odor and insect problems. A drying bed is not considered a feasible option as it would not provide a significant cost savings in disposal and hauling. In addition, required odor control would be expensive and would not provide any additional benefit.

4.8 Vactor Truck Handling

The City currently takes stormwater Vactor© truck waste to be processed at a private, ADEC approved receiving pit at Mile 67 on the Sterling Highway. It requires two operators of the City's two Vactor© trucks approximately six hours for each truck delivery (round trip). The addition of a decant facility on site would greatly reduce the operational costs of hauling and disposing of Vactor© truck waste. The available space on the

WWTP site is limited and the City recommended an area near clarifier 1. The available space is approximately 1,500 square feet, which would be covered to eliminate inclement weather decreasing drying time of the solids and inflow into the WWTP. This facility would consist of a concrete tipping floor with a slope into a small basin where solids would accumulate. A sluice gate would be used to allow water to be skimmed off the top and sent to the headworks of the WWTP. Solids would be collected with a bobcat and placed in the adjacent drying bed dedicated to Vactor© truck stormwater waste. The dewatered solids could be disposed of at the landfill or mixed with the biosolids to ultimately be disposed of at the landfill.

This facility would reduce operational costs and is estimated to save approximately $1,200 for every five days of operating two Vactor© trucks each day due to reduced travel requirements (two hours of operation versus six hours of operation). Savings for the reduction of the amount of waste disposed of at the landfill was not included in this cost savings analysis. However, the savings would also be significant due to the waste being dewatered and hauled in a dump truck rather than a Vactor© truck.

5 Recommended Improvements

Overall, there are no pressing treatment process upgrades that are required to meet the current and future effluent requirements throughout the planning horizon. However, potential effluent limits for metals, copper and zinc, which are anticipated in the next APDES permit may need wastewater treatment process modifications to attain them. The relatively low copper and zinc effluent limits would be difficult to treat within the WWTP because of high capital cost for enhanced clarification and filtration equipment, long term operational costs for chemical addition, and overall operational complexity of metal removal. The recommended method for compliance is a two-pronged approach to address the metals issue outside of the WWTP processes. This approach would seek to lower these metals in the drinking water system prior to entering the sanitary sewer system and ultimately the plant and develop of site-specific metals criteria for the effluent permit limits at the discharge point in the Kenai River, as recommended by ADEC and EPA.

While there are no pressing upgrades required based on treatment capacity or process, there are a number of improvements that the City of Soldotna may consider to reduce operational costs and to replace equipment that reaches the end of its useful life. Due to the relatively small scale of the plant, significant capital investments made solely to reduce operational costs would be difficult to justify in most cases, but when done in combination with scheduled replacement or upgrade for other reasons sufficient benefit may be realized within a reasonable time frame. Recommended capital improvements are described below.

5.1 Replace Existing Centrifugal Blowers with High Speed Turbo Blowers (2016-2020)

Based on current average air flows and anticipated future operation of the plant, the installation of new high–efficiency blowers would result in significant energy savings and pay for itself within several years of operation. The three existing centrifugal blowers that serve the WWTP are approaching the end of their useful lives (approximately 20 to 30 years), and represent an older, less efficient means to supply the air flows needed at the facility. Preliminary evaluation suggests the installation of HST blowers at the plant to replace the existing blowers could result in considerable energy savings and long-term operational savings for the City. It is recommended that the new blowers be installed in a new building located between the existing headworks and aeration basins. An option to isolate the existing blower room in the headworks building was evaluated but not recommended based on constructability and long-term recommendations for the Headworks Building (described below).

5.2 Construct a Vactor Truck Dump Station (2016-2020)

A small dumping station for Vactor© trucks, including a tipping floor and drying area, would be a relatively small capital investment that would provide savings for operational costs and time. Currently, it takes two operators approximately three fourths of a day to run the Vactor© trucks to KPB landfill for dumping. Having an on-site option at the plant would free up operator time and provide savings on fuel, windshield time, and wear and tear to the vehicles.

5.3 Headworks Building Roof Repair (2016-2017)

It is recommended to perform the roof repair to the existing Headworks Building to help extend its useful life and allow operating of the headworks processes until a replacement headworks building is constructed. It is not recommended to do large scale equipment replacement or building renovation on the existing building to maintain its operation as a headworks because of the extent of repairs and upgrades required and that the headworks processes must remain operating during construction.

5.4 Convert the Existing Cold Storage Building to Warm Storage (2017)

When the existing storage buildings were constructed, only approximately half of the area was developed for warm storage due to funding limitations. Converting the cold storage to warm storage would provide space for storage of temperature sensitive equipment and chemicals and provide a valuable work area for the operators to maintain equipment, vehicles, etc.

5.5 Refurbish Clarifiers 1 and 2 (2020)

The two small clarifiers that were constructed in the 1970s and have not been refurbished. All internal mechanical equipment and gear boxes are worn and in need of replacement.

One clarifier is used as for effluent polishing. Using the clarifier decreases effluent turbidity which decreases UV bulb maintenance, saving operating costs.

The second clarifier is used as an equalization basin for sludge decanting and belt filter press pressate. Using the clarifier allows these two high strength liquid streams to be metered into the influent stream over 12 to 36 hours. This decreases the chance of upsetting the treatment process and lowers O&M costs associated with these disruptions.

Using the clarifiers for these purposes helps lower O&M costs and levels manpower needs.

The mechanical components of both clarifiers - arms, scum boxes, and motors - should be replaced in the first 5 planning years. This can be done in stages over subsequent years if needed.

5.6 Construct New Headworks Building (2020-2025)

It is recommended that a new Headworks Building with screening and grit facilities be constructed while the existing building remains operational. The facility will be designed to have a two channel screening facility with one screen installed and a bypass channel with a 1-inch coarse screen. A second mechanical screen could be installed in a future phase. Manufacturer cut sheets for screening and grit equipment have been included in Appendix B for reference.

Given the extent of the renovation and cost that would need to take place to utilize the current structure as a headworks it would be much simpler, cleaner, and cost effective to construct a new Headworks facility. The existing screening and grit removal equipment is at the end of its useful life and should be replaced with new, more efficient equipment as the old equipment fails and requires more operational attention. The new headworks building would include a new influent pump station, new screening and grit facilities and could be constructed without disruption to the existing headworks. Once the new headworks is brought on-line, the existing building could be refurbished or demolished based on City needs.

5.7 Aeration Basin Modifications (2020-2025)

Preliminary process calculations indicate that near the end of the planning horizon (2035), the existing number of diffusers in the aeration basins may be insufficient to meet projected air demands. It is likely, however, that the City will need to replace the existing diffusers before the end of the planning horizon. It is recommended that the City plan on adding more diffusers with the next diffuser replacement – which would be approximately 10 years out given the typical life span of diffusers. Other process modifications may be considered at the time of diffuser replacement to enhance nutrient removal capabilities.

5.8 Aerobic Digester and Dewatering Modifications (2020-2025)

The existing aerobic digester is too small to achieve significant VSS destruction (currently get approximately 15%) or comply with pathogen reduction requirements. The latter however is not required, and neither is VSS destruction, as the solids are lime stabilized and landfilled. As long as the current operation of landfilling the solids continues, then it is not recommended to make a significant capital investment to increase digester capacity.

The overall digester operational cost could be optimized, however, by running the digester as a simple sludge storage tank followed by mechanical thickening upstream of dewatering. The existing belt filter press is nearing the end of its useful life and will require replacement within the planning horizon. The lime volume required to raise the pH to 12 is dependent on the amount of water in the sludge. Prethickening the sludge between 5% and 7% would reduce the water in the sludge before lime addition by up to 80%. The existing digester could be functionally subdivided into aerated WAS storage and mechanically mixed thickened WAS storage to which the lime would be added. Alternatively, a small drum thickener could be added after the digester and upstream of the dewatering unit. Using a small drum thickener and screw press, thickening and dewatering can be designed for 24/7 operation, which reduces equipment size and cost as well as the internal loads returned to the head of the plant.

5.9 Refurbish/Demolish Existing Headworks Building (2025-2030)

After bringing a new headworks building on-line, the City can re-evaluate the use of the existing building. As described above, the building would require significant electrical and mechanical upgrades to bring the building up to current standards. After being taken out of service as a headworks, the building could be used for cold storage, be upgraded or refurbished to house treatment unit processes that may be required in the future, or it may be decided that demolition of the structure makes the most sense in the future.

5.10 Other Recommendations

In addition to the capital improvements described above, there are several studies, on-going sampling additions, and minor repairs and improvements to consider for the Soldotna WWTP. These could be implemented as soon as funding is available. The additional recommendations include:

- Inflow and Infiltration Study: Maximum day and peak hour flows generally correspond to significant rain events in the area; the peak hour flows can also be exaggerated by multiple pump station discharges combining at the WWTP. The peak flow seen at the plant in 2015 was approximately 3.16 MGD, which exceeds the hydraulic capacity of several treatment plant processes. These high peak flows can cause operational problems at the facility, particularly since they generally come with a sharp increase in solids. Headworks processes, including screening, grit removal, etc., have not be designed for the large peak flows (exceeding approximately 2.7 MGD) and can be inundated with grit and inert solids. During these peak events solids can make it through the preliminary treatment units and settle out in the Aeration Basins, which ultimately requires more frequent cleaning of the basins to maintain full capacity and operating efficiency. Identifying and fixing the I&I issues would help alleviate the peak flows to the WWTP and could help extend the life of older equipment, improve overall treatment and operational efficiency, and potentially delay future plant capacity upgrades.
- Additional Sampling: It is recommended that the City develop a routine sampling plan as well as an influent characterization sampling plan to gather the necessary data for future designs, capacity evaluations, or planning efforts. In addition to the current sampling at the facility, it is suggested that the WWTP staff begin testing for alkalinity (influent and aeration basins), ammonia (influent and through the aeration basins), and TKN (influent).
- Miscellaneous Electrical Improvements: The electrical switchgear in the Control Building is divided into two age classes of equipment. A new main service circuit breaker, MCC feeder circuit breakers and the standby generator Automatic Transfer Switch sections were installed in a single switchgear lineup with the new diesel-fired generator upgrade within the last five years. The second class of equipment is the MCCs (MCC-1 and MCC-310) and other switchgear installed during the original construction and near the end of their useful life. The original MCCs should be considered for replacement as part of another upgrade project

(dewatering upgrades, etc.) or done as a stand-alone project over the course of the 20-year planning horizon.

- Another recommended electrical improvement is to upgrade the control panel/PLC for the UV system to allow the unit to be incorporated into the plant SCADA system.
- Miscellaneous Mechanical Improvements: The building contains a gas-fired boiler that serves hydronic unit heaters in the southeast corner, and baseboard heaters in the generator room and the second floor. A make-up air system it still in place although not operational, as the heating coil has been disconnected. The gas system within the building is medium pressure (regulated to 2 psig at the meter outside) with pressure regulators at each heating unit. The pressure regulators within the building have relief vent openings into the building. Current code requires that regulator vents be routed outside the building unless the regulators have a vent limiting feature. The gas meter at the control building also serves other buildings via underground piping. One such connection to underground on the south side of the building lacks a flexible connector, making the piping vulnerable to damage due to ground settlement or seismic activity.

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6 Recommended Improvement Plan

In developing recommendations for the improvement plan, proposed projects were evaluated for the severity of need, how each project would effect the other recommendations, potential cost savings and the ability to keep the WWTP in compliance with future demands. Based on this evaluation, projects were placed into a ranking and a proposed order of construction. The following sections describe this evaluation and final recommended improvements.

6.1 Administrative Plan

6.2 Staffing

6.2.1 Current Workload

The Soldotna utilities system, the combined water supply and distribution system, wastewater collection system, and wastewater treatment plant are operated and maintained by the same staff pool. Operators are cross trained between water and wastewater operations, and the staff works between each utility component. Therefore, staffing must be discussed in the context of the entire water and wastewater utility.

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

- Inspection of new water and sewer service connections installed by developers;
- Fulfillment of water and sewer pipe location requests;
- Operation and maintenance of the water supply and distribution systems, including cross-connection surveillance;
- Twice-annual water main flushing;
- Fire hydrant maintenance;
- Operation, cleaning, and maintenance of the sanitary sewer collection system;
- Operation and maintenance of the wastewater treatment plant;
- Sampling and monitoring to meet all regulatory requirements, including:
- Water supply sampling,
- Wastewater plant influent and effluent sampling, and
- Dewatered wastewater sludge sampling;
- Reporting as required by water and wastewater regulations and permits;
- Development and implementation of computerized maintenance management system for all utility equipment;
- Oversight of contractors hired to construct projects;
- Development and management of budgets and staff; and

- Maintenance of grounds, including snowplowing, at all water and wastewater utility sites.

The facility plan that addressed utilities operation was completed in 2001. Table 21 presents a comparison of general water, sewer, and wastewater treatment plant components operated by the utilities staff in 2001 and 2014. In general, systems and services have grown about 30% between 2001 and 2014. Several components decreased in size or complexity (e.g., the number of active wells), but the vast majority increased in operational requirements. Some system components, such as the number of water meters and lift stations, have increased quite significantly. Also, the system is now 13 years older, so some mechanical components of the treatment plant are now more than 30 years old. These increases in the utilities' system size, complexity, and age have resulted in additional work for staff.

Table 21. Soldotna Water and Sewer General System Changes, 2001 to 2014

Water System			Change	
Year	2001	2014	13	years
Customers	2700	3350	24%	increase
Average demand, MGD	0.6	0.71	18%	increase
Peak demand, MGD	0.9	0.88	-2%	decrease
Wells	5	4	-20%	decrease
Reservoir sites	1	2	100%	increase
Reservoirs	2	2	0%	change
Booster/PRV station	0	1		increase
Pipe length, miles	32	38	19%	increase
Hydrants	240	315	31%	increase
Service connections	1200	1810	51%	increase
Meters	30	377	1157%	increase
SCADA	limited	extensive		increase

Sewer System			Change	
Year	2001	2014	13	years
Customers	2700	3400	26%	increase
Pipe length, miles	24	29.5	23%	increase
Manholes	393	483	23%	increase
Lift stations	10	16	60%	increase
Vactor truck	1	1	0%	change
SCADA	none	In each LS		increase

WWTP				Change	
Year		2001	2014	13	years
Customers		2700	3400	26%	increase
Average flow, MGD		0.51	0.56	10%	increase
Maximum month, MGD		0.59	0.78	32%	increase
Aeration Basins		2	2	0%	change
Clarifiers		2	3	50%	increase
Disinfection	Cl		UV		
SCADA	limited		extensive		increase
Equipment age					
Clarifiers, years		19	32, 10		increase
Aeration Basins		19	32	79%	increase
Belt Press		19	32	79%	increase

6.2.2 Current Staffing

In 2014, the operations and maintenance staff for the water and wastewater utility consisted of one manager and four operators. Additional labor for utility-related tasks and special projects in 2014 was obtained from the following:

- Staff overtime (approximately 400 hours per year);
- Local contractors (about 80% of all electrical work and 90% of all mechanical work);
- City maintenance shop (approximately 80 hours per year); and
- Summer hire staff (approximately 475 hours annually).

The labor from the city maintenance shop, overtime, and temporary employees totals 960 hours annually. Using the EPA criteria of 1,500 hours per year of productive time (productive time is defined as normal full-time work year, 2,080 hours, excluding vacation, sick leave, and holidays) the borrowed labor, overtime, and temporary staff equals the equivalent of 0.65 full-time equivalent (FTE) employee.

Combining the current full-time staff of five with the borrowed, overtime, and temporary labor FTE of 0.65 results in a total equivalent staff of 5.65 people in the utility operation.

6.2.3 Staffing Analysis

The most recent utility staff analysis was completed in 2001 for the *City of Soldotna Wastewater Facilities Master Plan* (HDR Alaska, 2001). The 2001 *Wastewater Facility Plan* staffing analysis reported that the utilities' staff consisted of four full-time staff and one FTE consisting of 1,300 hours borrowed City maintenance shop staff and the remainder of utilities staff overtime. The 2001 report concluded that the utilities operations was understaffed by approximately one FTE based on the size of the systems operated, staff duties, and comparison with other similar utilities.

In 2003, Soldotna utilities operations added another operator, increasing the number of operators to four. Hiring the fourth operator allowed for reduced use of City maintenance shop staff, which was experiencing increased workloads as the city grew and had less time available to loan to the utilities maintenance.

With no staff additions since 2003, in 2014 the utilities had five full-time staff and used some summer hire staff. A comparison of the staffing between 2001 and 2014 is shown in Table 22.

Table 22. Soldotna Utilities Staff Levels

Year	FTEs	Employees	Staff OT FTE	Temporary or borrowed city staff FTE
2001	5	4	0.35	0.65
2014	5.43	5	0.18	0.25

WWTP Staff

HDR used the *Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants* (2008) developed by New England Interstate Water Pollution Control Commission (NEIWPCC). This guide was developed to build upon the U.S. Environmental Protection Agency reference guide titled *Estimated Staffing for Municipal Wastewater Treatment Facilities* (1973). Using this guidance, a 2015 analysis of plant staffing recommends 3.8 full-time staff at the WWTP. This is higher than the staff estimate developed in 2001 of 3.1 FTE and in line with the current plant's treatment processes and discharge requirements.

As a comparison, AWWU's Eagle River WWTP is a slightly larger plant with a design capacity of 2.5 MGD and an average daily flow of 1.5 MGD. They have a tertiary filter, but otherwise a fairly comparable process, size, age, and treatment requirements to the Soldotna WWTP. This plant is staffed with six people: one WWTP Superintendent, one Operations Foreman, and four Operators. The AWWU Eagle River WWTP staff is dedicated to the plant. They may occasionally address FOG issues (e.g., visit a FOG offender regarding pretreatment), but generally the Eagle River WWTP staff is dedicated to the job of operating and maintaining the plant. Eagle River WWTP staffing indicates that the estimated staffing for the Soldotna WWTP is reasonable.

Water and Sewer System Staff

Based on the water distribution and sewer collection system growth, operating staff have not increased proportionally. The general system has grown in complexity and extents since 2001. Factors that would increase staff requirements include more customers (about 25% increase); pipe in the ground, hydrants, and manholes (ranging from 20 and 30% increase); adding a remote reservoir, booster station, and PRV; adding six sewage pump stations (60% increase); system age increasing by 13 years, and other related factors increase operation and maintenance work load for the system. These indicate that additional staff may be required to operate these systems effectively and meet regulatory requirements.

Soldotna has mitigated the increased work load through labor saving changes instituted by the utilities operations. These include installing SCADA at all pump stations, wells, reservoirs, and booster stations; cross training all utility staff in operating water and sewer systems; WWTP upgrades of additional clarifier capacity, changing from chlorine to UV disinfection; advocating for pipe insulation to reduce freezing risk in water pipes; and other measures. These measures have added labor efficiencies (e.g., not needing to inspect lift stations as often), and have allowed existing staff to keep pace with increasing workload from system expansion and aging. However, after 10 years of no staff increases while the system size and complexity increased, the workload to operate the utilities system should be considered.

The 2001 staffing analysis estimated that the maintenance of the water distribution and sewer collection system would require 2.9 FTEs. This was based on the miles of pipe in the ground, the number of lift stations, and the water supply and storage methods. In the past 13 years, the pipe length has increased by about 25%, lift stations increased by 60%, and a booster and PRV statin was added to the system. Because of these additions to the distribution and collection system, it is reasonable to assume that additional labor is required to operate the system. Maintenance of these systems generally increases with size, so a system increase of approximately 30% would represent a need of approximately 30% more labor to operate the system. This would equate to a labor need of 3.7 FTEs dedicated to the operation of the combined water supply and distribution system and the sewage collection system.

6.2.4 Total Staffing

The results of the individual staff analyses are presented in Table 23. Also shown is the current staffing level as evaluated in Section 6.2.2 The previous analysis indicates that the utility operation should have a staff of 7.5 people.

Table 23. Staff Analyses Results

Staff	Staffing Level
Water supply and distribution and sewage collection FTEs	3.7
Wastewater treatment plant FTEs	3.8
Total estimated FTE requirement	7.5
Current FTE total	5.4
Estimated staff deficit	2.0

6.2.5 Staffing Recommendations

The existing staff consists of one full-time supervisor and four operators plus borrowed, overtime, and temporary labor help for an equivalent full-time staff of 5.4 employees. The staffing analysis presented above recommends considering increasing utilities staff by one or two FTEs. As the system expands to serve additional customers and when the APDES permit is renewed, staff requirements should be reevaluated.

6.3 Capital Improvement Plan

6.3.1 Capital Improvement Plan

Recommended projects to address identified WWTP needs and future service are compiled in Table 24.

Table 24 also presents the recommended project implementation schedule in the years 2016 to 2035. The schedule attempts to tie improvements to consistent funding of projects and avoiding large rate increases. Revisions to the planned schedule will be necessary should growth patterns change.

The 2015 WWMP's elements were developed on the basis of being flexible to accommodate changes in growth patterns. The projects are developed to a planning level only; they are conceptual in nature and subject to refinement as they are implemented. The recommended projects are also represented in the following Figure 39.

The project cost estimates presented in Table 21 have been prepared in accordance with the guidelines of the AACE International. According to the definitions of AACE International, the "Class 5 Estimate" is defined as:

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

Table 24. Soldotna WWTP Recommended Projects

Project #	Project Name	Implementation Year	Description	Estimated Cost (2015 Dollars)
T1	Replace Existing Centrifugal Blowers	2016-2020	Install of HST blowers at the plant to replace the existing blowers. The new blowers will be located in a new building located between the existing headworks and aeration basins.	$1,108,000
T2	Vactor Truck Dump Station	2016-2020	Construct a small dumping station for vactor trucks, including a tipping floor and drying area.	$671,000
T3	Headworks Building Roof Repair	2016-2017	Repair roof on headworks building.	$60,000
T4	Cold Storage Building	2017	Converting the cold storage to warm storage would provide space for storage of temperature sensitive equipment and chemicals and provide a valuable work area for the operators to maintain equipment, vehicles	$346,000
T5	Refurbish Clarifier 1 and 2	2020	Replace mechanical components of Clarifiers 1 and 2	$500,000

Project #	Project Name	Implementation Year	Description	Estimated Cost (2015 Dollars)
T6	New Headworks Building	2020-2025	Construct a new Headworks Building with screening and grit facilities north of the existing building. Then new building would be constructed while the existing building remains operational	$4,163,000
T7	Aeration Basin Modifications	2020-2025	Replace the existing diffusers with reconfigured diffusers to enhance the aeration process and ammonia removal.	$997,000
T8	Aerobic Digester and Dewatering Modifications	2020-2025	Operated the digester as a simple sludge storage tank. Replace the belt filter press with mechanical thickening upstream of new sludge dewatering equipment. This project may need to be accelerated if the existing belt press operation becomes costly due to replacement parts unavailability.	$927,000
T9	Refurbish or Demolish Existing Headworks Building	2025-2030	After bringing a new headworks building on-line, the City can evaluate the use of the existing building and repurpose or demolish it as appropriate.	TBD

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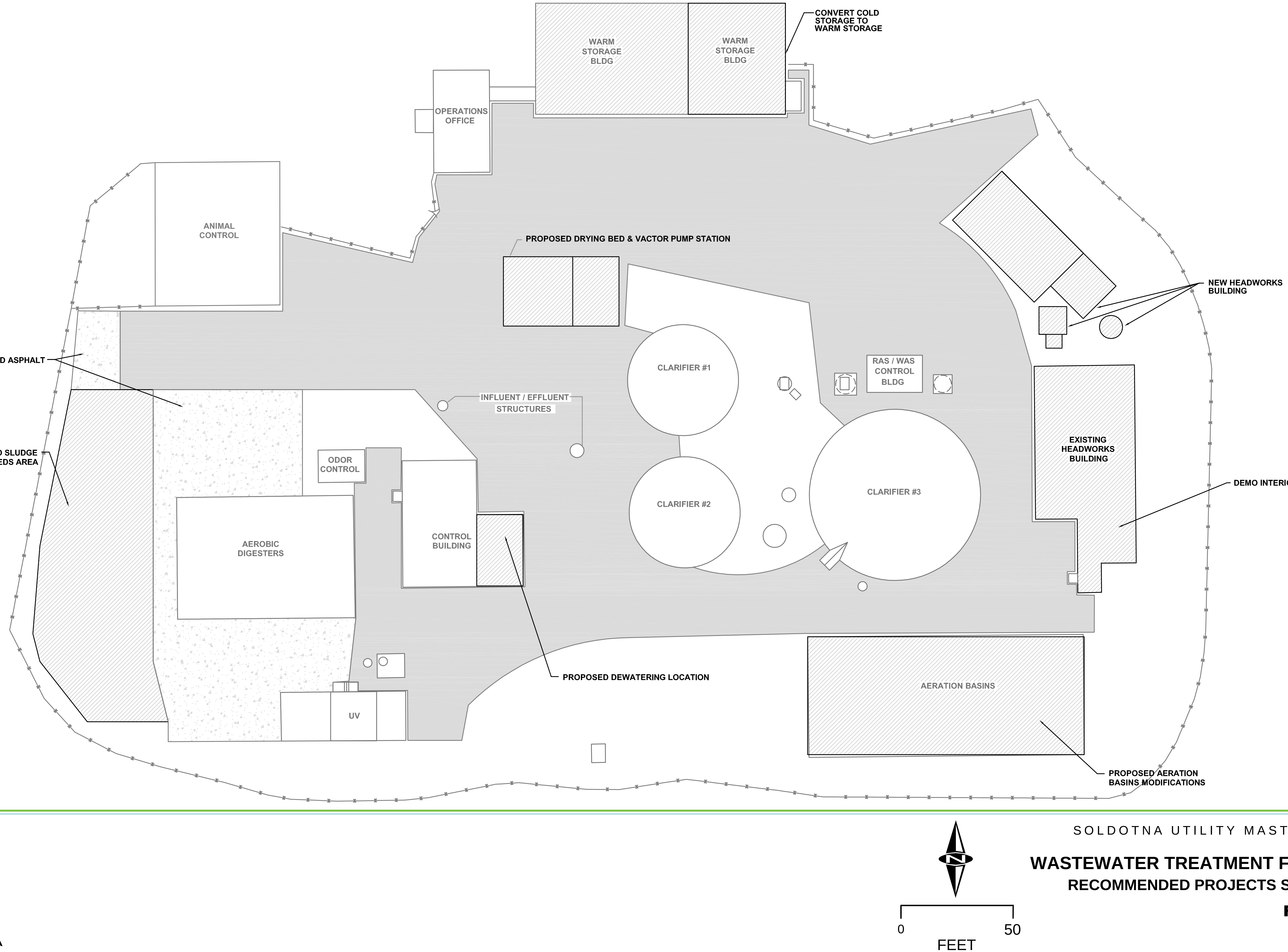

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

WASTEWATER TREATMENT FACILITY

RECOMMENDED PROJECTS SITE PLAN

Figure 39

HDR

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Appendix A

Current WWTP NPDES Permit

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Permit No.: AK-002003-6

U.S. Environmental Protection Agency (EPA), Region 10
1200 Sixth Avenue
Seattle, Washington 98101
(206) 553-1214

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, 33 U.S.C. §1251 et seq., as amended by the Water Quality Act of 1987, P.L. 100-4, the "Act,"

City of Soldotna

is authorized to discharge from the Soldotna Wastewater Treatment Facility, located in Soldotna, Alaska to receiving waters named the Kenai River at the following location

Outfall Serial Number	Latitude	Longitude
001	60E 28' 44.2" N	151E 03' 51.3" W

in accordance with discharge point(s), effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective July 25th 2000.

This permit and the authorization to discharge shall expire at midnight, July 25th 2005

Signed this 22nd day of June 2000.

Randall F. Smith
Director, Office of Water, Region 10
U.S. Environmental Protection Agency

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I. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

A. Effluent Limitations

During the effective period of this permit, the permittee is authorized to discharge wastewater to the Kenai River from Outfall 001 provided the discharge meets the limitations and monitoring requirements set forth herein. This permit does not authorize the discharge of any waste streams, including spills and other unintentional or non-routine discharges of pollutants, that are not part of the normal operation of the facility as disclosed in the permit application.

1. The pH range shall be between 6.5 - 8.5 standard units. The permittee shall monitor for pH five (5) times per week on separate days. Sample analysis shall be conducted on grab samples from the effluent. The Permittee shall report the number and duration of pH excursions during the month with the DMR for that month.

2. There shall be no discharge of floating solids, visible foam in other than trace amounts, or oily wastes which produce a sheen on the surface of the receiving water.

3. The following effluent limits shall apply.

Effluent Characteristic	**Unit of Measure**	**Average Monthly Limits[1]**	**Average Weekly Limits[1]**	**Maximum Daily Limits[1]**
Biochemical Oxygen Demand 5-day (BOD_5)	mg/L 1b/day	30 255.2	45 382.8	60 510.4
Total Suspended Solids (TSS)	mg/L 1b/day	30 255.2	45 382.8	60 510.4
Fecal Coliform Bacteria[2]	#/100 ml	100[3]	---	200[4]
Total Residual Chlorine[2]	mg/L	---	---	.002
Flow	MGD	---	---	1.02[5]

Effluent Characteristic	Unit of Measure	Average Monthly Limits[1]	Average Weekly Limits[1]	Maximum Daily Limits[1]

1 If an analytical value is less than the method detection limit (MDL), the permittee shall report "< [numerical method detection limit]" on the DMR. For example, if the laboratory reports "not detected" for a sample, and states that the MDL is "5 µg/L" then the permittee shall report "< 5 µg/L" on the DMR. All other values shall be reported and used in calculating averages. For minimum levels and interim minimum levels, see section I.A.6. For the purposes of calculating averages, any value below the MDL may be set equal to zero.
2 Reporting is required within 24 hours if the maximum daily limit is violated. Once ultraviolet disinfection has been fully implemented at the Soldotna WWTF, and the permittee has notified EPA and ADEC, the TRC limitations and monitoring requirements will no longer be applicable.
3 Based on a geometric mean of a minimum of 5 separate samples taken within 30 days.
4 No more than one sample, nor more than 10 percent of the samples if there are more than 10 samples, may exceed 200 FC/100 ml.
5 See paragraph 4 below.

4. When the plant design capacity of the Soldotna WWTF increases to 1.08 MGD, upon notification of EPA and ADEC, the effluent limits for BOD_5 and TSS will be as follows. At that time, the flow limit shall increase to 1.08 MGD.

Effluent Characteristic	Unit of Measure	Average Monthly Limits	Average Weekly Limits	Maximum Daily Limits
Biochemical Oxygen Demand 5-day (BOD_5)	mg/L 1b/day	30 270.2	45 405.3	60 540.4
Total Suspended Solids (TSS)	mg/L 1b/day	30 270.2	45 405.3	60 540.4

5. Percent removal requirements for BOD_5 and TSS are as follows: For any month, the monthly average effluent concentration shall not exceed 15 percent of the monthly average influent concentration.

Percent removal of BOD_5 and TSS shall be reported on the discharge monitoring reports (DMRs). For each parameter, the monthly average percent removal shall be calculated from the arithmetic mean of the influent values and the arithmetic mean of the effluent values for that month.

6. The effluent limits for total residual chlorine are near or below detection limits using EPA-approved analytical methods. EPA will use the minimum level[1] (ML) as the compliance evaluation level for total residual chlorine.

Parameter	ML, mg/L
Total Residual Chlorine	0.100

B. Monitoring Requirements

1. Treatment Plant Monitoring

Parameter	Location[1]	Sample Frequency	Sample Type
Total Flow, MGD	Influent or Effluent	Continuous	Recording
BOD_5[2], mg/L	Influent & Effluent	1/week 1/week	24-hour Composite 24-hour Composite
TSS[2], mg/L	Influent & Effluent	1/week 1/week	24-hour Composite 24-hour Composite
pH, S.U.	Effluent	5 days/week	Grab
Total Ammonia as N, mg/L	Effluent	1/month[3]	24-hour Composite
Copper[4], ug/L	Effluent	1/quarter[5]	24-hour Composite
Zinc[4], ug/L	Effluent	1/quarter[5]	24-hour Composite
Hardness as $CaCO_3$, mg/L	Effluent	Whenever metals are sampled	24-hour Composite
Alkalinity as $CaCO_3$, mg/L	Effluent	Whenever metals are sampled	24-hour Composite
Fecal Coliform, #/100 ml	Effluent	1/week	Grab
Total Chlorine Residual, mg/L[6]	Effluent	5 days/week	Grab

1 See Part IV.R., "Definitions" for definitions of minimum and interim minimum levels.

Whole effluent toxicity, TUc	Effluent	August 2001, November 2002, June 2004	24-hour Composite

1 Effluent samples shall be collected after the last treatment unit prior to discharge.
2 Influent and effluent composite samples shall be collected during the same 24-hour period.
3 Monitoring for this shall continue for 12 months after the effective date of the permit.
4 These parameters shall be analyzed as total recoverable. The permittee shall use a method which achieves a method detection limit (MDL) of 3 Fg/L for copper and 2 Fg/L for zinc.
5 Monitoring shall continue for 3 years or until 10 samples are collected.
6 <u>See</u> below for further requirements.

2. Total Chlorine Residual Requirements. Once ultraviolet disinfection has been fully implemented at the Soldotna WWTF, and the permittee has notified EPA and ADEC, the TRC limitations and monitoring requirements will no longer be applicable.

3. Whole Effluent Toxicity Testing. The permittee shall conduct three (3) toxicity tests on 24-hour composite effluent samples as described below.

    a. Organisms and protocols

        (1) The permittee shall conduct static-renewal tests with the cladoceran, *Ceriodaphnia dubia* survival and reproduction test and the fathead minnow, *Pimephales promelas* larval survival and growth test.

        (2) The presence of chronic toxicity shall be estimated as specified in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms*, Third Edition, EPA-600-4-91-002, July 1994.

    b. Tests shall be conducted in August 2001, November 2002, and June 2004.

    c. Results shall be reported in TUc (chronic toxic units). TUc = 100/NOEC (in percent effluent).

d. Chronic toxicity testing requirements are triggered when the NOEC exceeds 30.0 TUc (3.3 percent effluent). When chronic toxicity testing requirements are triggered, the permittee shall comply with the requirements set out in paragraphs g. and h. below.

e. Quality assurance

(1) A series of five dilutions and a control shall be tested. The series shall include the receiving water concentration (RWC), two dilutions above the RWC, and two dilutions below the RWC. The RWC is 3.3 percent effluent concentration.

(2) Concurrent testing with reference toxicants shall also be conducted if organisms are not cultured in-house. Otherwise, monthly testing with reference toxicants is sufficient. Reference toxicants shall be conducted using the same test conditions as the effluent toxicity tests (e.g., same test duration and type).

(3) If the effluent tests do not meet all test acceptability criteria as specified in the manual, then the permittee must re-sample and re-test as soon as possible.

(4) Control and dilution water shall be synthetic, moderately hard laboratory water, as described in the manual. If the dilution water used is different from the culture water, a second control, using culture water shall also be used. Receiving water may be used as control and dilution water upon notification of EPA. In no case shall water that has not met test acceptability criteria be used as dilution water.

f. Preparation of initial investigation toxicity reduction evaluation (TRE) plan

(1) The permittee shall submit to EPA a copy of the permittee's initial investigation TRE workplan within 180 days of the effective date of this permit. This plan shall describe the steps the permittee intends to follow in the event that toxicity, as defined in paragraph 2.d. above, is detected, and should include at a minimum:

(a) a description of the investigation and evaluation techniques that would be used to identify potential causes/sources of toxicity, effluent variability, treatment system efficiency;
(b) a description of the facility's method of maximizing in-house treatment efficiency, good housekeeping practices, and a list of all chemicals used in operation of the facility; and
(c) a description of who will conduct it if a toxicity identification evaluation (TIE) is necessary.

g. Accelerated testing

(1) If chronic toxicity testing requirements as defined in paragraph d. above are triggered, the permittee shall implement the initial investigation workplan. If implementation of the initial investigation workplan indicates the source of toxicity (for instance, a temporary plant upset), then only one additional test is necessary. If toxicity is detected in this test, then paragraph g.(2) shall apply.

(2) If chronic toxicity testing requirements as defined in paragraph d. above are triggered, then the permittee shall conduct six more tests, bi-weekly (every two weeks), over a twelve-week period. Testing shall commence within two weeks of receipt of the sample results of the exceedance.

h. TRE and toxicity identification evaluation (TIE)

(1) If chronic toxicity testing requirements as defined in paragraph d. are triggered in any of the six additional

tests required under g.(1), then, in accordance with the permittee's initial investigation workplan and EPA manual EPA 833 B-99-002 (Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants), the permittee shall initiate a TRE within fifteen (15) days of receipt of the sample results of the exceedance. The permittee will develop as expeditiously as possible a more detailed TRE workplan, which includes:

(a) further actions to investigate and identify the cause of toxicity;
(b) actions the permittee will take to mitigate the impact of the discharge and to prevent the recurrence of toxicity; and
(c) a schedule for these actions.

(2) The permittee may initiate a TIE as part of the overall TRE process described in the EPA acute and chronic TIE manuals EPA/600/6-91/005F (Phase I), EPA/600/R-92/080 (Phase II), and EPA-600/R-92/081 (Phase III).

(3) If none of the six tests required under paragraph g.(1) above indicates toxicity, then the permittee may return to the normal testing frequency.

(4) If a TIE is initiated prior to completion of the accelerated testing, the accelerated testing schedule may be terminated, or used as necessary in performing the TIE.

i. Reporting

(1) The permittee shall submit the results of the toxicity tests, including any accelerated testing conducted during the month, in TUs with the discharge monitoring reports (DMR) for the month in which the test is conducted. If an initial investigation indicates the source of toxicity and accelerated testing is unnecessary, pursuant to paragraph g.(2), then those results shall also be submitted with the DMR for the quarter in which the investigation occurred.

(2) The full report shall be submitted by the end of the second month in which the DMR is submitted.

(3) The full report shall consist of the results; the dates of sample collection and initiation of each toxicity test; the triggers as defined in paragraph d. above; the type of activity occurring; the flow rate at the time of sample collection; and the chemical parameter monitoring required for the outfall(s) as defined in the permit.

(4) Test results for chronic tests shall also be reported according to Chapter 10, "Report Preparation," of the manual and shall be attached to the DMR.

C. Receiving Water Monitoring.

1. Sampling and analysis of the Soldotna effluent shall be conducted on the same days as the receiving water sampling for the same parameters that are sampled in the receiving water.

2. The following parameters shall be sampled:

Parameter	Effluent Sampling Frequency	Receiving Water Sampling Frequency
Flow, mgd	Continuous	---
Fecal Coliform Bacteria, #/100/ml	1 day/week	See paragraph 3 for monitoring frequency.
Total Ammonia as N, mg/L	See paragraphs 6a. and 6b. below for monitoring frequency.	See paragraphs 6a. and 6b. below for monitoring frequency.
Temperature, EC	See paragraphs 6a. and 6b. below for monitoring frequency.	See paragraphs 6a. and 6b. below for monitoring frequency.
pH, standard units	5 days/week	See paragraphs 6a. and 6b. below for monitoring frequency.

Parameter	Effluent Sampling Frequency	Receiving Water Sampling Frequency
Copper[1], Fg/L	1/quarter	See paragraph 6c. below for monitoring frequency.
Zinc[1], Fg/L	1/quarter	See paragraph 6c. below for monitoring frequency.
Hardness as $CaCO_3$, mg/L	1/quarter	See paragraph 6c. below for monitoring frequency.
Alkalinity as $CaCO_3$, mg/L	1/quarter	See paragraph 6c. below for monitoring frequency.

1 These parameters shall be analyzed as total recoverable.

3. Receiving water reports summarizing each sampling event shall be submitted to EPA and ADEC annually by September 15. Each report shall include results from the receiving water sampling as well as the daily effluent flow from the treatment plant on the day of sampling.

4. For pH the permittee shall use the test methods approved in Methods for Chemical Analysis of Water and Wastes, (EPA-600/4-79/020) or any other approved method in Table 1B of 40 CFR Part 136.

5. River samples shall consist of three grab samples, one from each side of the river and one from the middle. Fecal coliform shall be monitored both upstream and downstream of the outfall. All other parameters shall be monitored upstream of the outfall.

6. Sampling Frequency.

   a. Ammonia, pH, and temperature shall be monitored once per month during May, June, July, August, September and October and twice during the remainder of the year, (November 1 through April 30) for two years after the effective date of the permit until a total of 10 samples of each parameter has been obtained. Depending upon the results of the testing, additional monitoring may be required by EPA and ADEC.

   b. Beginning with the effective date of the permit, fecal coliform shall be monitored once per month during May 1 through

October 31 and twice during the remainder of the year, November 1 through April 30. Samples for fecal monitoring must be collected from a minimum of one downstream/down current location at the outer edge of the mixing zone (or as close to it as is practical due to site and access limitations). Monitoring may be discontinued after two years if the results indicate that State of Alaska water quality standards have not been exceeded. The monitoring must start again if the method of disinfection is changed and may also be discontinued two years after that time if the results indicate that State of Alaska water quality standards have not been exceeded outside of the mixing zone.

c. Beginning with the effective date of the permit and continuing until 10 samples have been collected, copper, zinc, hardness and alkalinity shall be sampled once every two months during the period of May through October. After 10 samples have been collected, monitoring shall be reduced to twice per year, once in the period May 1 - October 31, and again in the period November 1 - April 30, until June 29, 2005.

7. Mixing zone.

a. The mixing zone for this discharge has a dilution of 30:1 and is defined as the area extending downstream from the diffuser a distance of 47 meters (152 feet) and having a width of 5 meters (16 feet).

b. Within 90 days of the effective date of the permit, the permittee shall submit to EPA and ADEC upstream and downstream monitoring locations.

c. Within 120 days of the effective date of the permit, the permittee shall place a sign, or signs, on the shoreline near the mixing zone and outfall line. The sign, or signs, shall state that treated domestic wastewater is being discharged, the name and owner of the facility, and the approximate location and size of the mixing zone. The sign, or signs, should inform the public that a mixing zone exists and certain activities should not take place in the mixing zone, as well as give a facility contact telephone number for additional information.

D. Quality Assurance Project Plan.

1. The permittee shall develop a Quality Assurance Plan. The primary purpose of the Quality Assurance Plan shall be to assist in planning for the collection and analysis of samples in support of the permit and in explaining data anomalies when they occur.

2. Throughout all sample collection and analysis activities, the permittee shall use the EPA approved quality assurance, quality control, and chain-of-custody procedures described in EPA QA/G-5 *Guidance on Quality Assurance Project Plans*. This document is available as an Adobe Acrobat file at http:\\www.epa.gov\r10earth\offices\oea\qaindex.htm.

3. The Permittee must maintain this plan for a period of five years, and must make this plan available to the EPA upon request.

4. At a minimum the plan shall include the following: sampling techniques (field blanks, replicates, duplicates, control samples, etc); sampling preservation methods; sampling shipment procedures; instrument calibration procedures and preventive maintenance (frequency, standard, spare parts); qualification and training of personnel; analytical test method that will be used to achieve the method detection limits in Part I.C.4.; and analytical methods (including quality control checks, quantification/detection levels).

5. Name(s), address(es) and telephone number(s) of the laboratories, used by or proposed to be used by the permittee, shall be specified in the Quality Assurance Plan.

6. The permittee may obtain copies of all references cited in this part of the permit from the following address:

   Quality and Data Management Program
   Office of Environmental Assessment
   U.S. EPA, Region 10
   1200 6th Avenue, OEA-095
   Seattle, Washington 98101.

E. Design Criteria Requirements. The design criteria for the permitted facility are as follows:

Design Criteria		
Criteria	**Value**	**Units**
Average Flow	1.02	mgd
Influent BOD_5 Loading	2,033	lbs/day
Influent TSS Loading	1,948	lbs/day

1. When the plant design capacity is expanded to 1.08 MGD, and upon notification of EPA and ADEC, the following design criteria shall apply.

Design Criteria		
Criteria	**Value**	**Units**
Average Flow	1.08	mgd
Influent BOD_5 Loading	2,205	lbs/day
Influent TSS Loading	2,110	lbs/day

2. Each month, the permittee shall compute an annual average value for flow, and BOD_5 and TSS loading entering the facility based on the previous twelve months data or all data available, whichever is less. If the facility performs plant upgrades that affect design criteria listed in the table, only data collected after the upgrade should be used in determining the annual average value. When the average annual values exceed 85% of the design criteria values listed in the table for three months in a row, the permittee shall develop a facility plan and schedule within 18 months from the date of the third exceedance. The plan must include the permittee's strategy for continuing to maintain compliance with effluent limits and will be made available to the Director or authorized representative upon request.

F. Operation and Maintenance Plan Review.

1. Within 180 days of the effective date of the permit, the permittee shall review its operation and maintenance (O&M) plan and ensure that it

includes appropriate best management practices (BMPs); the plan must be reviewed annually thereafter. BMPs include measures which prevent or minimize the potential for the release of pollutants to the Kenai River. The Plan shall be retained on site and made available to EPA and ADEC upon request.

2. The permittee shall develop a description of pollution prevention measures and controls appropriate for the facility. The appropriateness and priorities of controls in the Plan shall reflect identified potential sources of pollutants at the facility. The description of BMPs shall address, to the extent practicable, the following minimum components: spill prevention and control; optimization of chemical usage; preventive maintenance program; minimization of pollutant inputs from industrial users; research, development and implementation of a public information and education program to control the introduction of household hazardous materials to the sewer system; and water conservation.

II. MONITORING, RECORDING AND REPORTING REQUIREMENTS

A. Representative Sampling. Final effluent samples taken in compliance with the monitoring requirements established under Part I shall be collected from the effluent stream prior to discharge into the receiving waters. Samples and measurements shall be representative of the volume and nature of the monitored discharge.

B. Monitoring Procedures. Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

C. Reporting of Monitoring Results. Monitoring results conducted in compliance with Parts I.A.–C. of this permit shall be summarized each month on the Discharge Monitoring Report (DMR) form. The reports shall be submitted monthly and are to be postmarked by the 10th day of the following month. Legible copies of these, and all other reports, shall be signed and certified in accordance with the requirements of Part IV.J., Signatory Requirements, and submitted to the Director, Office of Water and ADEC at the following addresses:

original to: United States Environmental Protection Agency (EPA)
Region 10
1200 Sixth Avenue, OW-133
Seattle, Washington 98101,

copy to: Alaska Department of Environmental Conservation (ADEC)
Division of Air and Water Quality
555 Cordova Street
Anchorage, Alaska 99503.

D. Additional Monitoring by the Permittee. If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR. Such increased frequency shall also be indicated.

E. Records Contents. Records of monitoring information shall include the following:

the date, exact place, and time of sampling or measurements;
the individual(s) who performed the sampling or measurements;
the date(s) analyses were performed;
the individual(s) who performed the analyses;

the analytical techniques or methods used; and
the results of such analyses.

F. Retention of Records. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least three years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time. A copy of this NPDES permit must be maintained on-site during the duration of activity at the permitted location. Data collected on-site and copies of Discharge Monitoring Reports (DMRs) must be maintained on-site for three years, after which they may be stored off-site.

G. Twenty-four Hour Notice of Noncompliance Reporting.

1. The following occurrences of noncompliance shall be reported by telephone within 24 hours from the time the permittee becomes aware of the circumstances:

   a. any noncompliance which may endanger health or the environment;

   b. any unanticipated bypass which exceeds any effluent limitation in the permit (See Part III.H,. Bypass of Treatment Facilities.);

   c. any upset which exceeds any effluent limitation in the permit (See Part III.H., Upset Conditions.); or

   d. violation of a maximum daily discharge limitation for those toxic or hazardous pollutants identified in Part I.A.3. of the permit to be reported within 24 hours.

2. The permittee shall report any noncompliance, including transportation accidents, spills, and uncontrolled runoff from biosolid transfer or land application sites which may seriously endanger health or the environment as soon as possible, but no later than 24 hours from the time the permittee first became aware of the circumstances. The report shall be made to the EPA, Region 10, at (206) 553-1846 and to ADEC.

3. The following occurrences of noncompliance with biosolids requirements shall be reported by telephone to the ADEC and EPA, Region 10, NPDES Compliance Unit in Seattle, Washington, (206) 553-1846 by the first workday (8:00 a.m. - 4:30 p.m. PST) following the day the permittee became aware of the circumstances:

   a. violation of any limits of 40 CFR § 503.13, Table 1 (maximum individual sample) or Table 3 (monthly average);

   b. violation of the pathogen limits;

   c. violation of the vector attraction reduction limits; or

d. violation of the management practices for biosolids that has been land applied.

4. A written submission shall also be provided within five days of the time that the permittee becomes aware of the circumstances. The written submission shall contain:

   a. a description of the noncompliance and its cause;

   b. the period of noncompliance, including exact dates and times;

   c. the estimated time noncompliance is expected to continue if it has not been corrected; and

   d. steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

5. The Director may waive the written report on a case-by-case basis if the oral report has been received within 24 hours by the NPDES Compliance Unit in Seattle, Washington, by phone, (206) 553-1846.

6. Reports shall be submitted to the addresses in Part II.C., Reporting of Monitoring Results.

H. Other Noncompliance Reporting. Instances of noncompliance not required to be reported within 24 hours shall be reported at the time that monitoring reports for Part II.C. are submitted. The reports shall contain the information listed in Part III.H.2.

I. Inspection and Entry.

1. The permittee shall allow the Director, or an authorized representative (including an authorized contractor acting as a representative of the Administrator), upon the presentation of credentials and other documents as may be required by law, to:

   a. enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

b. have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

c. inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit including, but not limited to, biosolids treatment, collection, storage facilities or area, transport vehicles and containers, and land application sites; and

d. sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Act, any substances or parameters at any location including, but not limited to, digested biosolids before dewatering, dewatered biosolids, biosolids transfer or staging areas, any ground or surface waters at the land application sites, or biosolids, soils, or vegetation on the land application sites.

2. The permittee shall make the necessary arrangements with the landowner or leaseholder to obtain permission or clearance, so that the Director, or authorized representative thereof, upon the presentation of credentials and other documents as may be required by law, will be permitted to enter without delay for the purposes of performing their responsibilities.

III. COMPLIANCE RESPONSIBILITIES

A. Duty to Comply. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application. The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

B. Penalties for Violations of Permit Conditions.

1. Civil and Administrative Penalties. Any person who violates a permit condition implementing sections 301, 302, 306, 307, 308, 318, or 405 of the Act shall be subject to a civil or administrative penalty, not to exceed the maximum amounts authorized by sections 309(d) and 309(g)

of the Act and the Federal Civil Penalties Inflation Adjustment Act (28 U.S.C. § 2461 note) as amended by the Debt Collection Improvement Act (31 U.S.C. § 3701 note).

2. Criminal Penalties.

a. Negligent Violations. Any person who negligently violates a permit condition implementing sections 301, 302, 306, 307, 308, 318, or 405 of the Act shall, upon conviction, be punished by a fine and/or imprisonment as specified in section 309(c)(1) of the Act.

b. Knowing Violations. Any person who knowingly violates a permit condition implementing sections 301, 302, 306, 307, 308, 318, or 405 of the Act shall, upon conviction, be punished by a fine and/or imprisonment as specified in section 309(c)(2) of the Act.

c. Knowing Endangerment. Any person who knowingly violates a permit condition implementing sections 301, 302, 303, 306, 307, 308, 318, or 405 of the Act, and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine and/or imprisonment as specified in section 309(c)(3) of the Act.

d. False Statements. Any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under this Act or who knowingly falsifies, tampers with, or renders inaccurate any monitoring device or method required to be maintained under this Act, shall, upon conviction, be punished by a fine and/or imprisonment as specified in section 309(c)(4) of the Act.

e. Except as provided in permit conditions in Part III.G., Bypass of Treatment Facilities and Part III.H., Upset Conditions, nothing in this permit shall be construed to relieve the permittee of the civil or criminal penalties for noncompliance.

C. Need to Halt or Reduce Activity not a Defense. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

D. Duty to Mitigate. The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

E. Proper Operation and Maintenance. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.

F. Removed Substances. Collected screenings, grit, solids, biosolids, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

G. Bypass of Treatment Facilities.

1. Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs 2 and 3 of this section.

2. Notice.

   a. Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least 10 days before the date of the bypass.

   b. Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required under Part II.H., Twenty-four Hour Notice of Noncompliance Reporting.

3. Prohibition of Bypass.

a. Bypass is prohibited and the Director may take enforcement action against a permittee for a bypass, unless:

(1) the bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(2) there were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(3) the permittee submitted notices as required under paragraph 2 of this section.

b. The Director may approve an anticipated bypass, after considering its adverse effects, if the Director determines that it will meet the three conditions listed above in paragraph 3.a. of this section.

H. Upset Conditions.

1. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph 2 of this section are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

2. Conditions necessary for a demonstration of upset. a permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

a. An upset occurred and that the permittee can identify the cause(s) of the upset;

b. The permitted facility was at the time being properly operated;

c. The permittee submitted notice of the upset as required under Part II.H., Twenty-four Hour Notice of Noncompliance Reporting; and

d. The permittee complied with any remedial measures required under Part III.D., Duty to Mitigate.

3. Burden of proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

IV. GENERAL REQUIREMENTS

A. Notice of New Introduction of Pollutants. The permittee shall provide adequate notice to the Director, Office of Water, of the following.

1. Any new introduction of pollutants into the treatment works from an indirect discharger which would be subject to sections 301 or 306 of the Act if it were directly discharging those pollutants; and

2. Any substantial change in the volume or character of pollutants being introduced into the treatment works by a source introducing pollutants into the treatment works at the time of issuance of the permit.

3. For the purposes of this section, adequate notice shall include the following information:

a. the quality and quantity of effluent to be introduced into such treatment works; and

b. any anticipated impact of the change on the quantity or quality of effluent to be discharged from such publicly owned treatment works.

B. Control of Certain Pollutants. Under no circumstances shall the permittee allow introduction of the following wastes into the waste treatment system.

1. Wastes which will create a fire or explosion hazard in the treatment works;

2. Wastes which will cause corrosive structural damage to the treatment works, but in no case, wastes with a pH lower than 5.0, unless the works is designed to accommodate such wastes;

3. Solid or viscous substances in amounts which cause obstructions to the flow in sewers, or interference with the proper operation of the treatment works;

4. Wastewaters at a flow rate and/or pollutant discharge rate which is excessive over relatively short time periods so that there is a treatment process upset and subsequent loss of treatment efficiency; and

5. Any pollutant, including oxygen demanding pollutants (BOD, etc.) released in a discharge of such volume or strength as to cause interference in the treatment works.

C. Requirements for Industrial Users. The permittee shall require any industrial user of these treatment works to comply with any applicable requirements of sections 204(b), 307, and 308 of the Act, including any requirements established under 40 CFR Part 403.

D. Planned Changes. The permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are not subject to effluent limitations in the permit.

E. Anticipated Noncompliance. The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

F. Permit Actions. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

G. Duty to Reapply. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application should be submitted at least 180 days before the expiration date of this permit.

H. Duty to Provide Information. The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

I. Other Information. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Director, it shall promptly submit such facts or information.

J. Signatory Requirements. All applications, reports or information submitted to the Director shall be signed and certified.

1. All permit applications shall be signed by either a principal executive officer or ranking elected official.

2. All reports required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person. a person is a duly authorized representative only if:

    a. the authorization is made in writing by a person described above and submitted to the Director, and

    b. the authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

3. If an authorization under paragraph IV.J.2. is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements

of paragraph IV.J.2. must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

4. Any person signing a document under this section shall make the following certification.

> **"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."**

K. Availability of Reports. Except for data determined to be confidential under 40 CFR Part 2, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the State water pollution control agency and the Director. As required by the Act, permit applications, permits and effluent data shall not be considered confidential.

L. Oil and Hazardous Substance Liability. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under section 311 of the Act.

M. Property Rights. The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

N. Severability. The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

O. Transfers. This permit may be automatically transferred to a new permittee if:

1. the current permittee notifies the Director at least 30 days in advance of the proposed transfer date;

2. the notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit responsibility, coverage, and liability between them; and

3. the Director does not notify the existing permittee and the proposed new permittee of his or her intent to modify, or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in Part IV.J.2. above.

P. State Laws. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by section 510 of the Act.

Q. Reopener Provision. This permit is subject to modification, revocation and reissuance, or termination at the request of any interested person (including the permittee) or upon EPA initiative. However, permits may only be modified, revoked or reissued, or terminated for the reasons specified in 40 CFR §122.62 or 122.64, and 40 CFR §124.5. This includes new information which was not available at the time of permit issuance and would have justified the application of different permit conditions at the time of issuance, including but not limited to future monitoring results. All requests for permit modification must be addressed to EPA in writing and shall contain facts or reasons supporting the request.

R. Definitions.

1. “Ambient monitoring” means receiving water monitoring.

2. “Annual Average” means the sum of all values reported in a twelve month period divided by the number of values.

3. “Average monthly discharge limitation” means the highest allowable average of “daily discharges” over a calendar month, calculated as the sum of all “daily discharges” measured during a calendar month divided

by the number of "daily discharges" measured during that month. For fecal coliform bacteria, the average monthly discharge shall be calculated as a geometric mean.

4. "Average weekly discharge limitation" means the highest allowable average of "daily discharges" over a calendar week, calculated as the sum of all "daily discharges" measured during a calendar week divided by the number of "daily discharges" measured during that week. For fecal coliform bacteria, the average weekly discharge shall be calculated as a geometric mean.

5. "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility.

6. "Chronic toxicity" measures a sublethal effect (e.g., reduced growth, reproduction) in an effluent or ambient waters compared to that of the control organisms.

7. "Daily discharge" means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

8. "Discharge measurement" means measuring width, depth, and velocities using a tape or tagline, sounding equipment, and a current meter.

9. "Geometric mean" is the *n*th root of the product of the values in a list. Geometric mean = $\sqrt[n]{k1 * k2 * ... kn}$, where n = the number of fecal coliform values and k = the coliform value. Where the fecal coliform value is zero, k shall be set equal to 1.

10. A "grab" sample, for monitoring requirements, is a single "dip and take" sample or measurement taken at a specific time or over as short a period of time at a representative point anywhere in wastewater treatment or biosolids land application processes, as is feasible.

11. A "grab-composite" means a sample that consists of a minimum of 3 aliquots over an 8-hour period.

12. "Inhibition concentration, IC", means a point estimate of the toxicant concentration that causes a given percent reduction (p) in a non-quantal biological measurement (e.g., reproduction or growth) calculated from a continuous model (the EPA Interpolation Method). The effective concentration, EC, is a point estimate of the toxicant concentration that would cause a given percent reduction (p) in quantal biological measurement (e.g., larval development, survival) calculated from a continuous model (e.g., Probit).

13. "Interim Minimum Level" is calculated when a method-specified ML does not exist. It is equal to 3.18 times the method-specified method detection limit rounded to the nearest multiple of 1, 2, 5, 10, 20, 50, etc.

14. "Method Detection Limit (MDL)" is the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero as determined by a specific laboratory method (40 CFR Part 136).

15. "Minimum Level (ML)" is the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method-specified weights, volumes and processing steps have been followed.

16. "Maximum daily discharge limitation" means the highest allowable "daily discharge."

17. "No Observed Effect Concentration" (NOEC) is the highest concentration of toxicant to which organisms are exposed in a full life-cycle or partial life-cycle test, that causes no observable adverse effects on the test organisms (i.e., the highest concentration of toxicant in which the values for the observed responses are not statistically significantly different form the controls).

18. “Pollutant” for the purposes of this permit is an organic substance, an inorganic substance, a combination of organic and inorganic substances, or pathogenic organisms that, after discharge and upon exposure, ingestion, inhalation, or assimilation into an organism either directly from the environment or indirectly by ingestion through the food-chain, could, on the basis of information available to the Administrator of EPA, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunction in reproduction), or physical deformations in either organisms or offspring of the organisms.

19. “Receiving water concentration (RWC)” is the concentration of pollutant, including toxicity, at the edge of the mixing zone. For whole effluent toxicity, RWC, percent effluent concentration, is equal to 1/(minimum dilution) X 100.

20. “Severe property damage” means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

21. A “24-hour composite” sample shall mean a flow-proportioned mixture of not less than 8 discrete aliquots. Each aliquot shall be a grab sample of not less than 100 ml and shall be collected and stored in accordance with procedures prescribed in the most recent edition of *Standard Methods for the Examination of Water and Wastewater*.

22. “Upset” means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

Appendix B

Manufacturer Cut Sheets

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Dryer Proposal

Soldotna, AK

SRT Solar Dryer

<u>Huber Regional Sales Manager</u>
John Lewis
West Regional Manager
704-995-5451

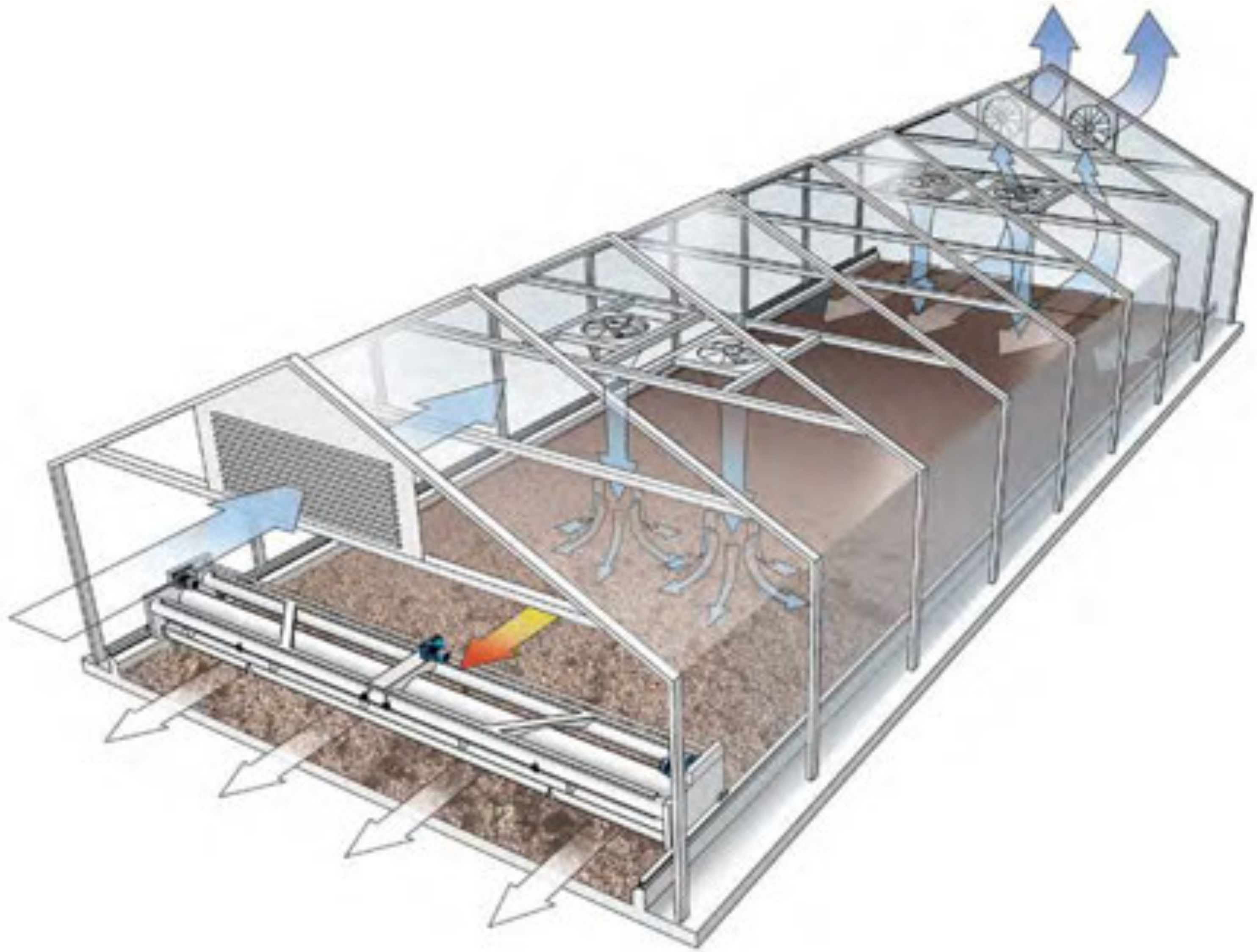
<u>Huber Representative</u>
John Simon
Goble Sampson Associates, Inc
425-392-0491

7/2/15

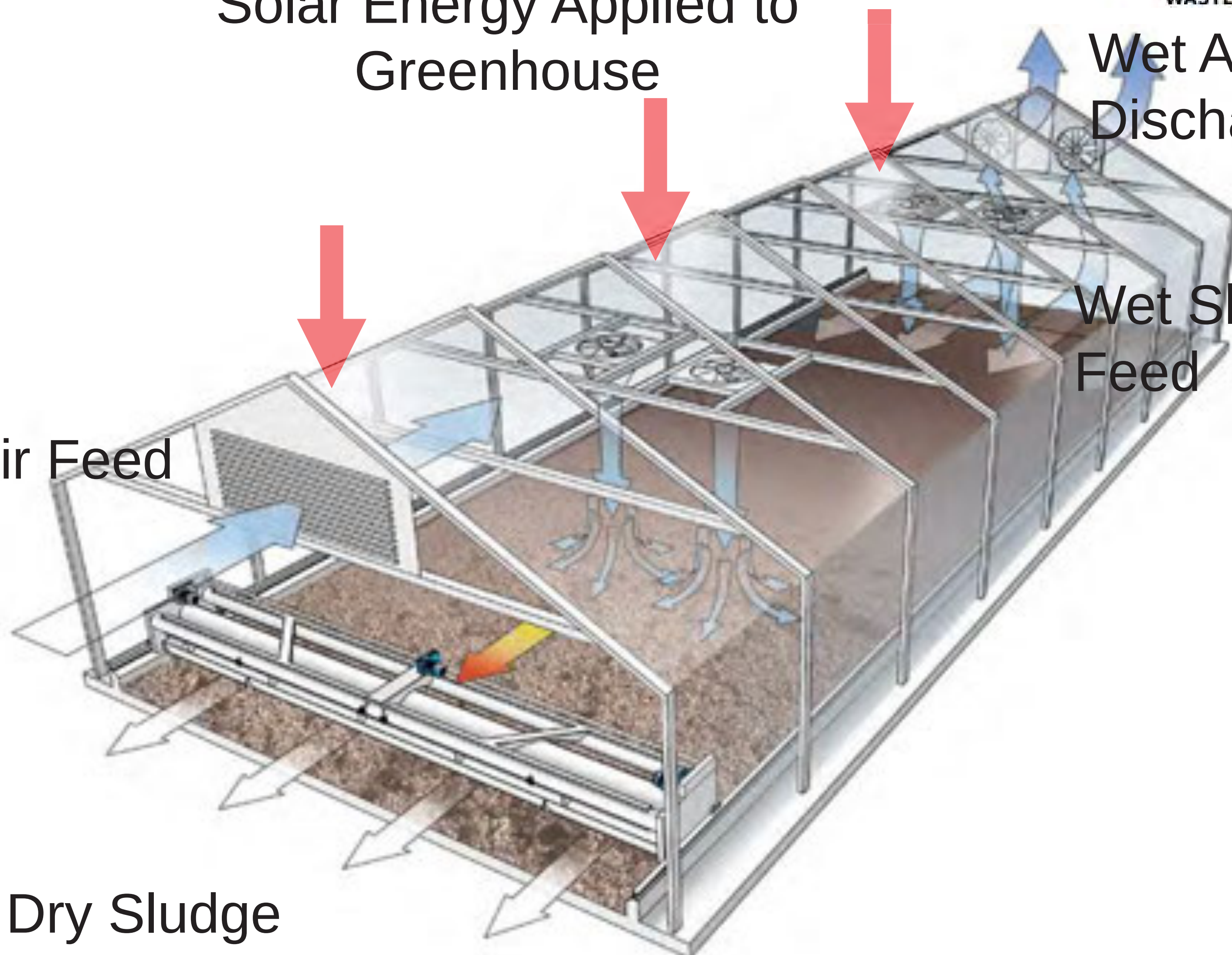
Huber Technology, Inc.

Huntersville, NC

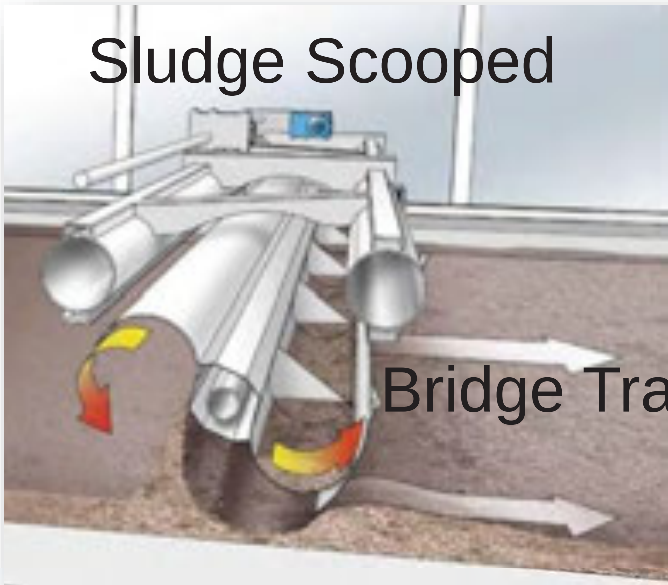
Design for Huber Solar Dryer SRT

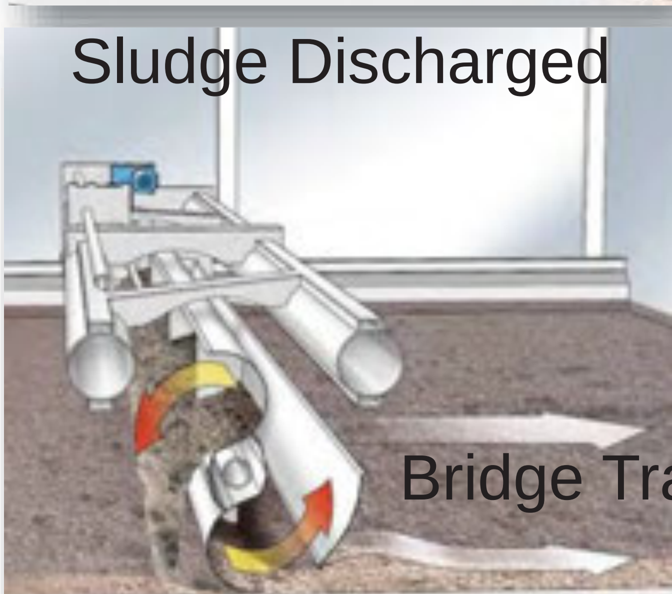


How the SRT Works



How the Sludge Turning Device Works





1. Sludge is Scooped by the Rotating Shovel

2. Shovel Counter-rotates to the Bridge Travel

3. Sludge Rotates Over the Drum – Sludge is Turned and Transported in One Step

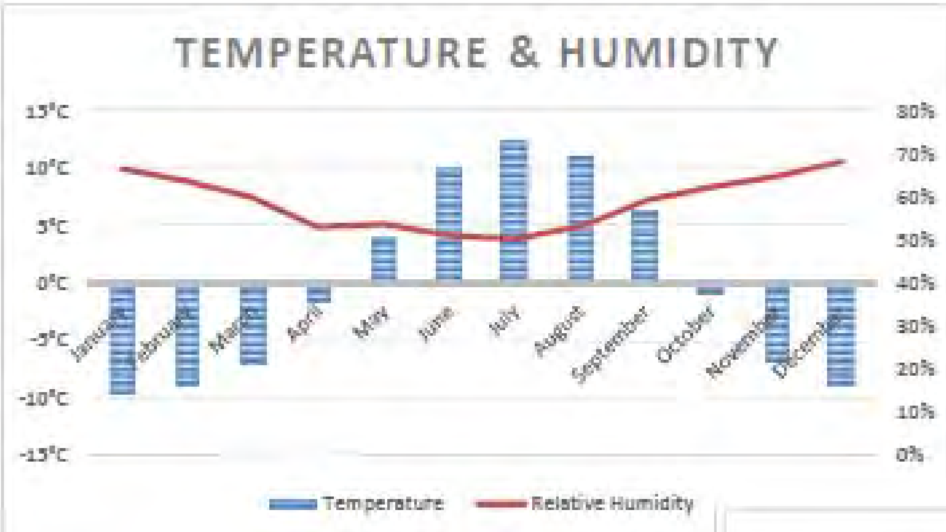
See Operational Video: huberforum.net/srt

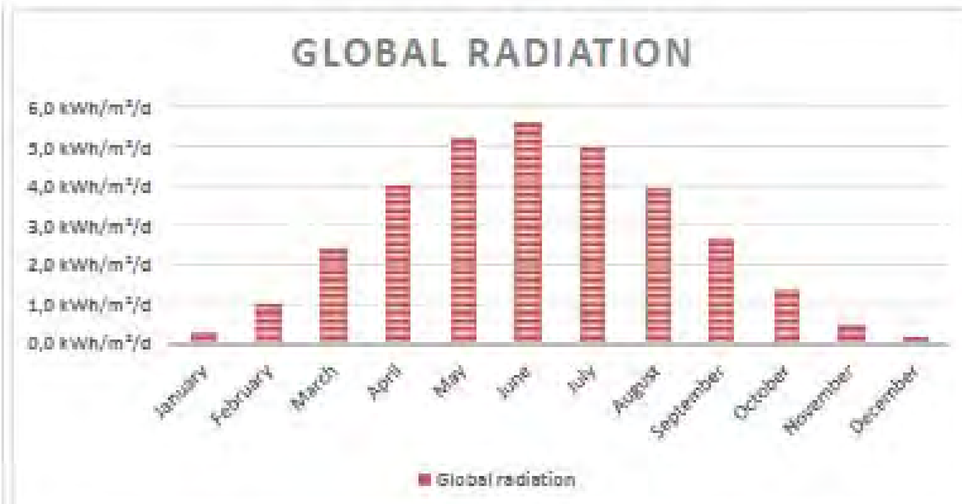
Project Design – SRT

Design	
Sludge Amount	1260 ton/year at 18%
Evaporation Rate	960 ton/year
Final product	75%
Supplimental Thermal heat source	None
Operation Schedule	April-October (Drying is not possible Nov-March)
Dryer Design	**Solar Dryer: 1 x SRT 11** **Greenhouse Width: 40ft** **Greenhouse Length: 375ft**

SRT 11 – Typical Layout – See Attached Drawing

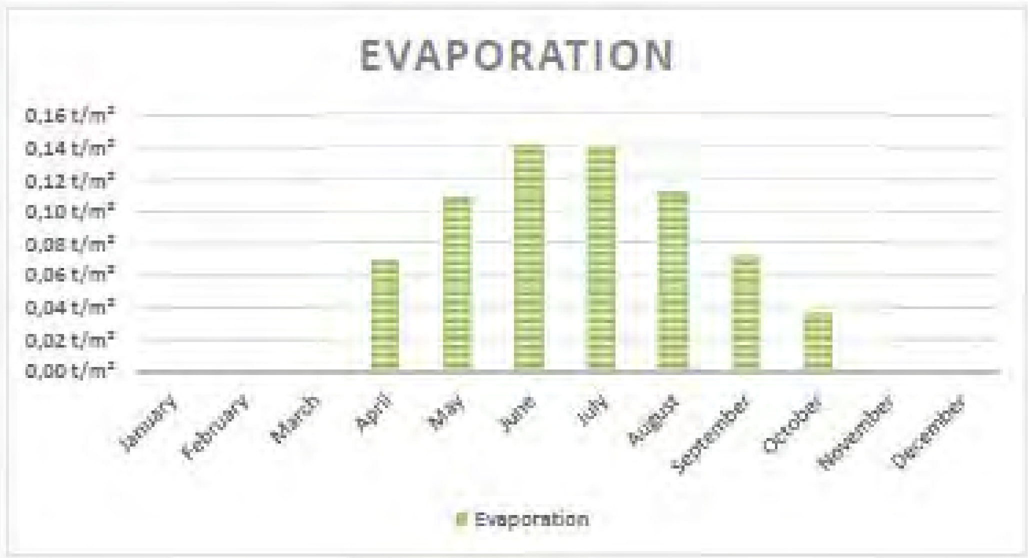
SRT Solar Information – Soldotna, AK





SRT Design – Without Supplemental Heating

	Input	DS_{In}	Output	DS_{Out}	Water evaporation
January	95 t	18%	0 t	0%	0 t
February	95 t	18%	0 t	0%	0 t
March	95 t	18%	0 t	0%	0 t
April	95 t	18%	28 t	75%	89 t
May	95 t	18%	44 t	75%	139 t
June	95 t	18%	57 t	75%	180 t
July	95 t	18%	56 t	75%	177 t
August	95 t	18%	45 t	75%	144 t
September	95 t	18%	29 t	75%	93 t
October	95 t	18%	15 t	75%	47 t
November	95 t	18%	0 t	0%	0 t
December	95 t	18%	0 t	0%	0 t
Sum/average	1143 t	18%	274 t	75%	869 t



Scope of Supply – SRT 11

- One (1) Total SRT 11
- Cost - $1,000,000
- Each Including
  - Sludge Turning device in 304 L stainless steel; Pickled and Passive
  - Traction Drive System and Chain
  - Galvanized Steel Rail System
  - Standard Startup Services
  - Control System
  - Greenhouse

Not Included in Scope of Supply

- Concrete Work
- Installation of solar drying equipment and controls
- Electrical Wiring
- Odor Control System (if required)

Why a Huber SRT Solar Dryer?

HUBER TECHNOLOGY
WASTE WATER Solutions

- Linear Feed
- Uniform Mixing
- Low Odor & Dust
- Precise Control
- Adaptable
- Automated Design
- Experience

Linear feed design

Process sludge as it is dewatered

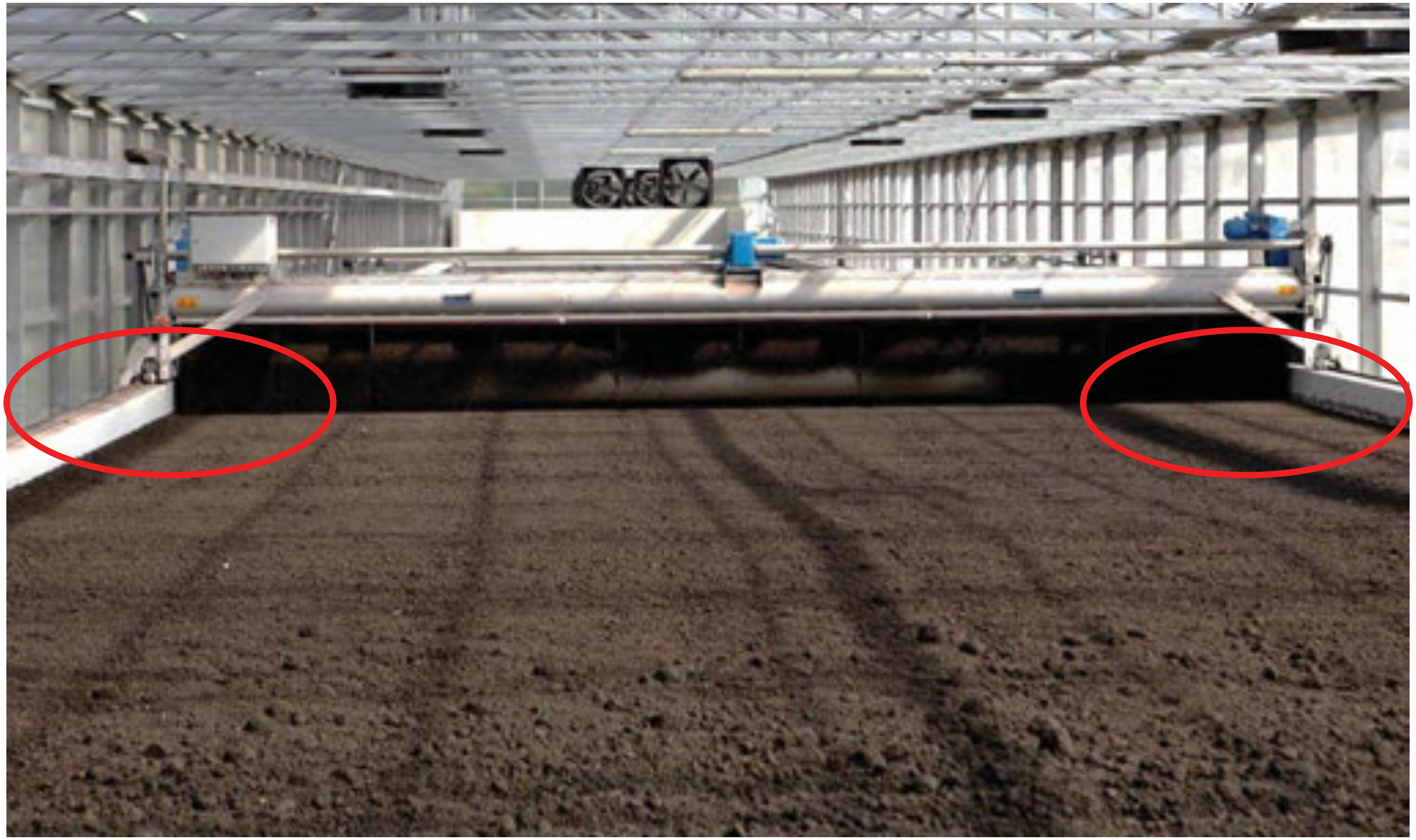
- Matches production

Automation is possible

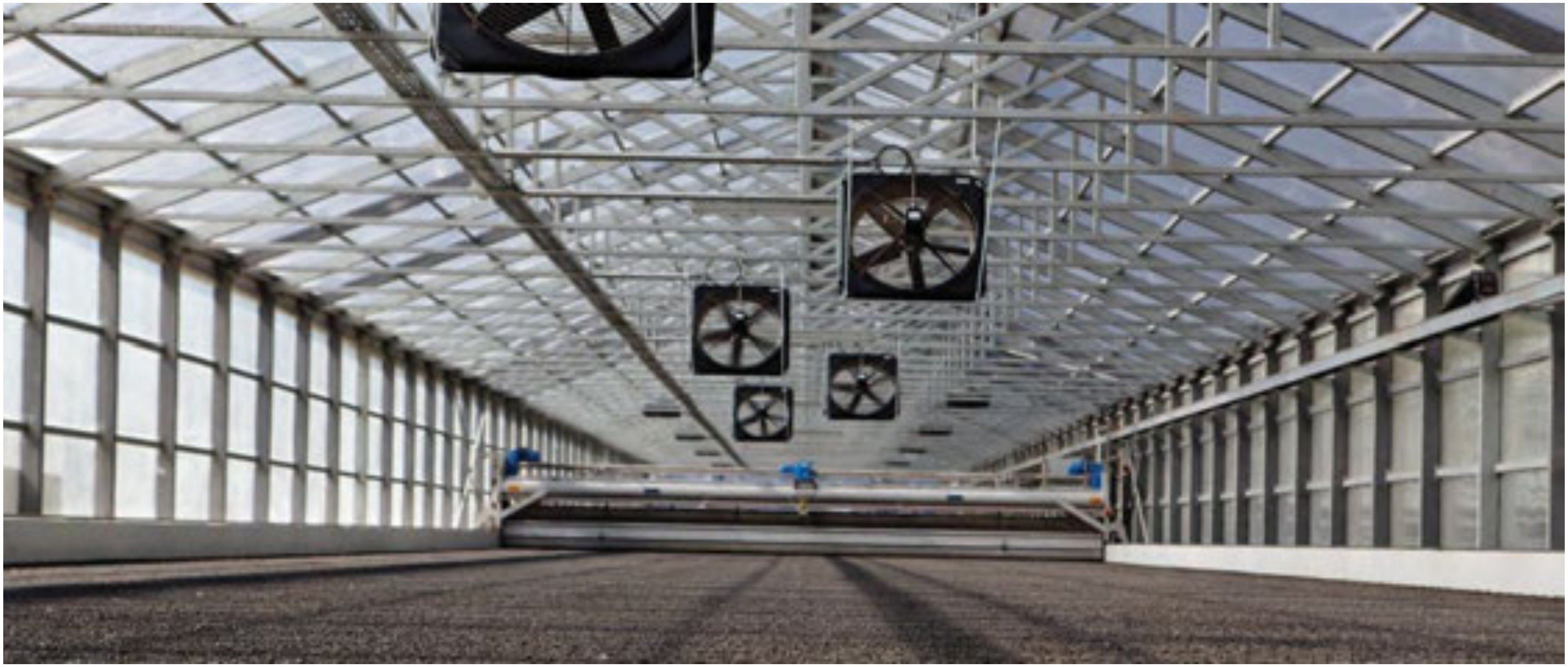
- Minimize operator requirement

Perfect mixing for a proper aeration

Entire sludge field is turned (no dead zones)



Short guidewalls allow for maximum exposure

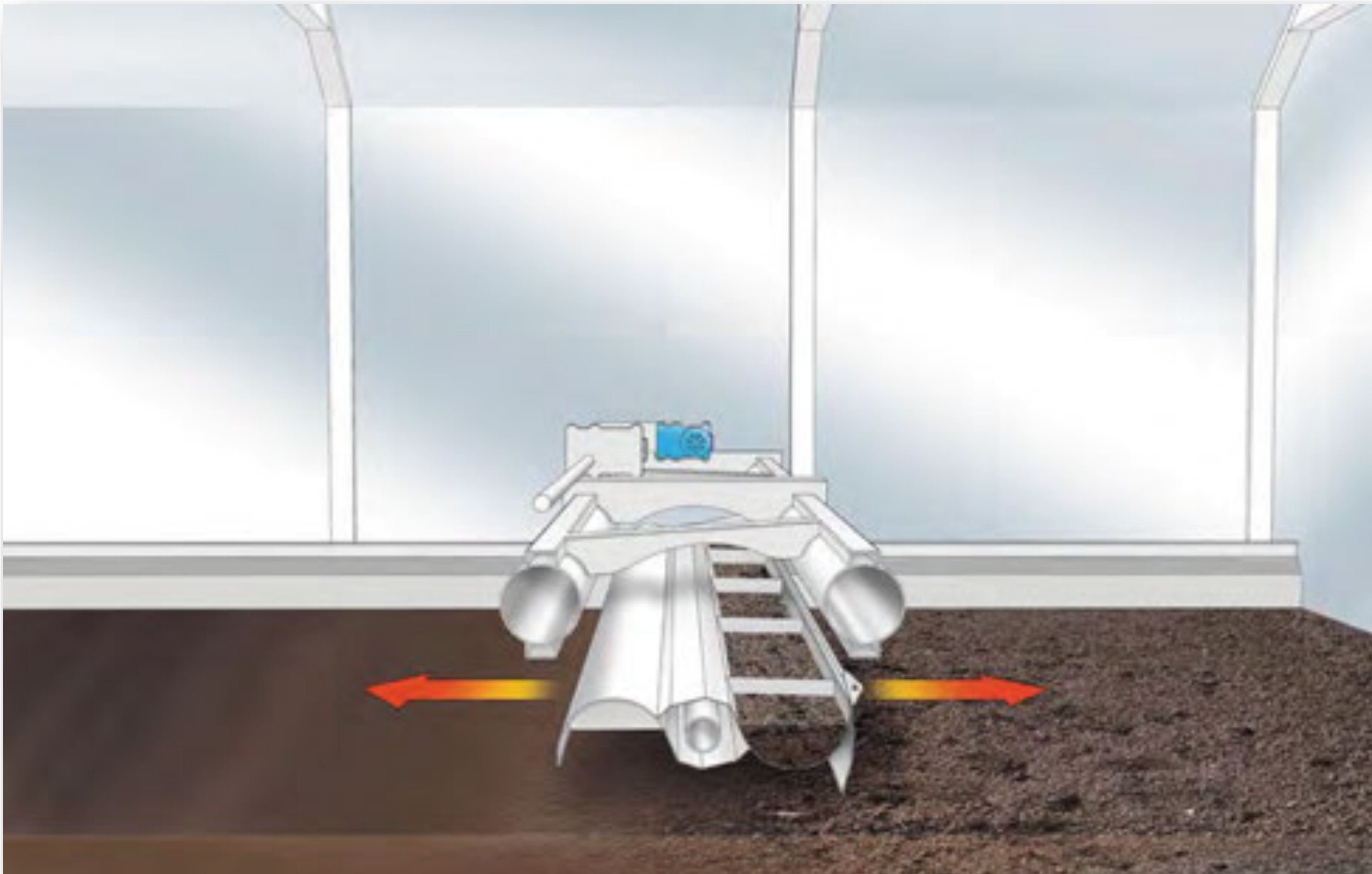


Alternate feed & extract flexibility

Sludge feeding and receiving on the same side of the greenhouse

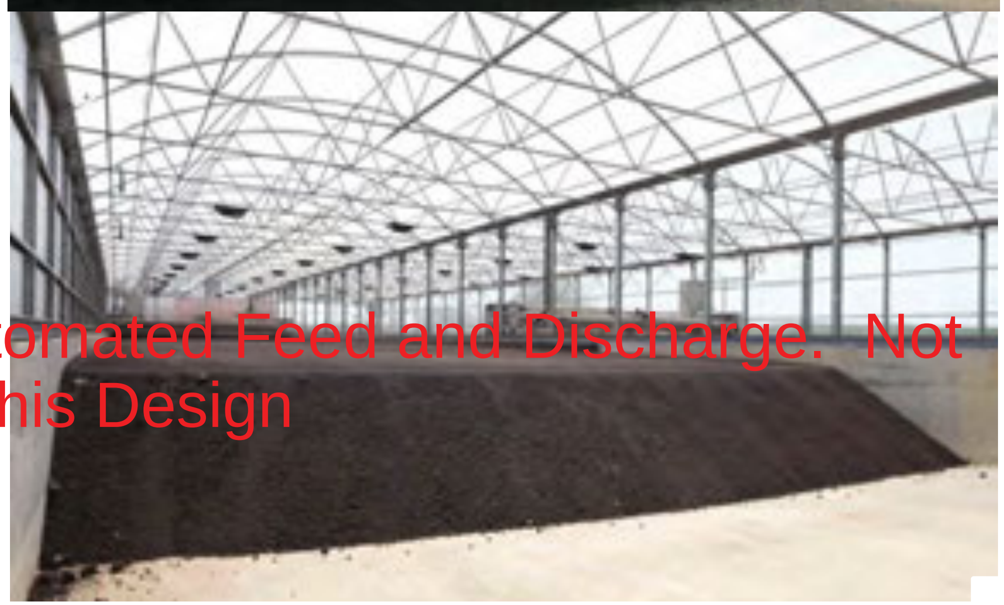
Transport with the shovel

HUBER TECHNOLOGY
WASTE WATER Solutions



Optional Flexible Design for Storage and Automation

HUBER TECHNOLOGY WASTE WATER Solutions



Optional Automated Feed and Discharge. Not Included in this Design

Optional - Floor heating

55 machines & 10 years of experience

HUBER TECHNOLOGY
WASTE WATER Solutions

Installation	Units	Installation	Units
Arequipa, PE	1	NOIRMOUTIER EN L`LILE	2
Ozimek, PL	2	Lherm, FR	1
Mako, HU	4	Marktbergel KA	1
Mietesheim, FR	1	TARADEAU-VIDAUBAN, FR	1
Zagan WWTP, PL	3	Rodemack, FR	1
Tooele UT, US	4	Livron, FR	1
Barjols, FR	1	Bonneval, FR	1
DIE, FR	1	Gunstett, FR	2
Cali, CO	1	Evron, FR	2
GODERVILLE, FR	1	AYGUEPERSE, FR	1
ILLIERS-COMBRAY, FR	1	LA SCHWALB, FR	1
NOGENT LE ROI, FR	1	BOURRON MARLOTTE, FR	1
SNECMA, FR	1	ERNEE, FR	1
Penzing-Weil KA	1	BELLEME, FR	1
KLODZKO WWTP, PL	1	LAVAL, FR	2
Cali, CO	3	Bourg Achard, FR	1
VALLERES LIGNIERES, FR	1	St. Maúrice de Beynost, FR	1
VILLAINES LA JUHEL, FR	1	Barbezieux, F	1
LE CHATELET EN BRIE, FR	1	Hayingen	1

Tooele City, UT

Contact:
Mr. Ray Henninger
(435) 882-1952

Thank You For Your Interest In Huber Dryers!

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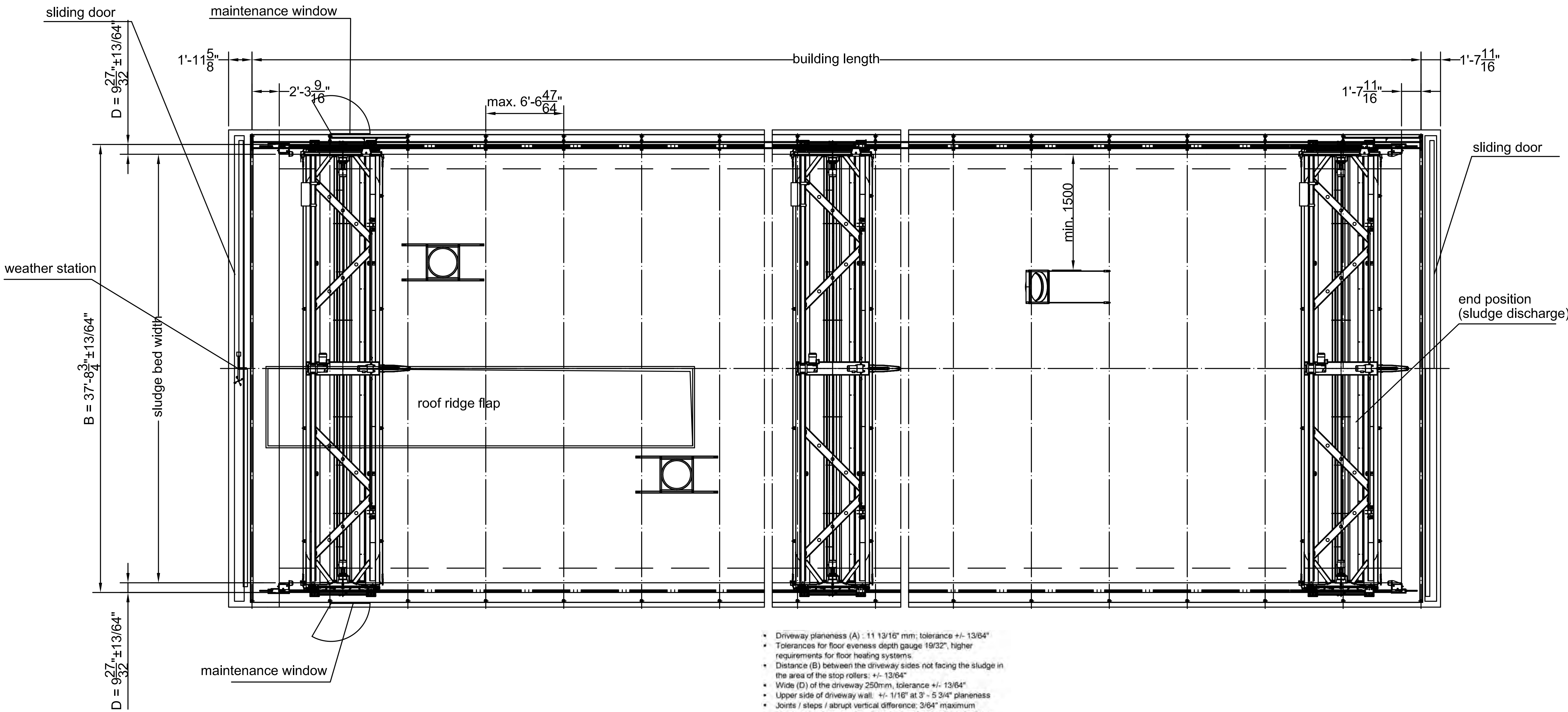
plan view



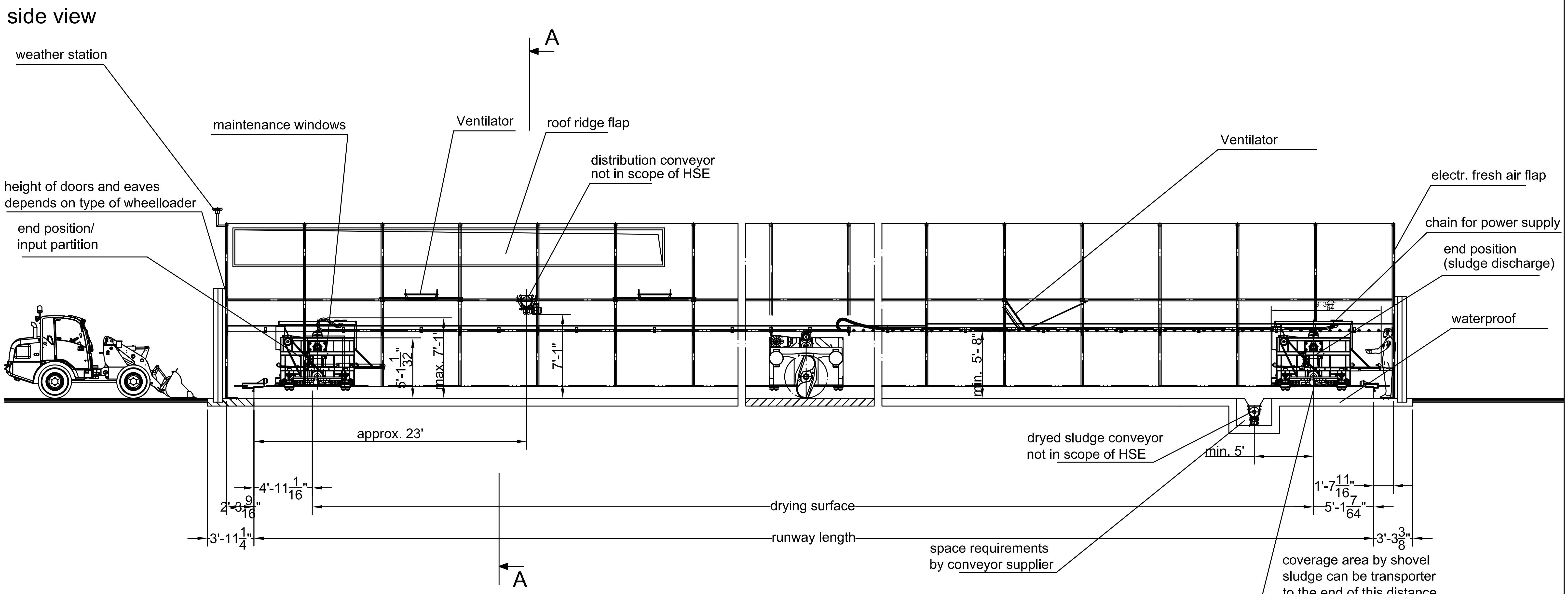
- Driveway planeness (A) : 11 13/16" mm; tolerance +/- 13/64"
- Tolerances for floor eveness depth gauge 19/32", higher requirements for floor heating systems
- Distance (B) between the driveway sides not facing the sludge in the area of the stop rollers: +/- 13/64"
- Wide (D) of the driveway 250mm, tolerance +/- 13/64"
- Upper side of driveway wall: +/- 1/16" at 3' - 5 3/4" planeness
- Joints / steps / abrupt vertical difference: 3/64" maximum
- Unintended steps resulting from joints, change of width of the driveway around the guiding tracks 3/64" mm
- Tolerance in the alignment of the outer wall of the drive way over the entire length of the driveway around the guiding tracks +/- 19/32"; Tolerance in the straightness of the centre line of the driveway over a distance of 32'- 9 3/4": 19/32" mm
- Higher tolerances may be acceptable on inquiry but require prior consultation with HUBER SE

Dimensions are for reference only!
For binding dimensions please refer to the final installation drawings

DATE	REVISION	NO.	BY	CK	APP		
						DESIGNED	kep
						DETAILED	
						CHECKED	gr
03/13/2013	dimensioning added	a	kep			APPROVED	
						DATE	10/19/2012

HUBER TECHNOLOGY
9735 NorthCross Center Court, Suite A
Huntersville, NC 28078
Tel. 704-949-1010
info@huber-technology.com

Fig No.		Scale:
1/10	SRT 11 sheet of dimensions	1/8" = 1'–0'
Project No.	Drawing No.	
–	000000_280585	



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Dimensions are for reference only!
For binding dimensions please refer to the final installation drawings

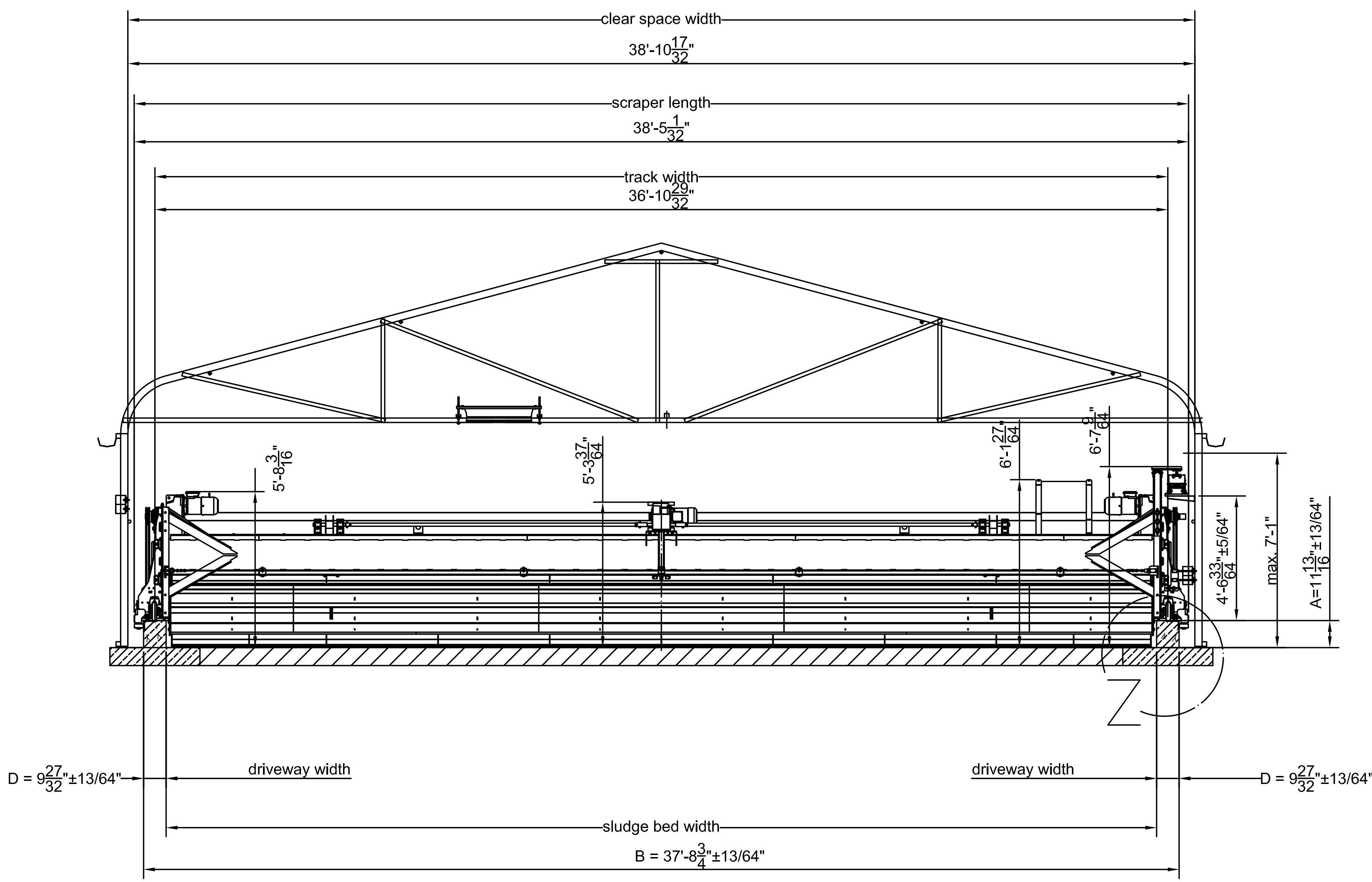
DATE	REVISION	NO.	BY	CK	APP
03/13/2013	dimensioning added	a	kep		

DESIGNED	kep
DETAILED	
CHECKED	gr
APPROVED	
DATE	10/19/2012

HUBER
TECHNOLOGY
9735 NorthCross Center Court, Suite A
Huntersville, NC 28078
Tel. 704-949-1010
info@huber-technology.com

Fig No.		Scale:
2/10	SRT 11 sheet of dimensions	1/8" = 1'-0'
Project No.		Drawing No.
–		000000_280585

section: A-A



Dimensions are for reference only!
For binding dimensions please refer to the final installation drawings

DATE	REVISION	NO.	BY	CK	APP		
						DESIGNED	kep
						DETAILED	
						CHECKED	gr
03/13/2013	dimensioning added	a	kep			APPROVED	
						DATE	10/19/2012

HUBER
TECHNOLOGY
9735 NorthCross Center Court, Suite A
Huntersville, NC 28078
Tel. 704-949-1010
info@huber-technology.com

Fig No.		Scale:
3/10	SRT 11 sheet of dimensions	1/4" = 1'-0'
Project No.		Drawing No.
–		000000_280585

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LAKESIDE
EQUIPMENT CORPORATION
Water Purification Since 1928

1022 E. Devon Avenue | P.O. Box 8448 | Bartlett, IL 60103
T: 630-837-5640 | **F:** 630-837-5647 | **E:** sales@lakeside-equipment.com
www.lakeside-equipment.com

May 20, 2015

Budgetary Pricing

To: **HDR Alaska, Inc.**
2525 C Street, Suite 305
Anchorage, AK 99503

From: **Dan Widdel**

Attn: **Mr. Ryan Moyers, P.E.**

Project: Soldotna, Alaska

RAPTOR® **Headworks Complete Plant (Model 31CPA-2.0)**

2.0 mgd Peak Flow
31FS-0.25 Fine Screen

Unit Price:	**$345,000**
Quantity:	**2**
Total Package Cost:	**$690,000**

Items Included In Pricing:

Headworks Complete Plant

Stainless steel tank
31FS stainless steel Fine Screen (with 2 hp drive)
8-inch horizontal grit screw (with 1 hp drive)
8-inch grit dewatering screw (with 2 hp drive)
Air header with diffusers
Screen and grit discharge chutes
Ultrasonic level sensor for screen
Anchor bolts (stainless steel)

Controls

Explosion proof design
NEMA 12 painted steel main control panel
NEMA 7 local control station
Variable frequency drive (screen)
NEMA reversing starters (grit screws)
PLC – Allen Bradley MicroLogix 1100
Fusible disconnect switch with door handle
Transformer
Overload control monitors
Selector switches and indicator lights

FOB:	Chariton, Iowa	Approvals:	6 to 8 weeks
Warranty:	One (1) year	Shipment after Approval:	26 to 29 weeks
Start-up service:	4 days in 2 trips	Full freight allowed to job site	

Items Not Included In Budget Pricing:

Erection of equipment
Piping and valves
Access stairway or platform
Electrical conduit and wiring
Spare parts or special tools
Screen and grit container

Optional Items:	**Unit Price:**
Bagger attachment (individual bagger design):	**$1,800 for screen & grit**
Blower package with 2.0 hp motor and fiberglass enclosure:	**$6,000**

NOTE: Due to the current volatility of steel prices, budgetary cost of equipment may be subject to change.

Dan Widdel (e-mail: dw@lakeside-equipment.com)

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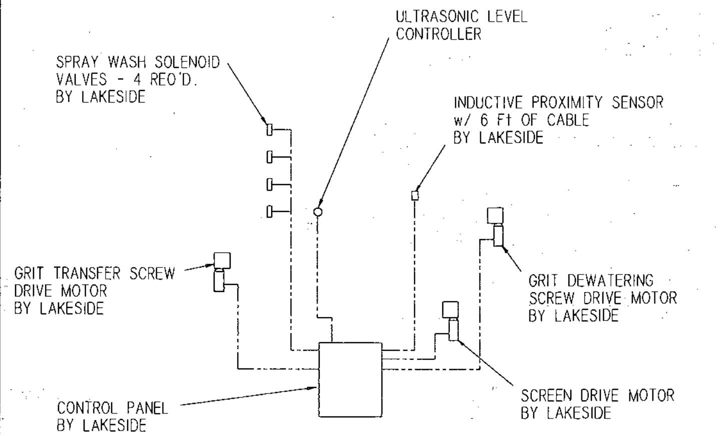
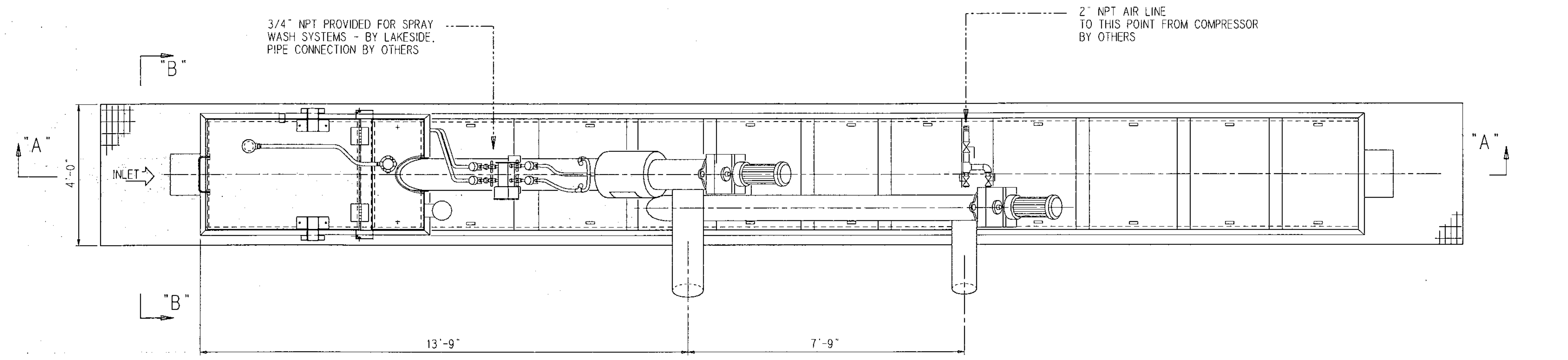
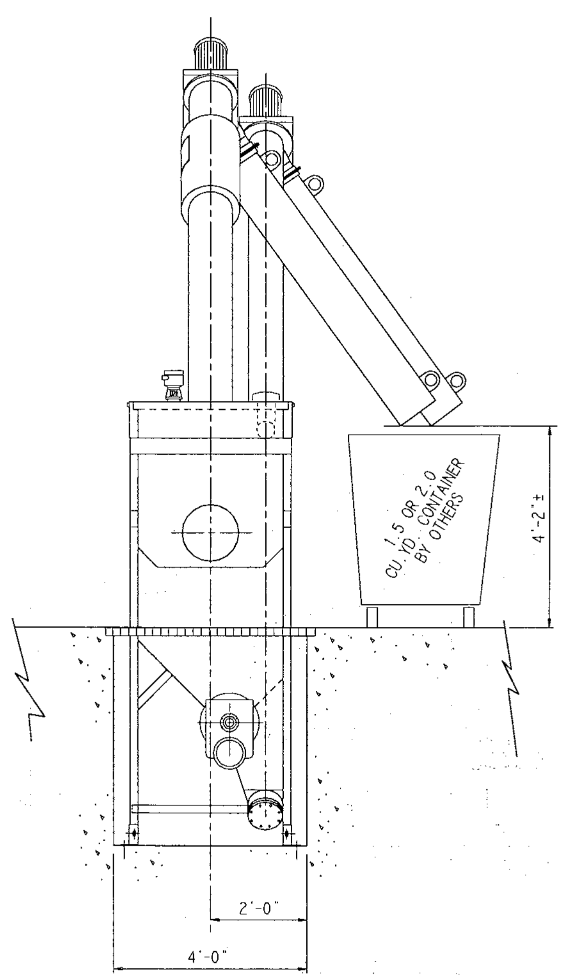


ELECTRICAL INTERCONNECTION DIAGRAM

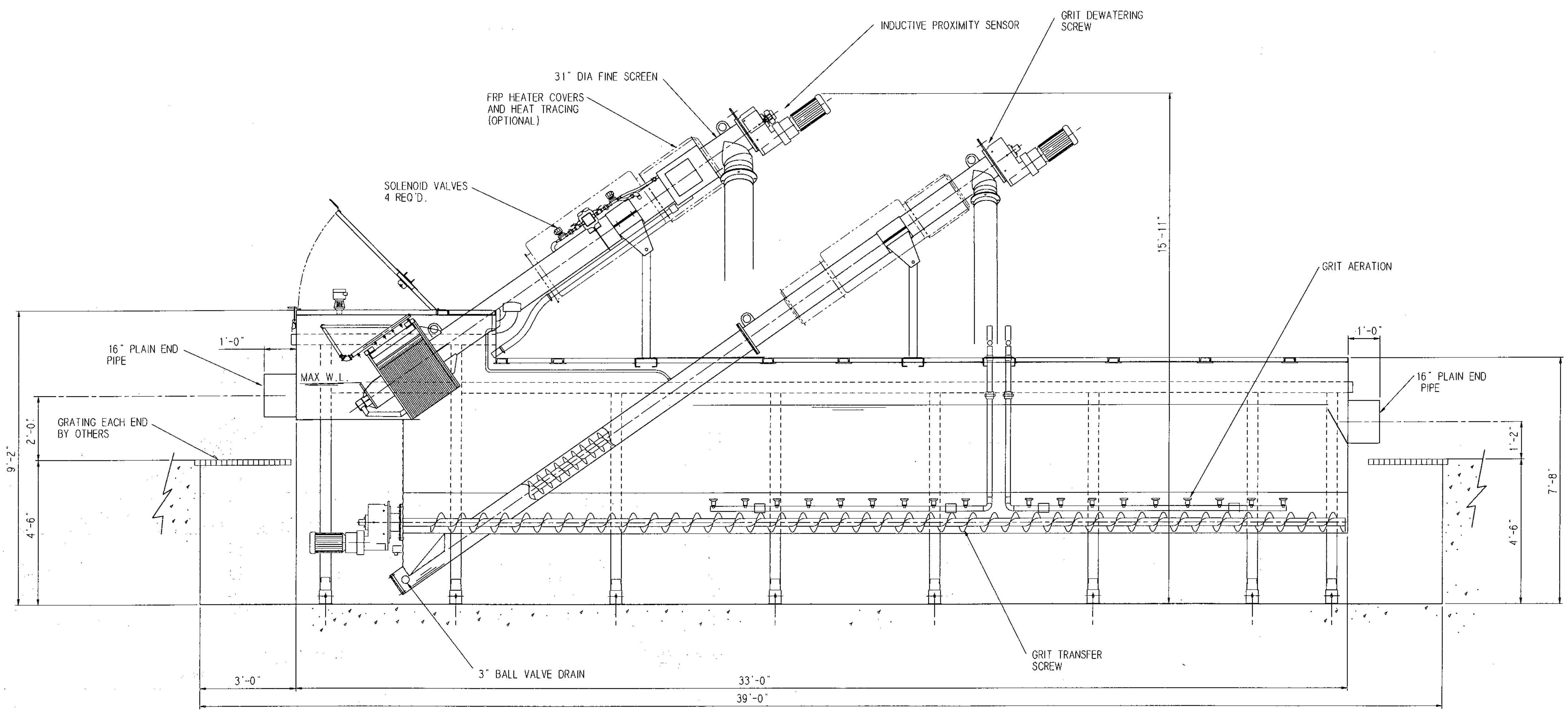
ALL CONDUIT AND WIRE CONNECTIONS BETWEEN CONTROL PANEL AND FINE SCREEN COMPONENTS BY OTHERS.



PLAN



VIEW "B-B"



SECTION "A-A"

REVISIONS	DATE	DR.	CHKD.	REVISIONS	DATE	DR.	CHKD.	REVISIONS	DATE	DR.	CHKD.	REVISIONS	DATE	DR.	CHKD.
												A REVISED	6-16-04	R.D.	

LAKESIDE EQUIPMENT CORPORATION

DR. SNYDER | CHKD. JS | DATE 12-31-92 | FILE NO. 250

RAPTOR® COMPLETE PLANT
MODEL 31CPA-2.0

DWG. NO. D-54109-S | REV. A

ORIGINAL

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T: 630-837-5640 | F: 630-837-5647 | E: sales@lakeside-equipment.com
www.lakeside-equipment.com

May 20, 2015 **Budgetary Pricing**

To: **HDR Alaska, Inc.**
2525 C Street, Suite 305
Anchorage, AK 99503

From: **Dan Widdel**

Attn: Mr. Ryan Moyers, P.E.

Project: Soldotna, Alaska

Lakeside H-Pac® Headwork's Package (Model 31FS-SG7-2.5)
with Self-Prime Grit Pump & Grit Classifier

		Unit Package Cost:	**$360,000**
2.5 mgd Peak Flow		**Quantity:**	**2**
31FS-0.25 Fine Screen			
7-ft Diameter Vortex Grit Chamber		**Total Package Cost:**	**$720,000**

Items Included In Pricing:

Headworks System
31FS stainless steel Fine Screen (with 2 hp drive)
Stainless steel screen tank
7-ft dia. vortex grit chamber (with 3/4 hp drive)
Stainless steel grit chamber tank
Stainless steel influent channel
Self-prime grit pump (with 7.5 hp drive)
Grit classifier (with 1.0 hp motor)
Cyclone separator
Shop prime paint of all ferrous components
Anchor bolts (stainless steel)

Controls
Explosion-proof design
NEMA 12 painted steel main control panels (2)
NEMA 7 local control stations (2)
VFD with line reactor (screen)
Allen-Bradley MicroLogix 1100 PLC (screen)
Motor starters (paddle drive, classifier, & grit pump)
Allen-Bradley MicroLogix 1100 PLC (grit system)
Fusible disconnect switch with door handle
Transformer
Selector switches and indicator lights

Components are carbon steel construction unless noted otherwise

FOB:	Chariton, Iowa	Approvals:	6 to 8 weeks
Warranty:	One (1) year	Shipment after Approval:	26 to 28 weeks
Start-up service:	4 days in 2 trips	Full freight allowed to job site	

Items Not Included In Budget Pricing:
Erection of equipment
Piping and valves
Screenings and grit containers
Electrical conduit and wiring
Spare parts or special tools
Finish paint

Optional Items:	**Unit Price:**
Bagger attachment (individual bagger design):	**$1,800 for screen & grit classifier**
Deck platform with access stairs:	**$36,000**
Type 304 stainless steel grit classifier:	**$14,000**

NOTE: Due to the current volatility of steel prices, budgetary cost of equipment may be subject to change.

Dan Widdel (e-mail: dw@lakeside-equipment.com)

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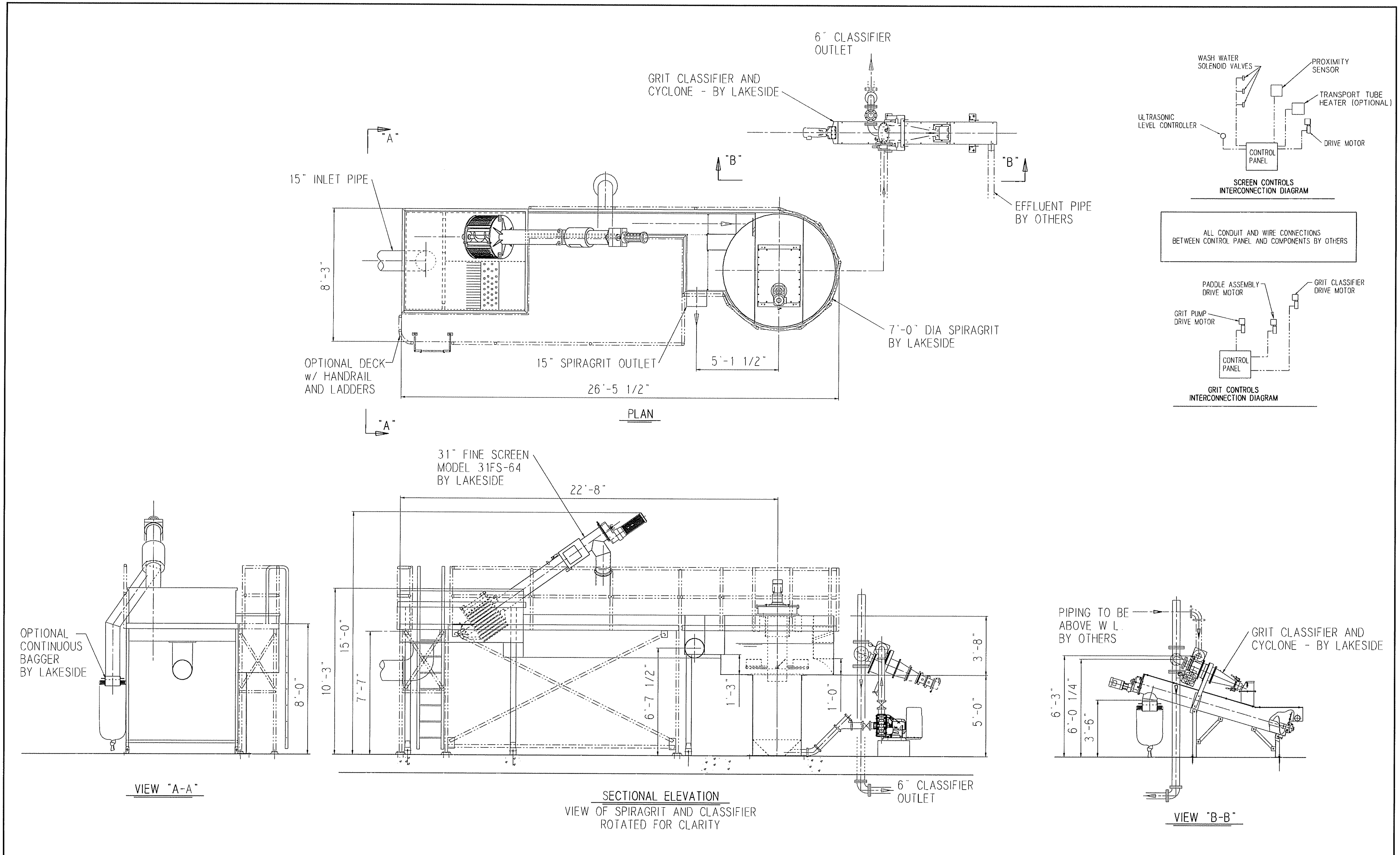

REVISIONS	DATE	DR.	CHKD.	REVISIONS	DATE	DR.	CHKD.	REVISIONS	DATE	DR.	CHKD.	REVISIONS	DATE	DR.	CHKD.

LAKESIDE EQUIPMENT CORPORATION | DR. K H | CHKD. | DATE 4-21-09 | FILE NO. 250

RAPTOR® H-PAC
MODEL 31FS-SG7-2.5

DWG. NO. D-82401-S | REV.

ORIGINAL

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Peterson, Teresa

From: Sedlacek, Roger <rsedlacek@hach.com>
Sent: Friday, June 05, 2015 1:07 PM
To: Peterson, Teresa
Subject: RE: I've asked for a better set of slides than I had showing the basics of RTC and the N/DN

Follow Up Flag: Follow up
Flag Status: Flagged

Ballpark Price for the following components is $60,000.

* NDNRTC1C
Which is: RTC105-N/DN Real-Time Nitrification and Denitrification Control Module (for Intermittent Control)
Which includes:
    * sc1000 controller modules/display
    * RTC N/DN Module
    * LDO Probe for DO
    * AN-ISE probe for nitrate/ammonia monitoring
    * In-line cleaning system for AN-ISE probe

* FSPNDN-ISE-RTC
Which is: Service Partnership for the N/DN system
Which includes:
    * 2 site visits to provide Preventative Maintenance (PM)

* 59COM
Which is: Commissioning for RTC N/DN
Which includes:
    * minimum two days of onsite commissioning
    * training
    * remote monitoring by Hach for up to 12 weeks (includes weekly reports, optimization by Hach)

* Travel Charge
Which is: Travel
Which includes: Travel expenses and time for commissioning and PM visits

** Just Ball Park Price**

We have a lot of work before I'd ever formally quote the system. I trust this is enough information to help you. I've not seen the slide deck and am going to create my own over the weekend. Give me some feedback on what your timeline is for presenting options to the City.

Thanks,

Roger Sedlacek
Sales Rep – AK/MT/NV
800-227-4224 x6284

970-646-5397 (Mobile)
970-619-5149 (Fax)
www.hach.com
http://tinyurl.com/HachMobileCatalog

From: Peterson, Teresa [mailto:Teresa.Peterson@hdrinc.com]
Sent: Thursday, June 04, 2015 12:18 PM
To: Sedlacek, Roger
Subject: RE: I've asked for a better set of slides than I had showing the basics of RTC and the N/DN

Roger,

Please see the attached PFD of the plant. There have been some upgrades since this PFD; however, this is the general layout.

Thanks,

Teresa Peterson, PE (WA)
D 907.644.2196 **M** 253.310.5433

hdrinc.com/follow-us

From: Sedlacek, Roger [mailto:rsedlacek@hach.com]
Sent: Tuesday, June 02, 2015 2:12 PM
To: Peterson, Teresa
Subject: I've asked for a better set of slides than I had showing the basics of RTC and the N/DN

Hope to have that tomorrow. What I had was "early versions" and a tad bit messy.

Would you say that the Nitrogen "control" is intermittent? Air is supplied "on/off"? If you have a basic drawing of the plant, can you send that along as well.

Thanks

Roger Sedlacek
Sales Rep – AK/MT/NV
800-227-4224 x6284
970-646-5397 (Mobile)
970-619-5149 (Fax)
www.hach.com
http://tinyurl.com/HachMobileCatalog

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Peterson, Teresa

From: Shane Harvey <sharvey@fkcscrewpress.com>
Sent: Friday, May 22, 2015 3:04 AM
To: Peterson, Teresa
Subject: RE: Screw Press Request
Attachments: BHX 250 Ski.pdf

Follow Up Flag: Flag for follow up
Flag Status: Flagged

Hi Teresa,

It was nice catching up with you as well! Glad you are enjoying Alaska – I've always wanted to move there.

The attached skid will process ~35 dry lbs. per hour of aerobic sludge and dewater to 16-18%.

Budget price $175k

To add a RST-S315x1000L thickener capable of 25-30 gpm, add $27k.

Let me know if you need anything else.

Regards,
Shane Harvey
FKC Co., Ltd
2708 W. 18th St.
Port Angeles, WA 98363
(360) 477-8038
sharvey@fkcscrewpress.com

From: Peterson, Teresa [mailto:Teresa.Peterson@hdrinc.com]
Sent: Monday, May 18, 2015 12:18 PM
To: sharvey@fkcscrewpress.com
Subject: Screw Press Request

Hi Shane,

It was nice to catch up with you. Please provide budgetary cost estimates for the following:

1. Location: City of Soldotna, Alaska
2. Two Estimates:
    a. Screw Press only
    b. Rotary Drum (or another mechanical thickening option) and Screw Press
3. Max Daily Values:
    a. Aerobic Digester Solids: 1,260 lbs./day
    b. 1 percent solids from digester
    c. 9.6 gpm

If you have any questions, please let me know.

Thanks,

Teresa Peterson, PE*
*Civil Engineer (*WA)*

HDR
2525 C Street, Suite 305
Anchorage, AK 99503
D 907.644.2196 **M** 253.310.5433

teresa.peterson@hdrinc.com

hdrinc.com/follow-us

Budgetary Proposal

Project Name:
Soldotna, AK - Option: Screw Press Only

Equipment Type:
RoS3-Q440 Screw Press

Proposal Date:
5/27/2015

Huber Contacts:
John Lewis
Western Regional Sales Manager
704-995-5451
John@hhusa.net

Ed Fritz, P.E.
Application Engineer: Sludge Treatment
704-990-2041
Ed.Fritz@hhusa.net

Represented by:
John Simon
Goble Samson Associates
425-392-0491
jsimon@goblesampson.com

HUBER TECHNOLOGY
WASTE WATER Solutions

Huber Technology, Inc.

9735 NorthCross Center Court
Suite A
Huntersville, NC 28078

Phone: (704) 949-1010
Fax: (704) 949-1020

Screw Press Design Summary

Soldotna, AK - Option: Screw Press Only May 27, 2015

Sludge Characteristics:

Upstream Process:	Information not provided
Digestion Process:	Aerobic Digester
Digestion Process Sludge Age:	Information not provided
Sludge Type:	WAS
Sludge VSS:	Information not provided

Project Design Parameters:

Sludge Feed Rate:	1,260 lb/day	
Sludge Concentration:	1%	
Operational Schedule:	40 hr/wk	(8 hr/day, 5 days/wk)
Calculated Total Hydraulic Loading Rate:	31.5 gpm	(7.1 m^3/hr)
Calculated Total Solids Loading Rate:	157.5 lb/hr	(71.4 kg/hr)

Equipment Recommendation:

Recommended unit model:	RoS3-Q440		
Recommended unit quantity:	1		

Typical Expected Unit Performance:

Hydraulic Loading Rate (per unit):	31.7 gpm	(7.2 m^3/hr)	at 1% solids
Solids Loading Rate (per unit):	158.5 lb/hr	(71.9 kg/hr)	at 1% solids

Equipment Performance:

Estimated Cake Solids:	14-27%
Capture Rate:	≥95%

NOTE: All performance is estimated based on typical screw press performance. In order to guarantee performance Huber must run a pilot test.

Equipment Weights:

Screw Press Empty Weight:	3100 lbs	(1410 kg)
Screw Press Full Weight:	3550 lbs	(1620 kg)

Equipment Requirements:

Instantaneous Air Requirement:	0.25 SCFM at 87 psi	(7 L/min at 6 bar)
Average Washwater Requirement[1]:	95.45 gph at 72.5 psi	(361.56 L/hr at 5 bar)

[1]Wash water cycle runs at 41.5 gpm for 46 seconds. Typical applications experience 1-3 wash cycles per hour.

Polymer:

Estimated Polymer Consumption:	25-40 lb active polymer/dry ton of sludge
Estimated Polymer Makeup Water[2]:	157 gal/hr potable water at 70-100 psi

[2]Assuming 48% active polymer in neat polymer solution and a 0.5% dilute polymer solution to the screw press.

Flocculation Detention Time:	45 sec at 32 gpm

Notes and Assumptions:

1. Equipment specification and drawings are available upon request.
2. If there are site-specific hydraulic constraints that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system.
3. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, whichever occurs first.
4. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in US dollars unless otherwise stated.
5. Equipment recommendations are based on information provided to Huber Technology. Subsequent information which differs from what has been provided may alter the equipment recommendation.
6. Pricing is based on Huber's standard control panel arrangement.

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A member of the HUBER Group

Equipment Summary

Soldotna, AK - Option: Screw Press Only May 27, 2015

Screw Press:

One (1) RoS3-Q440 Screw Press in 304L stainless steel construction; with full submersion passivated surface treatment for superior corrosion protection. Each including:

- Fully enclosed basket
- Shafted screw with integrated maintenance free bearing
- 15° inclined auger tube
- 2 hp, Class 1/Division 2 drive motor, 460 VAC, 60 Hz, 3 ph

Ancillary Equipment:

- One (1) Polymer injection ring and mixing device
- One (1) Compressor
- One (1) Sludge Flow Meter
- One (1) Control Panel - Huber Standard Control Panel Design (Stainless Steel NEMA 4X Enclosure, CompactLogix PLC, PanelView+ 600 HMI, pre-programmed and factory tested)
- Standard Huber Recommended Start-up Services (6 days, 2 trips)
- Freight to jobsite.

Total Price: $220,000 (per unit)

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Budgetary Proposal

Project Name: Soldotna, AK

Equipment Type:
RoS2S-Size 1 Disk Thickener

Proposal Date:
5/27/2015

Huber Contacts:
John Lewis
Western Regional Sales Manager
704-995-5451
John@hhusa.net

Ed Fritz
Application Engineer
704-990-2041
Ed.Fritz@hhusa.net

Represented by:
John Simon
Goble Sampson Associates
425-392-0491
jsimon@goblesampson.com

HUBER TECHNOLOGY
WASTE WATER Solutions

Huber Technology, Inc.

9735 NorthCross Center Court
Suite A
Huntersville, NC 28078

Phone: (704) 949-1010
Fax: (704) 949-1020

Disk Thickener Design Summary

Soldotna, AK — May 27, 2015

Sludge Characteristics

Upstream Process:	Aerobic Digester
Sludge Type:	WAS
Sludge Feed Rate:	1260 lb/day
Sludge Concentration:	1%

Equipment Design Parameters

Recommended unit:	RoS2S-Size 1	
Type of Unit:	Disk Thickener	
Recommended unit quantity:	1	
Operational Schedule:	40 hr/wk	(8 hr/day, 5 days/wk)
Maximum Hydraulic Loading Rate (per unit):	71.6 gpm	(16.3 m3/hr)
Maximum Solids Loading Rate (per unit):	350.5 lb/hr	
Estimated Thickened Sludge Solids:	5-6%	
Capture Rate:	95%	
Estimated Polymer Consumption:	10 lb active polymer/dry ton of sludge	
Average Potable Spray Water Requirement:	5.1 gpm at 43.5 psi	(0.32 L/sec at 3 bar)

NOTE: All performance is estimated based on typical Disk Thickener performance. Pilot testing is necessary to guarantee performance.

Notes:

1. Equipment specification and drawings are available upon request.
2. If there are site-specific hydraulic constraints that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system.
3. Electrical disconnects required per local NEC code are not included in this proposal.
4. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, whichever occurs first.
5. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in US dollars unless otherwise stated.
6. Equipment lead time from approval of shop drawings is expected to be around 26-28 weeks.
7. Equipment recommendations are based on information provided to Huber Technology. Subsequent information which differs from what has been provided may alter the equipment recommendation.

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Equipment Summary

Soldotna, AK May 27, 2015

Disk Thickener:

One (1) RoS2S-Size 1 disk thickener in 304L stainless steel construction; with full submersion passivated surface treatment for superior corrosion protection. Each including:

- Fully enclosed disk
- Spray wash system
- 0.75 hp, Class 1/Division drive motor, 460 VAC, 60 Hz, 3 ph

Ancillary Equipment:

- One (1) Flocculation reactor with stirrer.
- One (1) 0.25 hp Flocculation Drive Motor
- One (1) Polymer injection ring and mixing device
- One (1) Thin Sludge Flow Meter
- One (1) Thickened Sludge Pump
- One (1) Control Panel - Huber Standard Control Panel Design
- Standard Huber Recommended Start-up Services
- Freight to jobsite.

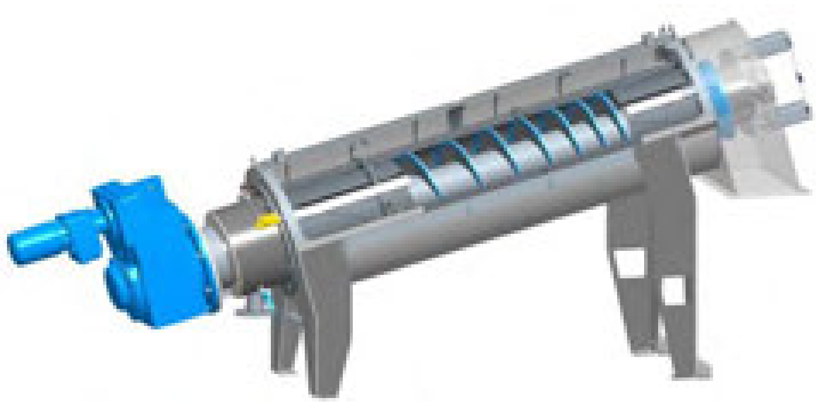
Total Price: $179,000 (per unit)

Budgetary Proposal

Project Name:
Soldotna, AK - Option: Thickener Before Screw Press

Equipment Type:
RoS3-Q280 Screw Press

Proposal Date:
5/27/2015



Huber Contacts:
John Lewis
Western Regional Sales Manager
704-995-5451
John@hhusa.net

Ed Fritz, P.E.
Application Engineer: Sludge Treatment
704-990-2041
Ed.Fritz@hhusa.net

Represented by:
John Simon
Goble Samson Associates
425-392-0491
jsimon@goblesampson.com

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WASTE WATER Solutions

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Huntersville, NC 28078

Phone: (704) 949-1010
Fax: (704) 949-1020

Screw Press Design Summary

Soldotna, AK - Option: Thickener Before Screw Press May 27, 2015

Sludge Characteristics:

Upstream Process:	Information not provided
Digestion Process:	Aerobic Digester
Digestion Process Sludge Age:	Information not provided
Sludge Type:	WAS
Sludge VSS:	Information not provided

Project Design Parameters:

Sludge Feed Rate:	1,260 lb/day	
Sludge Concentration:	5%	
Operational Schedule:	40 hr/wk	(8 hr/day, 5 days/wk)
Calculated Total Hydraulic Loading Rate:	6.3 gpm	(1.4 m^3/hr)
Calculated Total Solids Loading Rate:	157.5 lb/hr	(71.4 kg/hr)

Equipment Recommendation:

Recommended unit model:	RoS3-Q280		
Recommended unit quantity:	1		

Typical Expected Unit Performance:

Hydraulic Loading Rate (per unit):	6.4 gpm	(1.4 m^3/hr)	at 5% solids
Solids Loading Rate (per unit):	159.4 lb/hr	(72.3 kg/hr)	at 5% solids

Equipment Performance:

Estimated Cake Solids:	14-27%
Capture Rate:	≥95%

NOTE: All performance is estimated based on typical screw press performance. In order to guarantee performance Huber must run a pilot test.

Equipment Weights:

Screw Press Empty Weight:	1500 lbs	(680 kg)
Screw Press Full Weight:	1630 lbs	(740 kg)

Equipment Requirements:

Instantaneous Air Requirement:	0.25 SCFM at 87 psi	(7 L/min at 6 bar)
Average Washwater Requirement[1]:	55.4 gph at 72.5 psi	(210 L/hr at 5 bar)

[1]Wash water cycle runs at 27.7 gpm for 40 seconds. Typical applications experience 1-3 wash cycles per hour.

Polymer:

Estimated Polymer Consumption:	25-40 lb active polymer/dry ton of sludge
Estimated Polymer Makeup Water[2]:	157 gal/hr potable water at 70-100 psi

[2]Assuming 48% active polymer in neat polymer solution and a 0.5% dilute polymer solution to the screw press.

Flocculation Detention Time:	45 sec at 7 gpm

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A member of the HUBER Group

Notes and Assumptions:

1. Equipment specification and drawings are available upon request.
2. If there are site-specific hydraulic constraints that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system.
3. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, whichever occurs first.
4. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in US dollars unless otherwise stated.
5. Equipment recommendations are based on information provided to Huber Technology. Subsequent information which differs from what has been provided may alter the equipment recommendation.
6. Pricing is based on Huber's standard control panel arrangement.

Equipment Summary

Soldotna, AK - Option: Thickener Before Screw Press May 27, 2015

<u>Screw Press:</u>

One (1) RoS3-Q280 Screw Press in 304L stainless steel construction; with full submersion passivated surface treatment for superior corrosion protection. Each including:

- Fully enclosed basket
- Shafted screw with integrated maintenance free bearing
- 15° inclined auger tube
- 0.5 hp, Class 1/Division 2 drive motor, 460 VAC, 60 Hz, 3 ph

<u>Ancillary Equipment:</u>

- One (1) Polymer injection ring and mixing device
- One (1) Compressor
- One (1) Sludge Flow Meter
- One (1) Control Panel - Huber Standard Control Panel Design (Stainless Steel NEMA 4X Enclosure, CompactLogix PLC, PanelView+ 600 HMI, pre-programmed and factory tested)
- Standard Huber Recommended Start-up Services (6 days, 2 trips)
- Freight to jobsite.

Total Price: $200,000 (per unit)

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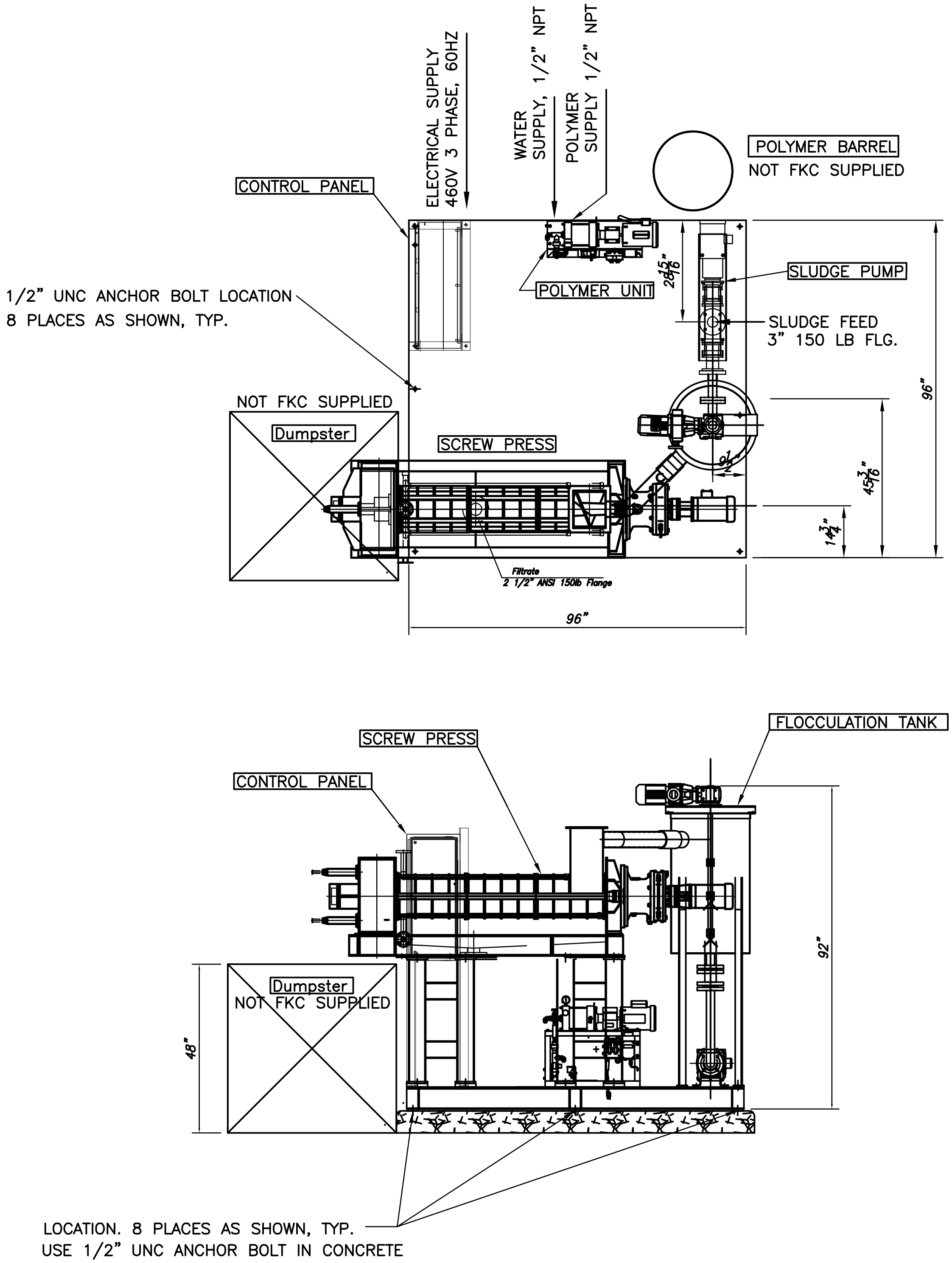

Job No.	Messrs.	Qty
REF	REFERENCE	
Drawing No.	Title	Date
BHX250SKID	FKC SCREW PRESS MODEL BHX-250x1500L DEWATERING SYSTEM	3/24/09
		Drawn by
		RJO
FKC	FKC CO., LTD. 2708 W. 18TH ST. PORT ANGELES, WA 98363 (360) 452-9472 FAX (360) 452-6880	
	REVISION 0	SHEET 1 OF 1

Peterson, Teresa

From: John Simon <jsimon@goblesampson.com>
Sent: Thursday, May 28, 2015 2:33 PM
To: Peterson, Teresa
Subject: RE: Request for Budgetary Quotes for a Complete Plant and H-Pac System
Attachments: 2015-05-27 Soldotna, AK RoS3-Q280 Budgetary Proposal (Thickener + Screw ....pdf; 2015-05-27 Soldotna, AK RoS3-Q440 Budgetary Proposal (Screw Press Only).pdf; 2015-05-27 Soldotna, AK RoS2S-Size 1 Budgetary Proposal (Thickener + Scr....pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Teresa,

Please review the attached HUBER budget quotations. A few notes:

- The thickener + screw press option does allow us to get into a smaller screw press unit. However, at this low of a solids feed the reduction in unit size doesn't result in a large reduction in price (RoS3-Q440 to RoS3-Q280).
- I've assumed they want to go straight from the thickener into the screw press. If they want to blend the thickened sludge back into the digester, then I need to thin the feed solids to the screw press.
- The option to thicken then dewater requires two pieces of equipment and is therefore more expensive. Is there an operational or process reason they would like to thicken before dewatering?
- I have not included the feed pumps or polymer systems. (I did include a TWAS pump since we will need to get thickened sludge away from the thickener.)

Let me know if you have any questions.

John Simon
Goble Sampson Associates
jsimon@goblesampson.com
P: (425) 392 0491
C: (425) 736 4584
www.goblesampson.com

From: Peterson, Teresa [mailto:Teresa.Peterson@hdrinc.com]
Sent: Monday, May 18, 2015 12:23 PM
To: John Simon
Subject: RE: Request for Budgetary Quotes for a Complete Plant and H-Pac System

Hi John,

Per our last discussion, I also need budgetary estimates for a Huber Screw Press (with and without a mechanical thickening option). I have the following information for the system:

1. Two Estimates:
    a. Screw Press only
    b. Rotary Drum (or another mechanical thickening option) and Screw Press
2. Max Daily Values:
    a. Aerobic Digester Solids: 1,260 lbs./day
    b. 1 percent solids from digester
    c. 9.6 gpm

If you have any questions, please let me know.

Thanks,

Teresa Peterson, PE (WA)
D 907.644.2196 **M** 253.310.5433

hdrinc.com/follow-us

From: Peterson, Teresa
Sent: Wednesday, May 13, 2015 12:29 PM
To: 'jsimon@goblesampson.com'
Subject: Request for Budgetary Quotes for a Complete Plant and H-Pac System

Hi John,

I am working on a Planning Study in Soldotna, Alaska and I need a couple budgetary quotes. The first is for an updated quote of the Haines WWTP Lakeside RAPTOR™ 2 MGD Complete Plant, Model 31CPA-2.0 (this was from back in 2013 – please see the attached email). The sizing for Soldotna is basically the same as Haines and an updated quote will work for the purposes of the planning phase.

The second item is for a Lakeside H-PAC™ SpiraGrit Vortex Grit System. Based on the information I have, the model that we are looking at is the Model 31FS-SG7-2.5. Again, the parameters are similar to Haines, Alaska (PDF attached from initial discussion for Haines, Alaska).

If you have any questions, please let me know.

Thank you for your help,

Teresa Peterson, PE*
*Civil Engineer (*WA)*

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teresa.peterson@hdrinc.com

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SOLDOTNA
City of Soldotna, Alaska

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City of Soldotna, Alaska

City of Soldotna

2015 Soldotna Wastewater Master Plan

City of Soldotna, Alaska
February 15, 2016

Table of Contents

Tables

Figures

Appendices

List of Acronyms

The following is a list of acronyms and short forms used in this plan.

AWWU	Anchorage Water and Wastewater Utility
CAC	Capacity Analysis Criteria
CDP	Census Designated Place
CIP	Capital Improvement Program
CPCN	Certificate of Public Convenience and Necessity
DCPM	Design Criteria and Practices Manual
DLWD	Alaska Department of Labor and Workforce Development
EPA	Environmental Protection Agency
FOG	Fat, oil, and grease
FSE	Food Service Establishment
gpcd	gallons per capita per day
gpm	gallons per minute
HPD	Habitat Protection District
I&I	Inflow and Infiltration
KPB	Kenai Peninsula Borough
KROD	Kenai River Overlay District
LGIM	Local Government Information Model
LS	Lift station
MG	Million Gallons
MGD	Million Gallons per Day
OHW	Ordinary High Wastewater Mark
RCA	Regulatory Commission of Alaska
R&R	Rehabilitation and Repair
SE	System Expansion
SSO	Sanitary Sewer Overflow
WWMP	Wastewater Master Plan (preceded by relevant date of publication)
WWTP	Wastewater Treatment Plant

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1 Introduction

1.1 Authorization

The City of Soldotna (City) has authorized HDR Alaska, Inc. to prepare the *2015 Soldotna Wastewater Master Plan* (2015WWMP). Preparation of this plan was authorized by a contract between the City and HDR Alaska, Inc., under City Project Utility Master Plans SOLP 14-02.

1.2 Purpose

The objective of the 2015 WWMP is to prepare a wastewater collection system master plan and associated Capital Improvement Program (CIP) to implement the plan's recommendations. The plan will evaluate a projected 20 year time horizon (i.e., 2016–2035) for the system and develop capital and operational improvements to the system to provide the City with adequate wastewater collection capacity to support its residents and future growth. This plan provides a description and justification for each plan recommendation, as well as the recommended implementation sequence and year.

This document presents information describing the existing condition of Soldotna's wastewater system, projections of future wastewater collection needs, analysis of system deficiencies, discussion of system improvement recommendations, and schedule implementation of a CIP to meet projected needs and to rectify system deficiencies.

1.3 Background

Soldotna is the commercial and recreational hub of the central Kenai Peninsula. Because of its location on the highway system and availability of developable land, the City has experienced both commercial business and residential growth. To manage the growth and develop a clear vision for a larger, livable Soldotna, the City prepared the *Envision Soldotna 2030 Comprehensive Plan*, adopted by the Soldotna City Council in January 2011. This plan noted that Soldotna will continue to infill with residential and commercial properties through the planning period. An important requirement to maintain and support this growth will be a robust wastewater collection system. Therefore a key recommendation of the comprehensive plan was that the City update its utility master plan. This plan fulfills the comprehensive plan recommendation for the wastewater collection system (DOWL HKM and Kevin Waring Associates 2011).

With growth in the 1960s planning for community-wide water and wastewater systems was needed. A combined water and wastewater master plan for Soldotna was prepared in the late 1960s (Adams Corthell Lee Wince, and Associates 1968). This planning effort developed the core system layout for the City, which was based on a projected service population of approximately 10,000 people in the year 2000.

The system described in the 1968 master plan is now the core wastewater collection system the City now operates. It was constructed in the early 1970s as part of US Department of Housing and Urban Development work in the city. This project also installed a stormwater collection and drainage system and wastewater treatment plant (analysis of these is covered in separate master plans).

Soldotna has grown substantially since the last wastewater planning effort with collection piping and lift stations (LSs) being incorporated into the wastewater system. With this backdrop the City authorized work on preparing a wastewater system master plan. Key planning issues included:

- Completion of the City's *Envision Soldotna 2030 Comprehensive Plan,* and policies for charting growth within it, contained implications on Soldotna's wastewater collection system and required upgrades and expansion.
- Wastewater production in Soldotna will continue to grow.
- Growth in the City, including areas not presently served by public wastewater collection.
- Soldotna's system is aging and has many pipes approaching over 40 years old. Repair and rehabilitation of these pipes will become a higher priority as the system continues to age.

1.4 Scope

The Scope of Work statement for preparing the 2015 WWMP is generalized as follows:

- Update and add information to the City's adopted ESRI Local Government Information Model (LGIM) for organizing its geospatial data. The data will be used for analyses preformed during the wastewater and sewer system and drainage planning work.
- Prepare population and community growth estimates and calculate wastewater production and sewer flows. Population and community growth will be projected for a 20 year time horizon. These flow projections will be used to evaluate the water and sewer systems, drainage needs, and wastewater treatment plant upgrades.
- Prepare a wastewater collection system master plan and associated CIP to implement the plan's recommendations. The plan will evaluate a projected 20 year time horizon.
- Prepare map products for use with the 2015 WWMP update and clearly display the plan to the general public.
- Present the final master plan and recommendations to the Soldotna City Council.
- Publish the final plan for distribution to the general public and Soldotna's future use.

1.5 Study Areas

The 2015 WWMP study area includes lands within the City of Soldotna sewer service area as defined in the Certificate of Public Convenience and Necessity (CPCN) No. 132. The certificate generally covers the City of Soldotna city limits and lands within a mile to one and one half miles of the city boundary in the Ridgeway Census Designated Place (CDP) and the Kalifornsky CDP. The study and surrounding areas are shown in Figure 1.

The portion of the study area within the City limits is consistent with *Envision Soldotna 2030 Comprehensive Plan*. Implementation strategies listed in chapter 4 of the plan were considered in the development of the recommendations contained in this master plan.

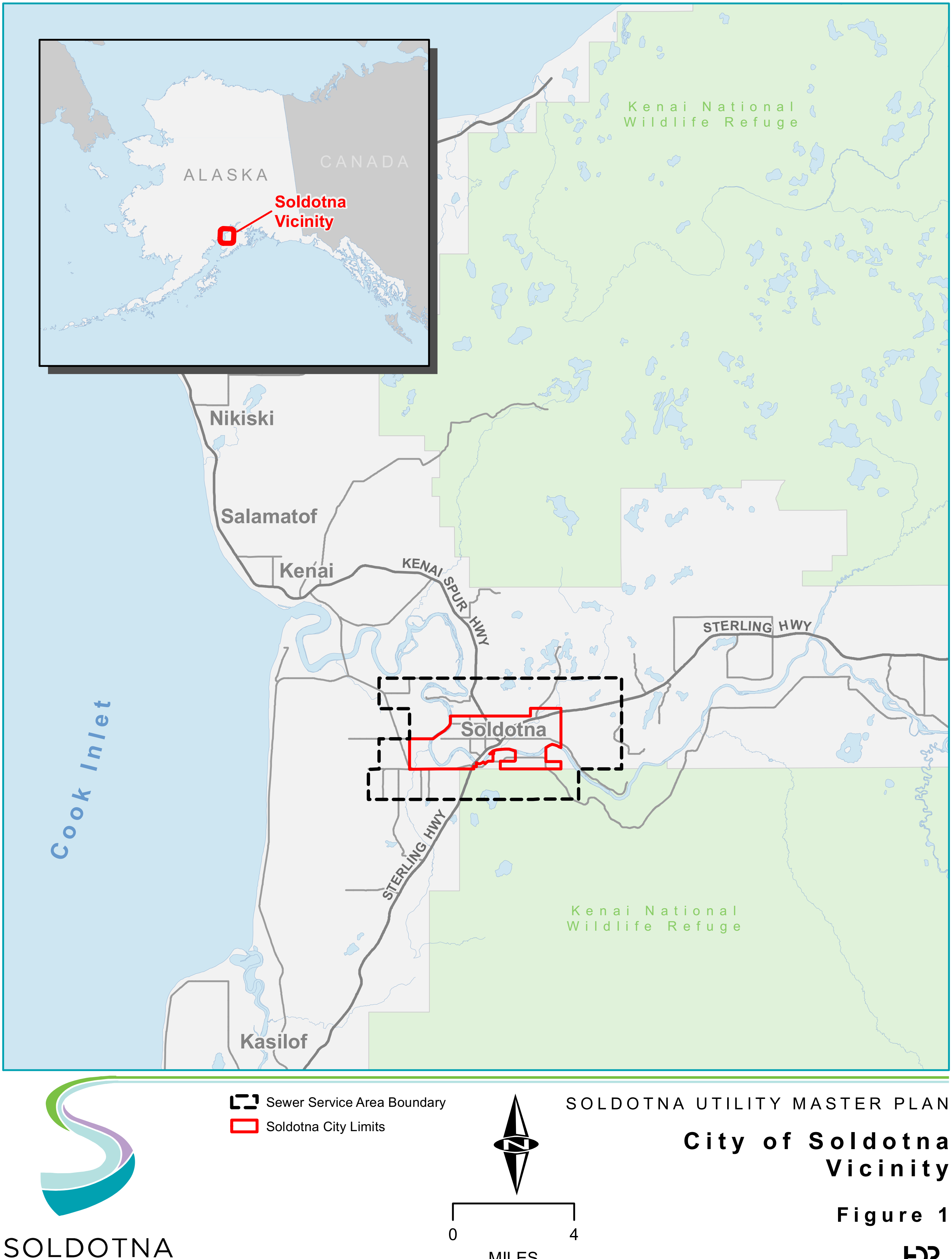
Surrounding the City are areas cited in the *2005 Kenai Peninsula Borough Comprehensive Plan* (KPB Comprehensive Plan) as rapidly growing and having a significant proportion of the population in the borough. The KPB Comprehensive Plan states that “according to 2003 population data, over half of the residents (about 55 percent [%]) of the Borough … live in the central peninsula area in the vicinity of Kenai, Soldotna, Sterling, Nikiski, Kasilof and Funny River….The number of parcels [in these areas] occupied by residential uses has increased significantly during the last decade and at a much faster rate than the population” (pages 6-25 of KPB 2005).

The study areas outside the City boundary were selected because they represent areas of rapid growth potential, some of which could have the City wastewater service extended into them during the planning period. Including these is consistent with the KPB Comprehensive Plan goals, objectives, and implementation actions listed in chapter 4 of that plan. These strategies were considered in the development of the recommendations contained in this master plan.

The study area includes the City of Soldotna’s Kenai River Overlay District (KROD). This district “is a special zoning district designed to provide opportunities for the development and use of land along the Kenai River, while also safeguarding and enhancing riparian habitat, controlling erosion, and protecting ground and surface wastewater. The district includes all lands within 100 feet of the ordinary high wastewater mark (OHW) of the Kenai River, or 25 feet back from a cut bank, whichever is greater” (Soldotna 2015).

The study area includes areas within the KPB Habitat Protection District (HPD) which “includes all lands within 50 horizontal feet of the waters set forth in KPB 21.18.025. This shall be measured from the OHW” (KPB 2011).The HDP places additional requirements on property development within the District.

Requirements of the KROD and HPD were considered in the development of the recommendations contained in this master plan.



SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

City of Soldotna Vicinity

Figure 1

HDR

2 Population Projections and Land Use

2.1 Introduction

To estimate future wastewater production, population projections and expected geographic distribution of the population were developed. For purposes of population analysis in the 2015 WWMP, the study area has been divided into three geographic areas that correspond to Soldotna's current and potential future service areas (Figure 1). The areas are:

- The City of Soldotna
- The Ridgeway CDP outside the City limits
- The Kalifornsky CDP outside the City limits

Within each of the three geographic regions of study, estimates of population distribution and extent of commercial development were made for purposes of establishing wastewater production projections on a small-area basis. These small area population projections were then used in modeling the wastewater system to plan specific extensions or improvements. The following sections address the procedures used to develop population estimates for use in wastewater production analyses and modeling described in Section 3.

2.2 Current Population

2.2.1 Total Planning Area Population

The City of Soldotna had a total population of 3,750 in 2000 (Alaska Department of Labor and Workforce Development (DLWD)). In the 2010 census, the City grew to a total population of 4,163. The City experienced a growth of 11% for this ten-year period. Population estimates continue to indicate growth in the City with an estimated 2014 population of 4,311. Table 1 summarizes the historical population of the City and the geographic areas of interest for the 2015 WWMP (Soldotna, Ridgeway CDP, and Kalifornsky CDP).

While the City grew rapidly in this period, the surrounding areas showed different growth patterns. The Ridgeway CDP has exhibited low growth between 1990 and 2014, while the Kalifornsky CDP has grown dramatically and surpassed the City in population.

Table 1. Historic Population

Year	City of Soldotna	Ridgeway CDP	Kalifornsky CDP
1960[1]	332	-	-
1970	1202	500 (estimated)[4]	-
1980	2320	-	-
1990[2]	3,482	2,018	285
2000	3,750	1,932	5,846
2010[3]	4,163	2,022	7,850
2014	4,311	2,187	8,441

[1]Data from 1960 and 1980 from *Envision Soldotna 2030 Comprehensive Plan*.
[2]Years 1990 and 2000 data from http://laborstats.alaska.gov/pop/popest.htm Historical Data: Places.
[3]Years 2010 to 2014 data from http://laborstats.alaska.gov/pop/popest.htm Cities and Census Designated Places, 2000 to 2014.
[4]Adams Corthell Lee Wince, and Associates. City of Soldotna Wastewater System and Sewer System. June 1968

2.2.2 Population served

Developing an estimate of the population served by the City wastewater collection system was a two part process. First the population served in 2010 was determined and then this estimate was systematically increased to estimate the population served in 2015. The following described the process and data sets used.

To determine the 2010 population for which City provided wastewater service, the 2010 Census data, KPB parcel database, City sewer connection data, and City sewer customer data sets were analyzed. These data sets were used to first determine which parcels were connected to the sewer system in 2010 and how many people were living in the connected parcels. Adding up the people at each parcel serviced provided an estimate of the total population served by the wastewater collection system

Next the sewer service connection data was used to determine the parcels that were added to the system between 2011 and 2014 and how may people this added to the sewer system. These new customers were added to the 2010 estimate to develop the population served estimate for 2014.These values were increased by estimated population growth rates described in the next section to estimate the population served 2015. Table 2 provides estimates of the City population and the estimated population served by the City sewer system. Those City residents not served by the City sewer system use private wastewater disposal systems.

Table 2. Total Population Served by City Sewer System

Year	City Population	City Served Population (number)	City Served Population (percentage)
2015	4,375	3,380	77%

2.3 Population Projections

2.3.1 Future Resident Planning Area Population

The Soldotna Planning Department made future population estimates for the City in the *Envision Soldotna 2030 Soldotna Comprehensive Plan.* The comprehensive plan estimates were completed in 2009. These projections were based on growth of 7% per decade, or 0.70% per year, through 2030.

The DLWD Research and Analysis Section prepared population projections for Alaska and Boroughs. Most recently updated in 2012 this data projects population from 2012 through 2042. DLWD population projections only cover the State of Alaska and KPB. DLWD does not prepare projections for areas smaller than boroughs. The portion of the DLWD projected growth rates applicable to this plan's planning period are shown in Table 3. These projections show a declining growth rate through the planning period.

Table 3. DLWD Estimated Annual Population Growth Rates 2012-2037

Year	Alaska	KPB
2012-2016	1.01%	0.85%
2017-2021	0.91%	0.72%
2022-2026	0.80%	0.55%
2027-2031	0.70%	0.38%
2032-2037	0.64%	0.24%

To evaluate issues related to wastewater planning population projections for the City and adjacent Ridgeway CDP and Kalifornsky CDP are needed. However, because of the differences between the Soldotna Comprehensive Plan and DLWD population projections, neither of these is directly applicable for this wastewater plan. To prepare population estimates for this plan the following assumptions were made.

- The City of Soldotna will continue to grow at a greater rate than the KPB as a whole, as has been the case for the past decade.
- The Kalifornsky CDP will continue to grow at a faster rate than the City of Soldotna, as has been the case for the past decade.
- The Ridgeway CDP will continue to grow at a similar rate as the City of Soldotna, as has been the case for the past decade.
- Growth rates over the planning period will slow at the rate indicated for KPB by DLWD projections.
- The City of Soldotna, Ridgeway CDP, and Kalifornsky CDP will continue to be the fastest growing areas in the KPB and will receive a greater proportion of the total projected KPB population growth during the planning period.
- The total population growth projected by DLWD for the KBP will hold for the planning period. That is to say, the growth rates selected for the City, Ridgeway CDP and Kalifornsky CDP could not result in a larger KPB population than estimated by the DLWD. Adopting this criterion allowed for higher growth rates in

the planning area but maintained the total KPB population equivalent to DLWD projections.

These criteria were used to develop growth rates and population estimates for use in this plan. The selected growth rates that provided the best fit estimate to the available data are show in Table 4.

Table 4. Estimated Annual Population Growth Rates 2012-2035

Year	KPB	City of Soldotna	Ridgeway CDP	Kalifornsky CDP
2012-2016	0.85%	1.00%	1.00%	1.20%
2017-2021	0.72%	0.87%	0.87%	1.07%
2022-2026	0.55%	0.70%	0.70%	0.90%
2027-2031	0.38%	0.53%	0.53%	0.73%
2032-2035	0.24%	0.39%	0.39%	0.59%

The selected growth rates in Table 4 were used to prepare population estimates for the planning area through the planning period. These are presented in Table 5. The selected growth rates project a slightly greater population in the City in 2030 than is projected in the comprehensive plan, 4,881 versus 4,674.

Table 5. Estimated Planning Area Population 2016-2035

Year	KPB	City of Soldotna	Ridgeway CDP	Kalifornsky CDP
2016	58,721	4,419	2,146	8,432
2017	59,220	4,458	2,165	8,523
2018	59,646	4,496	2,184	8,614
2019	60,076	4,535	2,203	8,706
2020	60,508	4,575	2,222	8,799
2021	60,944	4,615	2,241	8,893
2022	61,383	4,647	2,257	8,973
2023	61,720	4,680	2,273	9,054
2024	62,060	4,712	2,289	9,136
2025	62,401	4,745	2,305	9,218
2026	62,744	4,779	2,321	9,301
2027	63,090	4,804	2,333	9,369
2028	63,329	4,829	2,346	9,437
2029	63,570	4,855	2,358	9,506
2030	63,811	4,881	2,371	9,575
2031	64,054	4,906	2,383	9,645
2032	64,297	4,926	2,392	9,702
2033	64,452	4,945	2,402	9,759
2034	64,606	4,964	2,411	9,817
2035	64,761	4,983	2,421	9,875

2.4 Service Areas Land Use

Soldotna is certificated to provide sewer service the entire City and an area surrounding the City. The following section describes these service areas and assumptions made on how they may change during the planning period.

2.4.1 Certificated Service Area

On June 22, 1971, the Alaska Public Utilities Commission, now the Regulatory Commission of Alaska (RCA), granted a CPCN Number 132 to the City of Soldotna for operation of a sewer utility within a specified boundary area. The CPCN area is shown in Figure 2. As agreed to in the CPCN, the City of Soldotna makes no commitment to the RCA or area residents as to when it may extend services within this area in the future.

2.4.2 Land Use Pattern

To project future wastewater demands throughout the three geographical areas of study, assumptions about future land use were required. Land use for the years 2015 through

2030 was analyzed to develop a recommended CIP for the period. The City and KPB comprehensive planning process establishes land use patterns in each area of study and these patterns were used as the basis for the 2015 WWMP. Goals, objectives, policies, and strategies from the *Envision Soldotna 2030 Comprehensive Plan* and the KPB Comprehensive Plan developed during the community planning process were used to project wastewater use during the planning period and to evaluate potential system expansion (SE).

City of Soldotna

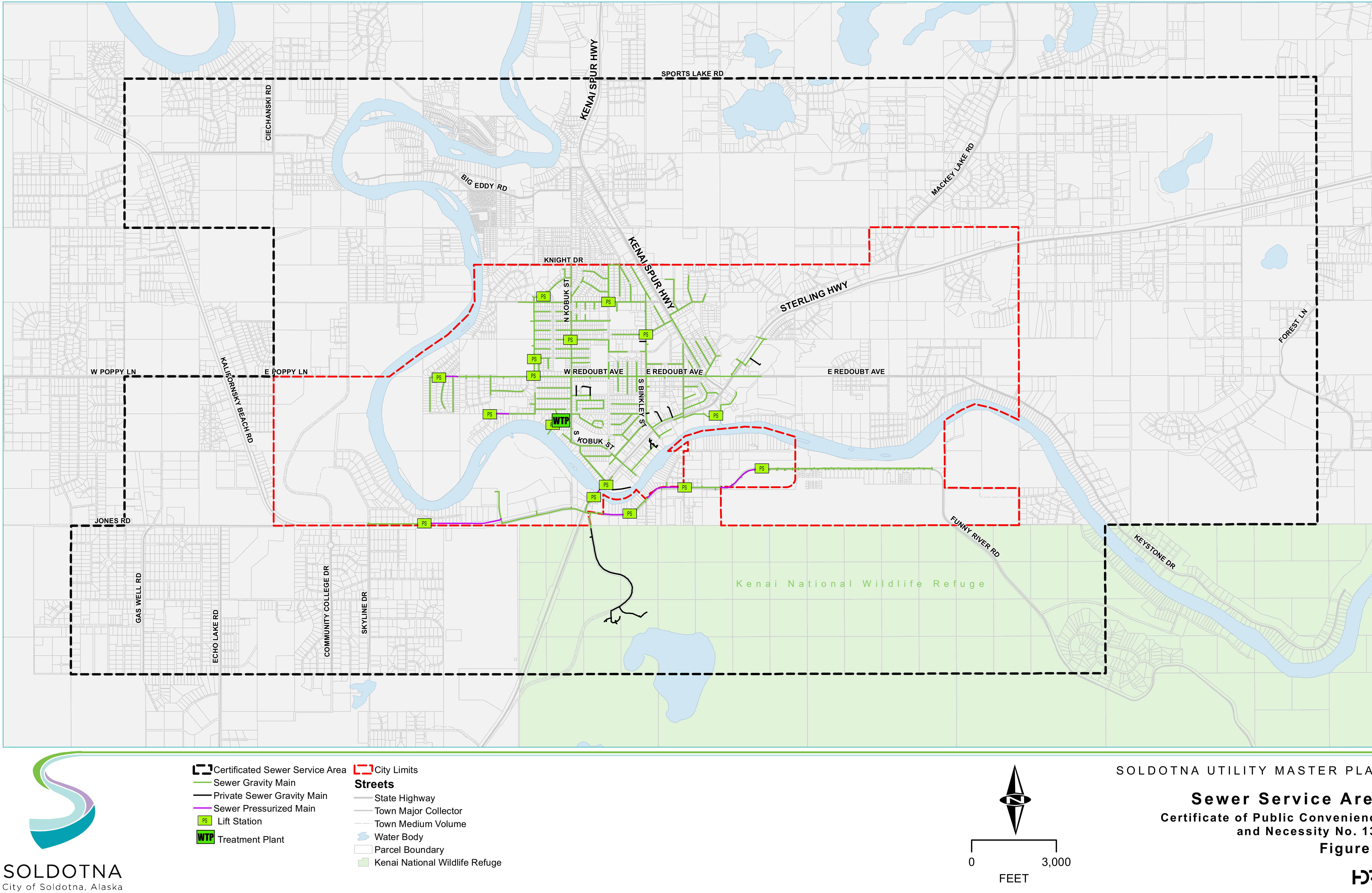
For future wastewater planning, growth patterns and land uses presented in *the Envision Soldotna 2030 Comprehensive Plan* were used for evaluating future wastewater collection needs. The plan provides for further development of commercial properties on the Sterling and Kenai Spur Highway corridors with additional mixed use development around the hospital. Higher density single and multi-family residential areas requiring city sewer will generally remain the same and will infill the remaining parcels with development. Rural residential areas are assumed to not require city sewer in the planning period. These projected land uses were used in modeling the operation of the wastewater collection system and its needs.

Ridge Census Designated Places

Bordering the City limits to the north is the Ridgeway CDP. This area contains the Kenai Spur Highway commercial corridor and a higher density residential area. Adjacent to the northern City limit and beyond this are rural residential areas and vacant land. Commercial and residential growth in this area is projected to continue through the planning period. Because of the adjacent commercial district of the City, commercial growth will likely be greater nearer to the City limit. Residential growth will be slower than the Kalifornsky CDP because there is less available land for such development. Rural residential areas are assumed to not require city sewer in the planning period. Some connection of adjacent parcels to the sewer collection network is possible at the outer edge of the system but will likely be limited by the cost of collection SE.

Kalifornsky Census Designated Places

Bordering the City limits on the west and south is the Kalifornsky CDP. This area contains Kalifornsky Beach Road commercial corridor and a small area of higher density residential area near the western City limit. Beyond these are rural residential areas and vacant land. This was the fastest growing area in the KPB in the past decade and is projected to continue to grow rapidly through the planning period. Residential growth will be greater than the Ridgway CDP because there is more available land for such development and will be primarily single family homes. Rural residential areas are assumed to not require city sewer in the planning period. Some connection of adjacent parcels to the sewer collection network is possible at the outer edge of the system but will likely be limited by the cost of collection SE.



SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Sewer Service Area

Certificate of Public Convenience and Necessity No. 132

Figure 2

HDR

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2.5 Future Population Served

The 2015 served population by the sewer collection system was estimated using the methodology previously discussed in Section 2.1.2. Some portion of the future development and population growth within the City limits will be in areas outside the wastewater service area. For planning purposes, it is assumed that 75% of the population growth in the City will be in areas currently serviced by wastewater and sewer. The remaining 25% of the City's growth in the planning period will use private wastewater disposal systems.

Not all buildings adjacent to the City sewer system are connected to it. Analysis of KPB parcel data and City sewer service data shows that approximately 80 parcels with buildings, either residences or other properties, are adjacent to the wastewater system but not connected to it. Owners of these buildings can connect to the wastewater system and do, for various reasons. It is assumed that this will continue during the planning period. For planning purposes it is assumed that those properties that currently front sewer laterals but do not have a service connection will become connected sometime over the next 20 years. It is assumed that the same number of parcels, and people, will be added to the system each year and all parcel residents will be connected by the end of the planning period.

The sewer system will continue to serve parcels outside the city limits. It is assumed that the parcels served by the sewer system will increase but only those parcels fronting the existing system or by areas very close to the system will connect. This assumption is made because the cost of connecting to the system is high compared to on-site wastewater treatment, if adequate lot size is available, and the desire by many outside the city limits to remain on on-site systems and have a rural residential neighborhood. Therefore, potential growth outside the city limits is accounted for through connection of adjacent parcels and is described in the previous paragraph.

The served population growth from population increase was added to the additions to the system from parcel connections. Table 6 shows the projected population served by wastewater in the City through 2035.

Table 6. Projected City of Soldotna Population Served by Sewer, 2016 to 2035

Year	Total City Population	Projected Annual Population Growth	Served Population, 75% of Population Growth	Projected Served Population Through Connecting Existing Fronting Parcels	Projected Population Served (number)	Projected Population Served (percentage)
2016	4,419	44	33	4	3,417	77%
2017	4,458	38	29	4	3,450	77%
2018	4,496	39	29	4	3,483	77%
2019	4,535	39	29	4	3,516	78%
2020	4,575	39	30	4	3,550	78%
2021	4,615	40	30	4	3,584	78%
2022	4,647	32	24	4	3,612	78%
2023	4,680	33	24	4	3,640	78%
2024	4,712	33	25	4	3,669	78%
2025	4,745	33	25	4	3,698	78%
2026	4,779	33	25	4	3,727	78%
2027	4,804	25	19	4	3,750	78%
2028	4,829	25	19	4	3,773	78%
2029	4,855	26	19	4	3,796	78%
2030	4,881	26	19	4	3,819	78%
2031	4,906	26	19	4	3,842	78%
2032	4,926	19	14	4	3,860	78%
2033	4,945	19	14	4	3,878	78%
2034	4,964	19	14	4	3,896	78%
2035	4,983	19	15	4	3,915	79%

3 Existing System and Wastewater Production

Wastewater flow is the fundamental criteria on which the sizing and design of wastewater collection systems are based. This section presents a description of the existing wastewater collection system and wastewater production information and includes projections of future wastewater collection system requirements based upon population planning and land use information presented in Section 2.

3.1 Existing System

3.1.1 Collection System Network

The City operates the public sewer system serving a portion of the City of Soldotna and several individual parcels adjacent to the City sewer pipe network located outside the city limits. The City also provides sewer service to the Kenai National Wildlife Refuge visitor's center on Ski Hill Road through a private sewer lateral from the visitor center to the City system on Funny River Road. The sewer system is shown in Figure 3.

Sewer collection pipes and system components have been divided into two asset classes. The first class is trunks. These are generally the larger diameter pipes and pump stations. These larger components provide the primary network for carrying wastewater from the collection laterals to the Wastewater Treatment Plant (WWTP). The trunk network is the 12-inch and larger diameter pipes and are shown in Figure 3.

The trunk sewer system serving Soldotna has three main branches. One branch extends north of the WWTP along South Kobuk Street and serves the northwestern part of the system, including the schools. Another branch extends east to serve the eastern portion of the system including the commercial areas of the Sterling and Kenai Spur Highways. The last branch extends south across the Kenai River and serves Funny River and Kalifornsky Beach Roads.

The second asset class is the collection lateral pipe and smaller pump stations. The primary purpose of these pipes' and pump stations' are to directly serve sewer customer connections and convey sewer flows to the trunk system. These pipes are found in service area neighborhoods and commercial areas where individual customers are connected to them. The parcels connected to the sewer system are shown on Figure 4.

3.1.2 Pump Stations

The sewage collection system contains 16 pump stations that pump sewage from lower areas of the system or from the south side of the Kenai River to gravity pipes on its way to the WWTP. Pump stations are found on the trunk and lateral asset class systems. Pump station information is shown in Table 7.

Table 7. Soldotna Wastewater Pump Stations

Pump Station	Location	Asset Class	Pumping Capacity (gpm)	Redundant Power Supply
1	SE Side of Kenai River Bridge	Trunk	370	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
2	River Terrace RV Park	Trunk	190	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
3	Porcupine Court	Lateral	260	One Portable generator that runs L.S. 3, 9, & 10 (GN-7)
4	Riverview Avenue and Daisy Lane	Lateral	230	One Portable Generator that runs LS-4 & 14 (Generator GN-11)
5	SE Corner of Middle School. Sterling Highway and Binkley Street	Trunk	320	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
6	West on path at end of West Sunrise Avenue	Trunk	510 this seems high to me	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
7	Kobuk Street and Corral Avenue	Lateral	300	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
8	West end of Sohi Lane	Lateral	250	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
9	Marydale Avenue and Fireweed Street	Lateral	170	One Portable generator that runs L.S. 3, 9, & 10 (GN-7)
10	Binkley Street and Corral Avenue	Trunk	230	Permanent on site generator powered with natural gas
11	Funny River Road West of Kenai River Raven Lodge	Lateral	540	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
12	Funny River Road and Oehler Road	Trunk	390/540	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
13	Kalifornsky Beach Road and Endicott Drive	Trunk	70	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
14	Westgate Subdivision between Blackstone Street and Green Valley Street on West Redoubt Avenue	Lateral	150	One Portable Generator that runs LS-4 & 14 (Generator GN-11)
15	Funny River Road 1/3rd mile west of Kenai River Center	Lateral	390	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)
16	Walgreen’s	Lateral	230	Three portable generators that runs L.S. 1, 2, 5, 6, 7, 8, 11, 12, 13, 15, & 16 (Generators GN-8, GN-9, & GN-10)

3.1.3 Wastewater Treatment

The City's collected wastewater is treated at the wastewater treatment plan on South Kobuk Street. Treated wastewater is discharged to the Kenai River adjacent to the plant. A separate WWTP facility plan has been prepared in conjunction with this collection system master plan (HDR, 2016). Detailed information about the WWTP can be found in that plan.

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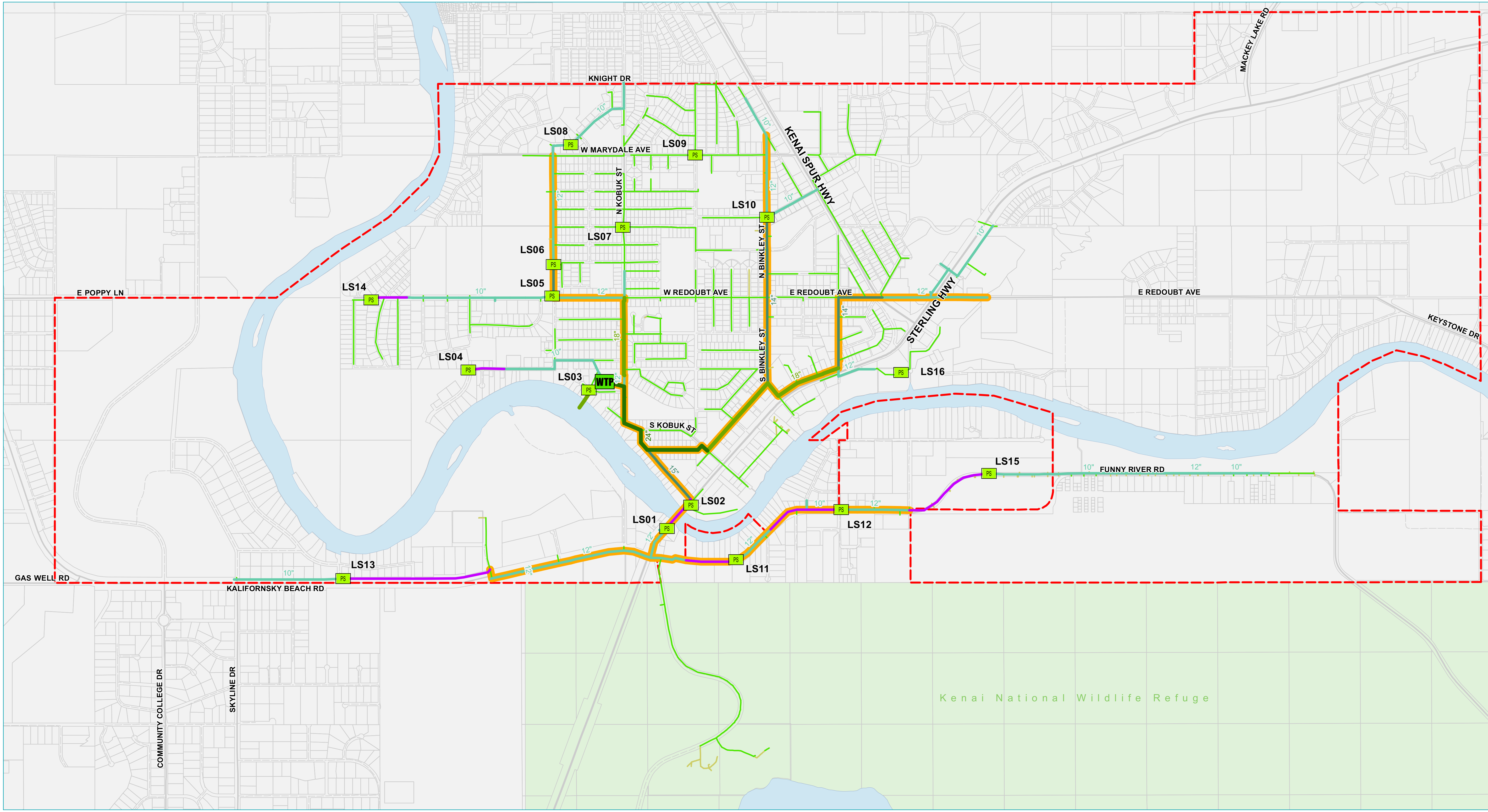

SOLDOTNA
City of Soldotna, Alaska

Sewer Gravity Mains by Diameter
- 4" - 6"
- 8"
- 10" - 12"
- 14" - 15"
- 18" - 21"
- 24"
- Sewer Pressurized Main
- Trunks

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets
- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

N

0 1,700
FEET

SOLDOTNA UTILITY MASTER PLAN

Sewer Collection System

Figure 3

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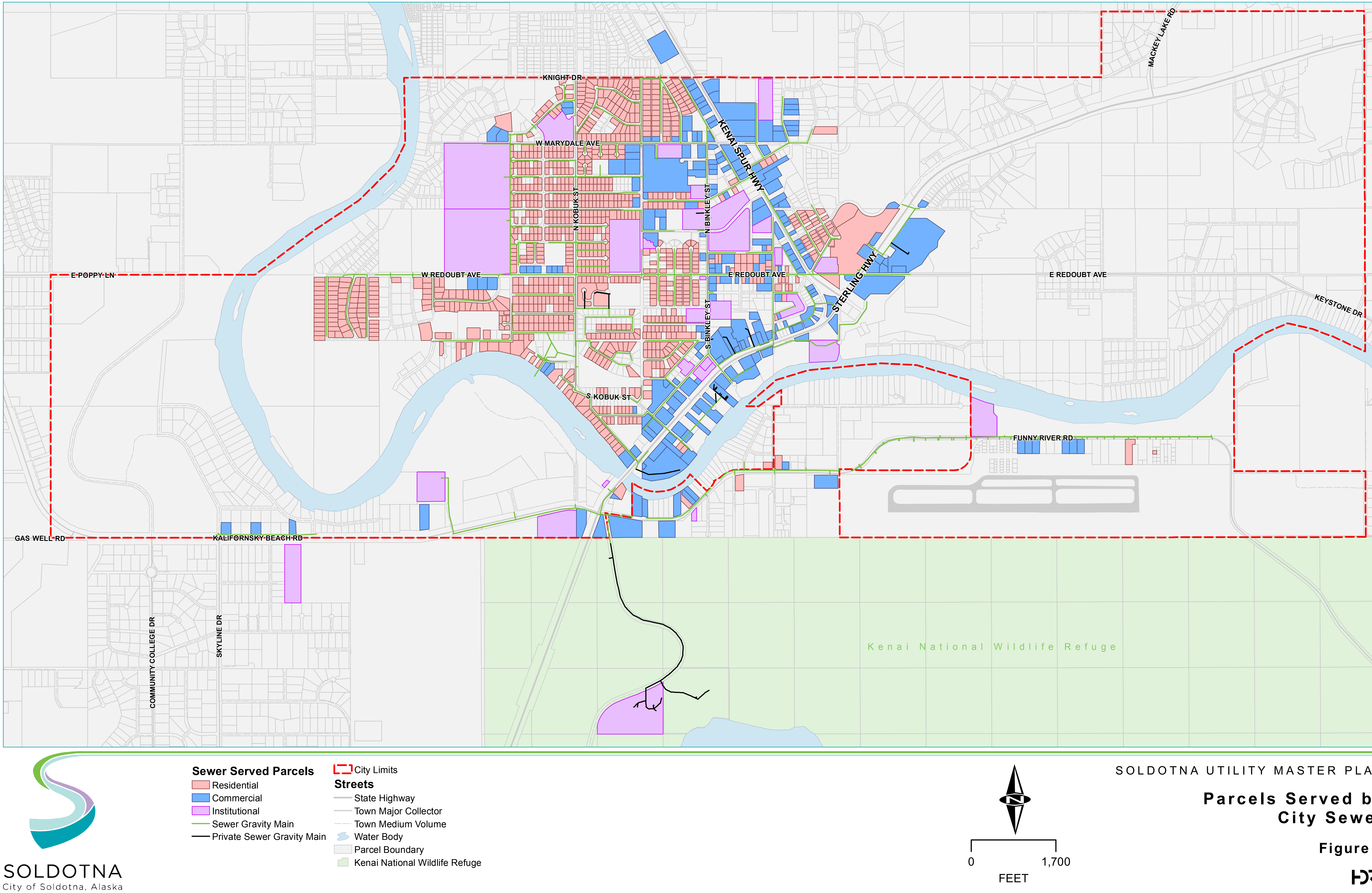

SOLDOTNA UTILITY MASTER PLAN

Parcels Served by City Sewer

Figure 4

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3.1.4 Existing Pipe Network Summary

The wastewater collection system contains trunks and lateral pipes of various ages and materials as well as pump stations. The wastewater system installation started in the early 1970s and has continued since. The system contains approximately 146,583 feet of gravity pipe, 8,925 feet of force main, 16 pump stations, 483 manholes, and 77 cleanouts. Figure 5 shows the length and type of pipe constructed in each year since the system construction began. Figure 6 shows the length and type of pipe length by pipe diameter. The locations of pipe types and ages are shown in Figure 7. This information is based on record drawings from the City utility archives.

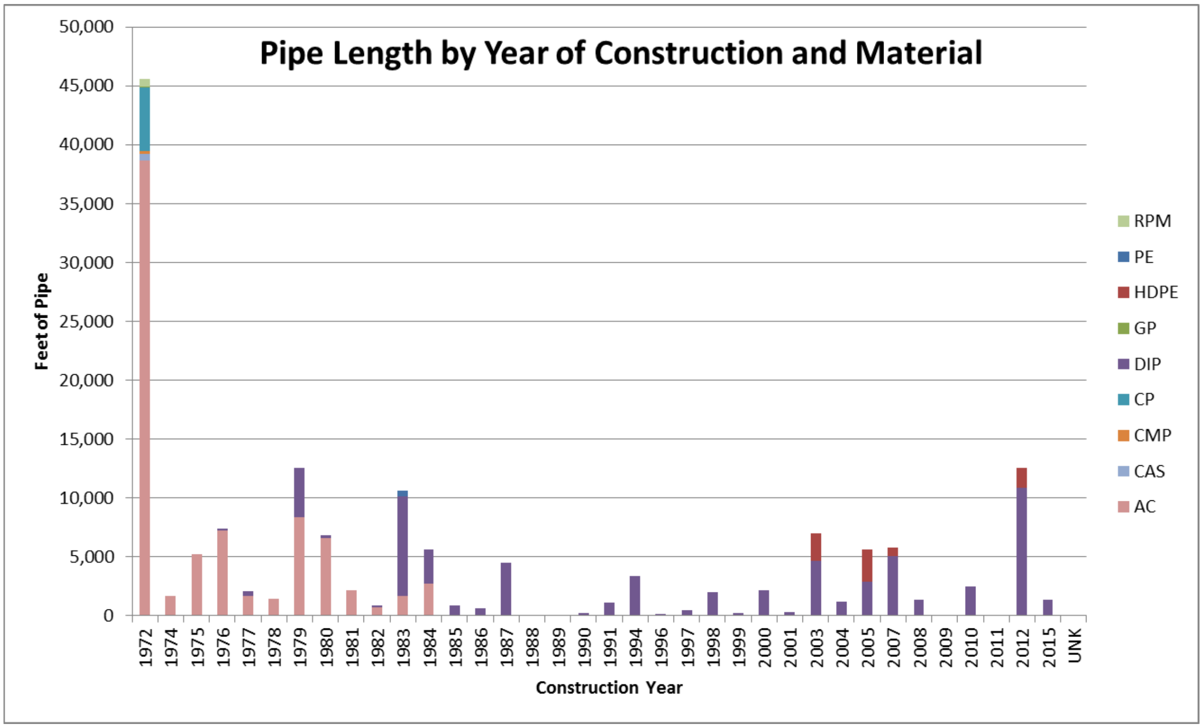


Figure 5 Pipe Length and Type by Year Constructed

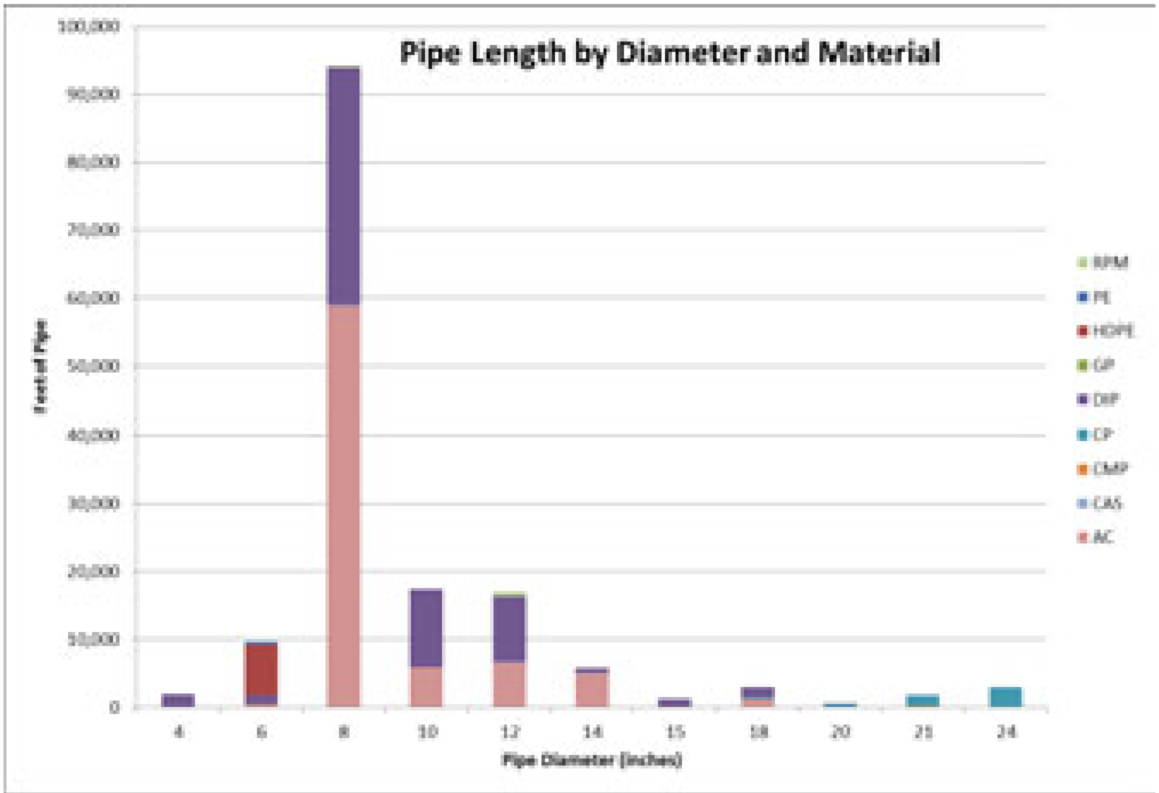
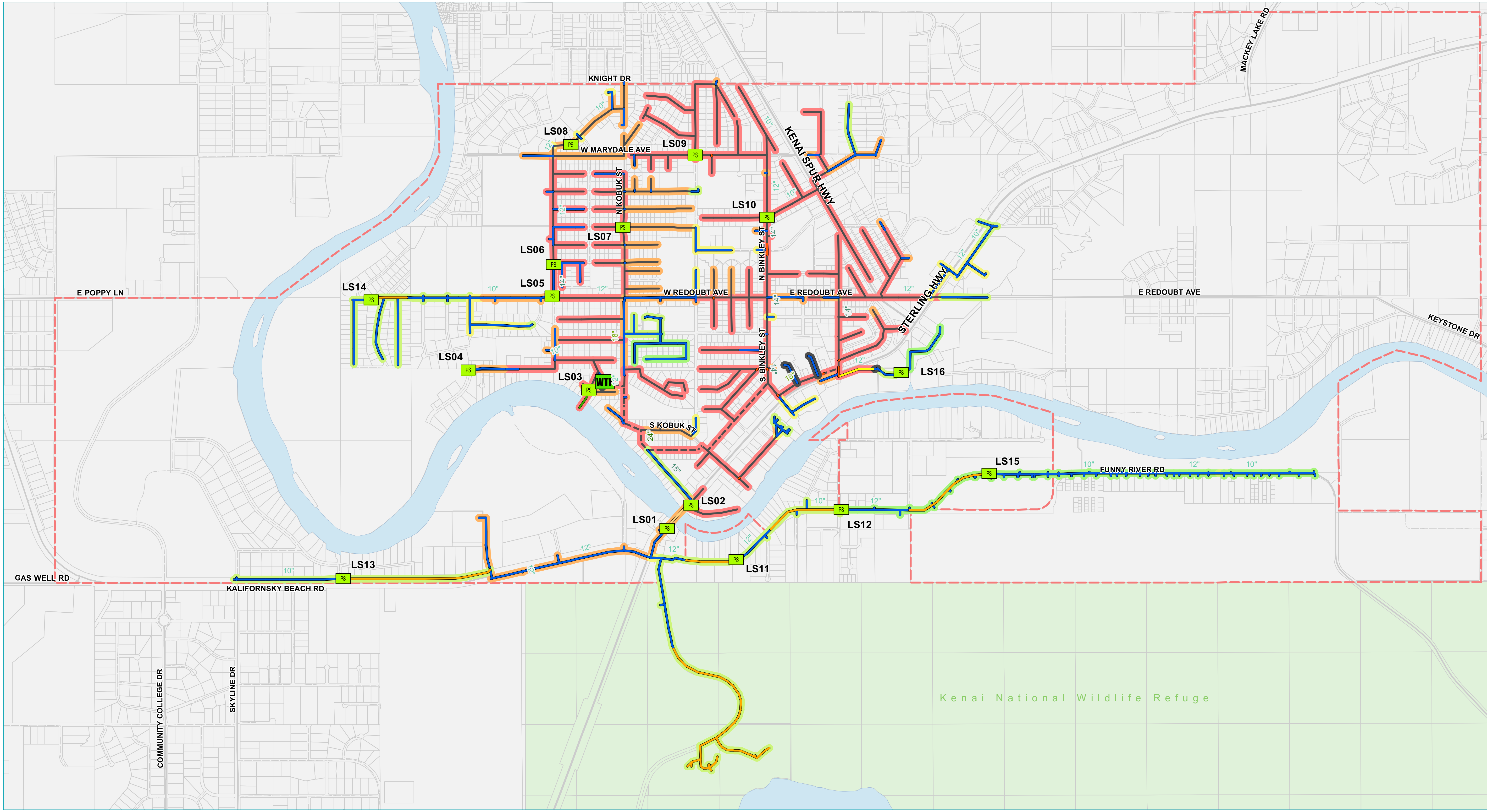


Figure 6 Pipe Length and Type by Pipe Diameter



Sewer Gravity Mains Material
- Asbestos Cement
- Concrete (Non-Reinforced)
- Cast Iron
- Corrugated Metal
- Ductile Iron
- Galvanized Pipe
- Reinforced Plastic (Truss)
- Polyethylene
- High Density Polyethylene

Sewer Gravity Mains Install Date
- 1970s
- 1980s
- 1990s
- 2000s
- 2010s
- Date Unknown

- Lift Station
- Treatment Plant
- City Limits

Streets
- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Sewer Collection System Pipe Material and Install Date

Figure 7

HDR

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3.1.5 System Operation

The City wastewater system is operated to efficiently collect and convey sewage to the WWTP for treatment and disposal. Of critical importance is to operate the system in a manner that eliminates the occurrence of a sanitary sewer overflow (SSO). An SSO is defined by EPA as when untreated sewage flows from a sanitary sewer on to the ground or in a building before reaching sewage treatment plant. Annual SSOs per 100 miles is the most common performance metric used in the US. The average SSO rate nationally has been estimated as approximately 4-7 SSOs per 100 miles. City staff has recalled experiencing roughly three SSOs in the past 20 years. This equates to an SSO rate of 0.5 SSO per 100 miles per year which is roughly 10 times better than industry average.

To manage SSO's the City has developed a systematic sewer pipe cleaning plan. In general, all gravity pipes are cleaned once every five years. Because of known potential clogging issues related to low pipe slope and debris accumulation a subset of pipes are cleaned annually or monthly between January and April to keep them from freezing. Another subset of pipes are cleaned monthly between December and April because of fat, oil, add grease and debris accumulation. Additional information about the pipe cleaning schedule is available in Appendix A.

The City's cleaning program is well with industry standards. However, in areas where velocities are high (i.e. self cleaning) or where historically, crews have found little evidence of grease, debris or other material that may block flow; cleaning frequencies may be extended to free up resources to focus on higher priority work. Conversely, if staff finds that pipes are heavily impacted, the City should place those pipes on an accelerated cleaning schedule. The City should also consider documenting the severity of cleaning findings during cleaning so these records can be referenced in the future when optimizing cleaning schedules. Severity finding can be as simple as:

1. Heavy – Consider cleaning the pipe more often
2. Moderate – Keep the pipe on the existing schedule
3. Light – Consider cleaning the pipe less often

Pump stations are also inspected regularly for pump wear and proper operation in order to ensure they operate correctly and do not overflow. City staff could not recall a break on the 1.7 miles of force mains owned.

The City's sewer collection maintenance practices have been successful in managing SSOs such that they have a near zero record of their occurrence in the system.

City maintenance crews assist contractors when they connect to the system. This assistance includes identifying whether a parcel has an existing connection stubbed out to the property line and assistance with locating these service connections at the property line or in the sewer pipe through cleaning and close circuit television camera (CCTV) inspection of the pipe. The utility manager does not charge for these services.

Currently, the City does not have a program to regularly inspect through CCTV, the collection system. While the majority of the collection system is anticipated to be in good condition and not in need of renewal work, voids can grow around pipe cracks or holes over the years without obvious indications at the surface or manholes. These voids will eventually lead to catastrophic structural failures. CCTV is an inexpensive (relative to failure, repair, lining, or replacement), effective, and industry accepted approach to regularly inspect the system. In addition to avoiding catastrophic failure, CCTV also helps utilities better understand the timing and extend of long term renewal investments that will be needed to sustain desired service levels, focus renewal investments, support cleaning optimization, and help the community to understand the infrastructure, the investments needed, and how their actions impact the infrastructure (e.g. FOG outreach).

HDR recommends a 10 year system wide recurring CCTV program. CCTV equipment is expensive to purchase and maintain and requires specialized training. Given the size and location of the City, the City should consider contracting this work out and only mobilizing the contractor once every two to five years to limit overhead and ensure the City gets good unit prices.

3.2 Existing Wastewater Flows

3.2.1 Wastewater Types

The City sewer collection system serves residential and commercial users. There is no large industrial wastewater source connected to the system. Residential use includes all domestic wastewater. Commercial wastewater include food service establishments (FSEs) (restaurants, kitchens, coffee shops, and other places that prepare and serve food), motels, hotels, offices, public institutions, schools, breweries, and other such buildings.

Of particular importance are FSEs as certain classes of them can be a source of fats, oils, and grease. When these materials enter the collection system they can solidify and collect on pipe walls forming “tallow”, eventually blocking flow. Such tallow deposits are labor intensive and costly to remove and are a primary cause of SSOs in systems. Regulating the amount of fat, oil, and grease (FOG) entering the collection system is important for managing a system and controlling maintenance costs. Sewage collecting system best practices require installation of grease separators for customers who can produce FOG and require they be maintained regularly.

Soldotna does require grease traps on these types of FSEs but the City does not have regular and systematic enforcement of their proper use and cleaning. Alaska Department of Environmental Conservation does perform public health inspections on FSEs but does not inspect grease traps or enforce their use. Therefore, while these devices may be in place, they may not be being used properly, which results in excessive FOG entering the system and increased City maintenance costs.

Organic wastes discharged to the sewer system can also be problematic. Two common sources are the processing of vegetables, as in a catering operation, and fish processing. If large amounts of these organic wastes are discharged to the system they can settle out in low gradient pipes and require additional system cleaning or they can be transported to the WWTP where they can clog screens and pumps, adding to maintenance. Educating the proprietors of these types of FSEs and eliminating these organic solids from the collection system can help moderate system operating costs.

Soldotna does not accept hauled wastes at the WWTP. Hauled wastes include septage from on-site septic system tanks, material pumped from grease traps, wastes from pit privies, landfill leachate, and other high organic content anaerobic concentrated wastes. They are not accepted because the plant has no mechanism to meter them into the treatment process. Also, these wastes are difficult to meter into the system without potentially disrupting the biological treatment process. Finally, some of these wastes can contain high concentrations of dissolved metals or oil and grease, which are not effectively removed by the current treatment process and if discharged could cause permit violations. Because of these reasons it is not recommended that the Soldotna accept these wastes.

3.2.2 Current Wastewater Flow

City wastewater flow records for the years 2007 to 2014 were used to evaluate sewage production. The data show that Soldotna sewage production has varied yearly depending on precipitation, spring break up melting, and winter freeze protection needs. Yearly wastewater production for the years 2007 to 2014 is shown in Table 8.

Also presented in Table 8 is an annual average daily wastewater flow. This value is calculated by dividing the yearly volume treated by 365 days. The flow has varied but remained in the same general range through this period. While data does not exist to understand exact causes for yearly use changes, wastewater production appears to vary in response to climate conditions like precipitation and winter temperature. Flow increases from population growth appear generally small compared to the variation caused by other factors. This low increase in sewage production from population growth is consistent with data from Anchorage and cities in the continental United States. The low increase compared to population is attributed to the increased use of low flow fixtures and appliances now required by plumbing codes. This trend is expected to continue for up to a decade longer.

Table 8. Soldotna Wastewater Production, 2007 to 2014

Year	Yearly (MG)	Annual Average Daily (MGD)	Maximum Month (MGD)
2007	210	0.58	0.71
2008	199	0.55	0.67
2009	222	0.62	0.77
2010	205	0.57	0.65
2011	231	0.64	0.71
2012	225[1]	0.60[1]	0.70[1]
2013	[2]	[2]	[2]
2014	194[3]	0.54[3]	0.58[3]

[1] Estimated from eleven months of data
[2] No data
[3] Estimated from ten months of data

Soldotna billing records were evaluated by the *Wastewater and Sewer Rate Study* (HDR, 2015) to estimate wastewater production by customer type. Data from this study for 2014 are presented in Table 9. Water meter records by customer type were used to estimate wastewater production from those customers, extrapolated to similar users, and then totaled by customer type to estimate total wastewater production. These data show that the residential customer sewage production accounts for about 56% of the yearly total and commercial wastewater production is about 44%.

Table 9. Soldotna Wastewater Usage by Customer Type

Customer Type	% of Total Yearly Wastewater Production
Single Family	47.1
Residential Multi-Family	7.7
Duplex	1.5
Commercial	43.7
Total	100.0%

The data presented in Table 9 does not include non-metered flow from line bleeding for freeze protection and inflow and infiltration (I&I) into the collection system. The extrapolated meter data was compared to metered influent wastewater flow at the treatment plant which indicated that approximately 10% of the total wastewater production in 2014 (the lower total wastewater volume years analyzed) may not be accounted for by meters. The value is likely greater in years of greater wastewater flows like 2012. Further analysis of wastewater flow data was done to identify sources of wastewater flow.

To evaluate the weather related component of sewage flow HDR compared annual sewage production with average Anchorage monthly temperature (see Appendix B). Anchorage weather data was used because it provides good information on general regional weather patterns. The temperature data is used to indicate whether a month was above or below normal temperature, which is the case for the entire region. Evaluating this data indicates that some of the Soldotna sewage production increase is associated with winter bleeding for freeze protection in cold winters.

Further analysis of the sewage influent flow data was done to evaluate the magnitude wastewater system I&I. Infiltration is generally defined as chronic leakage into pipes, which adds to base flows in sewers. Inflow is generally defined as water draining into sewers from roof drains, foundation drains, leaking manhole covers, and cross connections with storm drains. Inflow can peak during specific events like break up and rainfall.

The Environmental Protection Agency (EPA) has categorized total I&I as being "excessive" or "non-excessive." Non-excessive I&I includes the portion of I&I that is more economical to transport and treat than to eliminate from the sewer system. Excessive I&I may be more cost effective to eliminate than treat. These definitions are used to help develop the level of I&I abatement program appropriate for a system.

EPA has established guidelines for determining excessive and non-excessive I&I in wastewater collection systems. According to the guidelines, if the domestic flow plus I&I does not exceed 120 gallons per capita per day (gpcd) during periods when the water table is high, the flow is considered non-excessive and no further I&I analysis is required. This flow quantity allows for approximately 80 gpcd for base domestic flow and 40 gpcd for non-excessive I&I. The guidelines also allow for a total daily I&I flow of up to 275 gpcd during a rain storm, provided that this amount of flow causes no operational problems in the collection or treatment works.

Wastewater influent flow records at the WWTP were evaluated during rainfall and non-rainfall periods for flow changes related to I&I. The late night daily minimum sewage influent flows are very consistent and show little variation between rainy and non-rainy periods. This indicates that infiltration is low in the collection system and could be considered non-excessive.

Comparing spring snow melt periods and rain events to dry periods shows that inflow into the system can be very high. For example, on September 16, 2015 the City experienced a short duration, high intensity rain event that caused a distinct and extreme spike in flow to the WWTP. The flow data to the WWTP showed a peak hour sustained flow of approximately 1,800 gpm. While the treatment plant was able to handle the flow without operational problems, the flow equated to approximately 800 gpcd, a very high per capita flow. After the storm passed and the rain quit, the plant flows returned to expected values during the wee hours of the morning. This example indicates that system infiltration is low while inflow is high and should be addressed.

Three potential sources of excessive inflow can contribute to these precipitation related peak sewage flows. The first source is the older LSs where their access hatches are placed in drainage flow paths and large amounts of water leak through them and into the stations. The second is sewer manholes in ditches where the manholes have leaky lids and joints allowing inflow and the third may be building roof drains connected to the sewer system, which is not allowed by Soldotna codes. All these sources, and potentially others, contribute to the greater than expected flows during precipitation events.

Because of the large amount of I&I and freeze protection water bleeding, commercial and residential wastewater production was combined into a single value and used to estimate a composite annual average per capita flow. Based on the 2007 through 2014 data analyzed the Soldotna produces an average of 157 gpcd of sewage with a peak month average of 238 gpcd. These values are recommended for use in this plan to evaluate future wastewater flows.

4 Wastewater System Development Criteria

This section presents the criteria used to identify and evaluate recommendations. The factors used in screening and analyzing specific capital improvement recommendations for wastewater system improvements are developed. In addition, criteria for system hydraulics, fire flow storage, use of groundwater, and municipal planning for utilities are described.

4.1.1 Hydraulic Criteria

Soldotna operates a wastewater system that consists of a network of collection laterals, trunks, and pump stations. The following are recommended hydraulic objectives for Soldotna's wastewater system.

- Install local collection piping sized to ensure adequate collection capacity during peak flows and future build-out conditions.
- Construct pumping stations with adequate capacity to meet peak hour flows during wet-weather conditions.
- Design trunk sewers to provide peak-hour flow capacity during wet-weather conditions for the design year.
- Design and install pipes with adequate slope to encourage adequate scour velocities and prevent build up of solids.
- Operate the system to eliminate SSOs.

Soldotna does not have specific hydraulic design standards for the sanitary sewer systems. Without adopted design criteria professionals who design new components have some latitude on criteria to use. This can result in potential mismatch between system components. For this reason this plan recommends Soldotna adopt specific design criteria for use in future system development.

Over the past decades the Anchorage Water and Wastewater Utility (AWWU) has developed its *Design Criteria and Practices Manual* (DCPM) which contains a specific section on the design of sewer system components. AWWU has invested in the development of the DCPM and continues to do so. Because the AWWU DCPM reflects best practices for building sewer systems in the same climate and land forms as Soldotna and because the AWWU DCPM is based on industry standards approved for this specific region, this plan recommends Soldotna adopt the design criteria within the DCPM for use in Soldotna. Using these criteria can result in consistent designs that can function efficiently and effectively as a unified system with adequate capacity for current and projected flows.

Pump and Lift Station Design

Pump and LSs, referred to as stations in this and following sections, design criteria guide pump and station sizing based on appropriate codes, required number of pumps, wet well size, and a minimum force main size. Applying these design criteria results in selecting station pumps with specific discharge rates. It is important to note that the pump station design criteria generally do not address how the station discharge rate should affect the downstream gravity sanitary sewer nor require any analysis of such impacts. It is recommended that Soldotna include a requirement for analysis of how a station's discharge flow rate will impact the capacity and operation of the gravity sewer system. Reasons for this recommendation are discussed in the following sections.

Multiple Pump Stations

Components of the sewer system are sized based on estimated sewage flow rates. These rates are generally generated by system analysis that primarily considers gravity flow. Pump station wet wells and treatment plant components are based on these estimated gravity sewer flow. Where a pump station discharges into the gravity system, flow rates can be higher than predicted by a gravity flow model because the station pumps often have high discharge rates to meet force main scour requirements or other factors. Where two or more stations discharge into the same gravity trunk, the coincident peak of the station discharge may be much higher than estimated by the gravity flow based models. These higher peaks may overwhelm downstream pipes, station wet wells, pump capacity, or treatment plant components, potentially causing an SSO. For this reason, Soldotna should require an analysis of how station operation, in combination with all LSs contributing to that pipe network, will affect downstream system components, including the treatment plant.

New Pipe Capacity and Sizing

New gravity trunk and other pipe capacity requirements generally do not include pump station discharge rates. Design flow estimation is generally based on assumed gravity flow in the pipe. If a portion of the contributory area to the pipe flows through a pump station, the discharge rate of the station pumps may be larger than the assumed gravity flow from that area. Soldotna should require consideration of potential station discharge rates into potential trunks and other gravity sewer pipes during pipe design or connection to existing pipes.

Existing Pipe Capacity Allocation

The Soldotna pipe collection network has been constructed considering future development in the contributory basin and gravity flow in all pipes. Few sewer basins are at full development, and the pipes have potential capacity to handle the anticipated gravity flows. Where a pump station is connected to the pipe, the discharge rate from the station may be greater than the assumed gravity flow rate from that contributory area. Where the station discharge rate does exceed the assumed gravity flow rate, the station discharge can preclude undeveloped areas from connecting to the pipe or result in restrictions to potential sewage flow rates. Soldotna should require an analysis of how the discharge rate of proposed stations affects the City's ability to service all customers that were anticipated to connect to the pipe and regulate the station so that all potential customers can be served. The effects of station discharge rates will be important as sewer basins approach full development or extensions into new areas occur (such as annexation of area into the City).

Pipe Capacity Analysis

In general sewer pipe design criteria are intended to be used for the design and installation of new pipes. The criteria for capacity assessment of existing gravity sewers is generally selected by the system operator and will depend on many factors including maximizing the economic benefit of the existing infrastructure and replacement costs.

New pipe design criteria, especially if Soldotna adopts the AWWU DCPM sections, are selected to be conservative and to provide reserve capacity for unexpected future changes in the land use. For this reason, using design criteria for the capacity assessment of existing sewers may have unintended consequences. The conservative nature of design criteria, when used for the system capacity assessment, may lead to unnecessary projects, implementation of projects before they are needed, or proposed connections that could be served by the existing sewers not being allowed.

To better answer questions about the capacity of existing sewer pipes, the 2015 WWMP prepared a sewer capacity analysis memorandum, which is contained in Appendix A. This analysis contains recommendations for the analysis of gravity sewer pipes in the Soldotna system. The 2015 WWMP recommends Soldotna consider adopting Capacity Analysis Criteria (CAC) and differentiate between the new pipe design criteria and existing system CAC. Proposed design criteria from the AWWU DCPM and CAC are compared in Table 10.

Table 10. Proposed AWWU Design and Capacity Analysis Criteria

Capacity	Peak Factor	Slope	Flow	Per Capita Flow
Design Criteria for New Pipe				
2/3-full pipe flow, 2-fps minimum velocity with minimum number of homes	2 times average day design flow	Minimum based on pipe size	cfs/acre by zoning	150 gpcd
Capacity	**Peak Factor**	**Slope**	**Current Flow**	**Future Flow**
Capacity Analysis Criteria for Existing Pipes				
100% full pipe flow	Peak factors for Soldotna derived from observed RDII flows. Peak factors will account for the system reaction to precipitation events and associated impact on peak flows.	As constructed	Soldotna system model loaded based on water meters and billing records	Same as current flow with served area population increased by projected growth rates and new areas loaded based on projected population
cfs = cubic feet per second fps = feet per second gpcd = gallons per capita per day RDII = Rainfall Induced I&I				

The proposed CAC can be used for several functions. First, the analysis can be used to determine remaining pipe capacity and estimate how long until a pipe may need replacement. Basing the analysis on full pipe flow ensures Soldotna maximizes the economic use of the infrastructure.

Second, the analysis can be used to allocate remaining pipe capacity during land use redevelopment in a basin or annexation of new areas to the City. If a portion of a sewer basin is redeveloped to a land use that can produce higher peak sewer flows, allocating a portion of the pipe's remaining capacity to that area may be needed. Such allocation would identify whether the proposed redevelopment will need to provide peak storage and meter flows into the conveyance system. Requiring such metering systems can eliminate the need for pipe upsizing and save Soldotna customers the costs.

The capacity analysis of the Soldotna system was done using a sewer system model prepared by HDR modeling staff. As is true for all models it is based on simplifying assumptions. It is a good tool for identifying pipes with potential capacity issues but it does not have the predictive power in its current form to justify pipe replacement. Soldotna should use the current model to identify pipes with potential capacity issues and perform pipe inspections, surveys, and flow monitoring of the pipes to determine if a capacity issue does or will occur and what the appropriate countermeasures are. The collected data should also be used to update and refine the model and loading assumptions.

The results of this capacity analysis of the Soldotna system indicate that 99.8% of the pipe segments in the model will flow at less than 80% full during the peak hour wet weather flow condition in 2035. Those that at predicted to flow greater than 80% full are associated with pump stations combined discharges. Capacity in these could be managed by pump station changes instead of pipe upgrades.

Based on the model results and the capacity analysis methods in this memorandum, the following recommendations are made.

1. The City should update the sewer system model when the next master plan is done or when land use or population changes may impact sewer flows dramatically. Such an event may be annexation of a large area into the City. Model refinements at that time will improve its predictive capabilities and the City's confidence in using it to analyze the system.
2. The City should continue to invest in pipe maintenance, I&I reduction, FOG reduction programs, and system cleaning. These will help ensure pipe capacity is available for sewage flows and will reduce potential SSOs.
3. Many capacity issue pipes are downstream of pump and LSs and most of these are designated as over capacity pipes. Because of the number of pipes identified with this condition and associated with pump stations, the City should review the relationship between pump station discharge flows, downstream pipe capacity, and the potential of pumps operating simultaneously and compounding peak flows. LSs 5 and 6 are a good example of the issue of two pumps running into one pipe. LS 7 is a good example of a LS possibly exceeding the pipe capacity of the pipe downstream.
4. The capacity analyses done for this memorandum indicate that the collection is in good condition, has adequate capacity, and requires above average maintenance. The oldest parts of the system are now eclipsing 40 years old. Industry data indicates that the oldest pipes in the system have useful lives of 70 years or more. While pipe replacement due to age or deteriorating is not now recommended, data collection to monitor system condition is an important part of proactively managing a sewage collection system. Collecting and analyzing system condition data will help the City develop a program of timely and economically efficient replacement and repair projects. Recommended data collection should include line cleaning location

and frequency records, video inspection of sewers before cleaning, mapping locations of excessive FOG accumulations, and other data relevant to pipe condition. This data can be stored and analyzed in a Global Information System data format and can be linked to the pipe databases developed for this plan.

4.1.2 Annexation Impacts

The City could expand the city limits through annexation of adjacent areas and provide wastewater service to annexed areas through the extension of trunks and collection lateral pipes and pump stations, depending on the location of the annexed area. The impacts to the wastewater collection system from annexing specific areas were evaluated for this plan; see Appendix C. System extension and expansion was looked at five places at the periphery of the sewer collection system that are being evaluated for annexation. They were selected because they represent the likely places where the system could be extended to serve growth beyond the current system.

An analysis to find the limiting pipe segment between the upstream point where each of these areas would connect and the WWTP was done. For those pipe routes with pump stations, one of the pump stations was the limiting point in all cases. For the gravity trunk that serves the eastern Sterling Highway, the limiting section was one of the gravity pipes. This gravity trunk has no pump stations.

The analysis found that the existing sewer collection system has the capacity to serve projected growth in the City of Soldotna and excess capacity for extension of the system beyond its current extents. Depending on which area is annexed and subsequently connected there is collection system between 80 and 450 acres of single family residential development could be served without requiring increasing capacity work in the existing network.

If more capacity is needed to serve system extensions, the limiting segments of collection system could be enlarged. The cost associated with enlarging the system capacity could be spread over the entire rate base of the system, assigned to the expansion area requiring the increase in capacity, paid for through grants, or a combination of these. Which method is appropriate for funding system capacity increases to serve expansion beyond the system’s current capacity should be discussed by the City of Soldotna.

When evaluating providing wastewater service to potential annexation areas, the City should understand that extending the system is best done in a systematic manner and by avoiding ‘leap frog’ extensions. Systematic expansion adjacent to the edge of the existing system can result in revenue being generated from the entire length of new pipe installed whereas ‘leap frog’ development results in long segments of pipe being installed to serve more distant areas and those connecting segments of pipe not providing revenue through customer connections.

4.1.3 Consistency with Related Planning Efforts

The 2015 WWMP was developed to be consistent with comprehensive development plans for the study area. Maximum use of the findings in the current comprehensive plans for the City and KPB were made. In addition, specific strategies concerning extensions of public wastewater service were considered, including:

- Extensions of public wastewater collection systems are to be planned to adequate standards for peak flows and scour velocities balanced with future capacity.
- Extensions of the system should start with service to areas contiguous with the existing system and avoid ‘leap frogging’ through these areas.
- Extensions should not be planned to areas designated for low-density development, except to resolve public health needs or as requested by property owners.
- Utility improvements should be coordinated with other City or agency projects to achieve savings and prevent utility placement conflicts.

5 Future Wastewater Flow

Predicting trends in wastewater production is very difficult because of the number of variables that have the potential to influence production characteristics. Such factors as voluntary conservation water measures, low flow fixtures, and effective line freeze avoidance, I&I repair tends to lower the overall wastewater production. A rapid expansion of the wastewater system also tends to decrease the per capita wastewater production because the newly laid pipe generally exhibits less I&I than older piping within the system. Factors that tend to increase wastewater production are increased development of single family homes and aging and gradual deterioration of the existing wastewater collection pipes and services. Temperature extremes in winter as well as periods of high precipitation are variables that can affect the wastewater flow characteristics, but are difficult to predict.

Future Wastewater Flow

Future wastewater flow will be a function of the projected population served during the planning period and the estimated wastewater production by the served population. Served population estimates presented in Section 2 were used to estimate the total Soldotna population served by Soldotna in 2015. Of the total population of City residents, it is estimated that approximately 77% are currently served by wastewater, which will increase to 79% by 2035. The remaining people are served by private wastewater systems.

Future wastewater use was estimated based on served population estimates and the average and peak per capita flows previously presented. The projected wastewater production estimates are shown in Table 11.

Table 11. Future Wastewater Flow, 2015-2035

Year	Total Population	Projected Population Served	Estimated Average Month Wastewater Flow, mgd	Estimated Maximum Month Wastewater Flow, mgd
2015	4,375	3,380	0.53	0.80
2016	4,419	3,417	0.54	0.81
2017	4,458	3,450	0.54	0.82
2018	4,496	3,483	0.55	0.83
2019	4,535	3,516	0.55	0.84
2020	4,575	3,550	0.56	0.84
2021	4,615	3,584	0.56	0.85
2022	4,647	3,612	0.57	0.86
2023	4,680	3,640	0.57	0.87
2024	4,712	3,669	0.58	0.87
2025	4,745	3,698	0.58	0.88
2026	4,779	3,727	0.59	0.89
2027	4,804	3,750	0.59	0.89
2028	4,829	3,773	0.59	0.90
2029	4,855	3,796	0.60	0.90
2030	4,881	3,819	0.60	0.91
2031	4,906	3,842	0.60	0.91
2032	4,926	3,860	0.61	0.92
2033	4,945	3,878	0.61	0.92
2034	4,964	3,896	0.61	0.93
2035	4,983	3,915	0.61	0.93

6 Wastewater System Project Development

This section identifies system deficiencies and presents improvements to resolve them. Identified recommended improvements form the basis for the CIP discussed in Section 7.

6.1 Wastewater Collections System Recommendations

In preparation of the 2015 WWMP, it is acknowledged that most areas within the City of Soldotna's Certificated Wastewater Service area are anticipated to remain on individual or small community wastewater disposal systems through the 20-year planning horizon. These areas are the rural residential and commercial areas outside the Soldotna city limits, the rural residential areas in the eastern part of the City, and other areas within the city limits. However Soldotna wastewater collection service may be extended into portions of these areas adjacent to the existing system through private development.

6.1.1 Project Alternative Classes

In developing recommendations for the 2015 WWMP, potential projects were divided into two broad project categories: SE and Rehabilitation and Repair (R&R). These categories were selected as they represent the classes of capital projects Soldotna could undertake.

SE projects focus on extending the system to collect and convey wastewater and upgrading existing pipes and pump stations to meet future flows. Such projects provide the infrastructure for Soldotna to have ample wastewater collection capacity to serve existing and future flows.

The second class of recommendations is R&R projects. These projects focus on pipe upgrades needed to renew or replace aging infrastructure and thereby decrease emergency repair or operating costs and extend the useful life of the asset.

6.2 System Expansion Recommendations

Project development for the SE category relied on future served population estimates and evaluating alternatives to meet projected growth and wastewater production. Population growth scenarios were based on area comprehensive plans. These customer growth estimates were applied to the wastewater system using the InfoSewer wastewater system model developed for this planning process and used to evaluate recommendations.

The wastewater system model was used to evaluate the existing pipe network, as well as identify potential projects that effectively meet projected demands. Through this analysis no pipes or pump stations were found to be deficient for current or future flows. Also, as no specific areas have been identified for immediate annexation and extension of the sewer collection system, no system extension projects were identified. Therefore no SE projects to extend or increase trunk capacity are recommended.

If specific areas beyond the current reach of the sewage collection system are identified for service, the impacts of the area on the existing system capacity should be evaluated and recommendations made for pipe alignments identified. The system model prepared for this planning effort could be readily updated and used for this analysis and pipe sizing.

6.3 Rehabilitation and Repair Recommendations

Soldotna's wastewater collection system has both mature and relatively young network components. System inflow appears high compared to the number of customers and compared to regional large utilities. I&I may be a system legacy issue related to construction of manholes and pump stations in ditches and gravel roads. Other sources of inflow into the system are possibly present and should be identified.

R&R projects were developed to address the I&I issue in a systematic manner. If reduced, pump station and treatment plant capacity upgrades may be delayed with significant cost savings to the utility's customers. A Sewer System I&I Study would conduct an I&I study of the system to identify if excessive I&I exists and if any identified sources are severe enough to warrant repairs. The study can be phased over a few consecutive years to minimize budget and customer impacts.

If significant and repairable leaks are found I&I Reduction Phases 1 to 4 projects will develop a program to repair them or coordinate their repair with coincident projects. This work will be spread over the life of the plan and will develop a systematic program to continually work to reduce sources of I&I in the system. Reducing system I&I can reduce wastewater flow and delay pump station and WWTP increase projects.

The pump station on North Kobuk Street, LS 7, is constructed in a street corner and experiences heavy inflow during rain and spring melt. To reduce the inflow into this pump station this project, LS 7 Upgrades, would regrade the road, add storm drainage inlet, and replace the station access hatch.

The LS on West Riverview Avenue Street, LS 4, is constructed in the street and experiences heavy inflow during rain and spring melt. This project, LS 4 Upgrades, would regrade the road, raise the entrance, and replace the station access hatch in order to minimize inflow into the station.

The LS on south side of the Sterling Highway on the north Kenai River bank, LS 2, is constructed next to the highway and experiences high flows during rain and spring melt. This project, LS 2 Upgrades would evaluate the private system serving an RV park in order to reduce inflow into the station.

Sewer manholes along Kalifornsky Beach Road are in ditches. During spring melt and heavy rains the ditches flood, submerging manholes causing inflow. This Kalifornsky Beach Road Manhole Upgrades project would upgrade manholes and regrade the area surrounding them to reduce the inflow.

Soldotna has several businesses that serve tourists by providing seasonal RV parking. These provide places to park an RV and hook the RV to water and sanitary sewer. An RV is close to the ground and to drain wastewater to the system, the sewer connection can be constructed very close to the ground surface. This is done to provide gravity drain from the RV to the pipe with no humps and to keep the pipe from be broken off by the RV while it is parked. The connection pipe close to the ground surface can be a problem and be a source of I&I and gravel. Of the pipe is below the ground level, surface drainage can drain onto them and wash gravel and sand into the system. These pipes should be mounted in a small concrete pad with it several inches above the ground surfaced and be closed with a watertight locking plug when not in use.

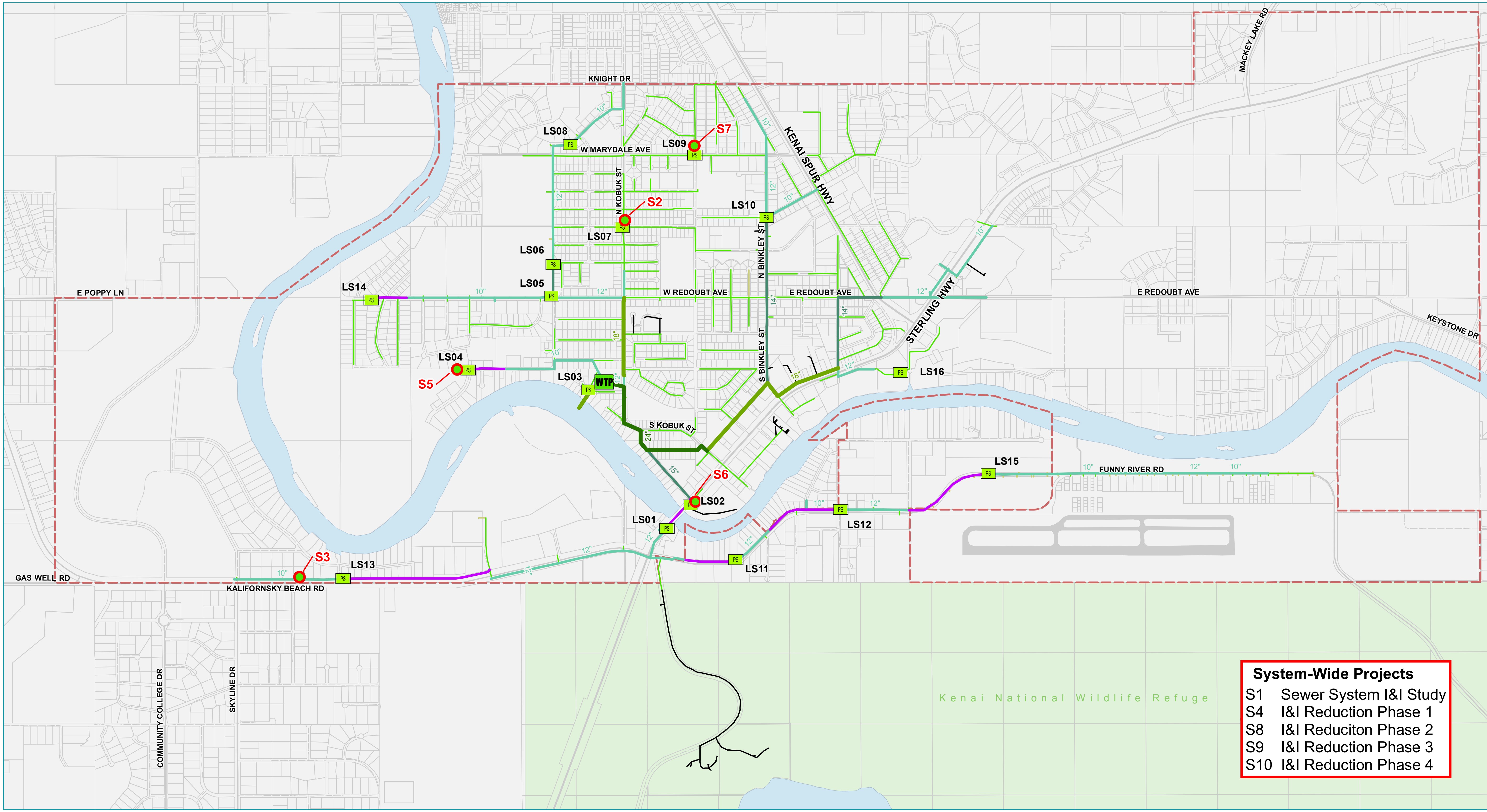
Soldotna has a culture of proactive utility maintenance and undertaking these recommended R&R projects represents continued investment by Soldotna in their system. Preventative maintenance to retain the integrity of a system is the hallmark of a well operated enterprise and will lower overall system operation costs by reducing emergency repairs and lowering treatment and pumping costs. Implementing these projects will upgrade system components in a systematic manner, within Soldotna's budgeting structure. Also these projects represent an investment in bringing all components in the system to the same level of service. Constructing these R&R projects is Soldotna investment in operating its system at its current high level of service far into the future.

6.4 Project Development Recommendations

The previous sections identified SE and R&R projects to address identified system needs and future service. The identified projects are compiled in Table 12 and their locations shown on Figure 8. The projects are developed on a planning level only; they are conceptual in nature and subject to refinement as they are implemented. Section 7 presents the method used to establish project priorities and the final project list.

Table 12. Soldotna Recommended Projects

Project #	Project Name	Project Type	Description
S1	Sewer System I&I Study	R&R	This project will conduct an inflow and infiltration (I&I) study of the system to identify if excessive infiltration or inflow exists and if any identified sources are severe enough to warrant repairs.
S2	LS 7 Upgrades	R&R	This project would regrade the road, add storm drainage inlet, and replace the station access hatch in order to reduce inflow into the station.
S3	Kalifornsky Beach Road Manhole Upgrades	R&R	This project would upgrade manholes and regrade the area surrounding them to reduce the inflow.
S4	I&I Reduction Phase 1	R&R	This project will systematically repair I&I sources identified through the Sewer System I&I Study.
S5	LS 4 Upgrades	R&R	This project would regrade the road, raise the entrance, and replace the station access hatch in order to reduce inflow into the station.
S6	LS 2 Upgrades	R&R	This project would replace the station access hatch in order to reduce inflow into the station.
S7	LS 9 Replacement	SE	This project will replace the lift station should be replaced with a larger station with more capacity, better access, and a redundant power source so it operates during power outages.
S8	I&I Reduction Phase 2	R&R	This project will systematically repair I&I sources identified through the Sewer System I&I Study
S9	I&I Reduction Phase 3	R&R	This project will systematically repair I&I sources identified through the Sewer System I&I Study
S10	I&I Reduction Phase 4	R&R	This project is will systematically repair I&I sources identified through the Sewer System I&I Study



SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Sewer Collection System Capital Improvement Projects

Figure 8

HDR

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7 Capital Improvement Program

7.1 Project Phasing and Priorities

The City of Soldotna uses a CIP as a basis for budgeting the planning, design, and construction of needed facilities. The projects recommended for the study areas were combined to create a 20-year list covering the period 2016 to2035. These projects form the Soldotna Wastewater Utility CIP.

7.2 Project Priority Criteria

All projects identified through this planning process could eventually be constructed. Soldotna, however, does not have the capital resources to build them all immediately and therefore prioritizes its CIP.

Six generalized criteria are used in evaluating recommendations that are developed to meet the projected wastewater flows. These include:

- Cost (capital and operating)
- Constructability
- Institutional and agency requirements
- Coordination with other agency projects
- Increasing system reliability and redundancy
- Public acceptance

Capital and operating costs are an important criteria used in evaluation. For purposes of the 2015 WWMP, operational costs considered were energy costs to pump wastewater and costs for pump station repair. Regular operation, maintenance, and replacement costs were assumed to be proportional to the volume of sewage pumped.

Constructability is considered in project selection because of its impact of cost. The reconstruction of road and ditches to minimize inflow into pumping stations was a large consideration if future projects. Also, because of sensitive habitat in and adjacent to the Kenai River, recommending infrastructure in or adjacent to the river is avoided.

Coordination of Soldotna projects with other agency projects, Alaska Department of Transportation and Public Facilities, road work for example, offers significant opportunities for Soldotna. Opportunities include reductions in overall project cost, reduction in public inconvenience during construction and others. Where possible and practical, Soldotna projects have been selected that coordinate with other agencies' work.

Increasing system reliability and redundancy is important in providing high levels of service. System reliability is enhanced by systematically performing preventative maintenance to reduce the occurrence of unforeseen system failures. System redundancy, or providing alternative means of service, gives Soldotna the ability to continue service in the event of unforeseen system failures. These criteria were used to evaluate and select projects.

Environmental impacts can be a significant factor in the siting of projects. Wastewater collection projects in developed areas seldom create insurmountable problems since most areas have already been disturbed. Pump stations can be exceptions, since these projects are sometimes best located away from disturbed areas. Floodplains and wetlands are areas to be avoided whenever possible and practicable alternatives exist.

The last criterion recognizes that public acceptance is a necessity before a project can be constructed. Knowledge of local issues and conformance with the Soldotna and KPB comprehensive plans were applied in an attempt to reflect public acceptance of improvement recommendations.

7.3 Capital Improvement Schedules

7.3.1 2016 to2035 Capital Improvement Program

Table 13and Figure 8 detail the projects recommended in the 2015 WWMP for the period 2016 to 2035. Projects are organized chronologically starting with projects to be executed in 2016 and ending with those projects to be constructed in 2035. Estimated costs are also included. Feasibility studies and master plans represent the lowest level of effort in developing estimates of cost, and the American Association of Cost Engineers specifies that these types of planning level cost estimates have an anticipated accuracy of +50% to -30%.

Construction Costs

All cost estimates developed in this 2015 WWMP are based on 2015 dollars, and they must be adjusted to account for inflation in the future. Sources of cost data used in development of the estimates include bid data from similar jobs, information from local contractors, budget quotations from equipment or material manufacturers, and standard cost estimating manuals. Cost estimates for I&I repair and pump station stations and appurtenances are based on engineering judgment of the probable costs.

Contingencies

Cost estimates presented in the 2015 WWMP include a 25% contingency added to the construction cost estimates. This contingency is added to cover many construction unknowns, such as soil conditions, season of construction, bidding climate, unforeseen physical conflicts with other utilities, and various incidental costs for labor and materials not specifically included in the estimated construction quantities.

Engineering, Administration, and Right-of-Way Costs

Implementation of projects like this typically requires a variety of in-house and outside professional services including: engineering during design, construction administration, and project startup; in-house administrative costs during design and construction; legal fees; and costs associated with permit and right-of-way acquisition. The engineering and construction management portion of the project cost is estimated to be approximately 25% of the construction cost. In addition, Soldotna administration and legal fees are approximately 5% of construction cost. Land cost for pump stations is based on KPB assessed values for property in Soldotna. These costs are added to the construction cost with the contingency described in 7.3.1 under Construction Costs to develop the total relative order of magnitude project cost.

7.4 Project Recommendations

Recommended projects to address identified system needs and future service are compiled in Table 13 and their locations shown on Figure 8. Table 13 also presents the recommended project implementation schedule in the years 2016 to 2035. The schedule attempts to tie improvements to consistent funding of project and avoiding large rate increases. Revisions to the planned schedule will be necessary should growth patterns change.

The 2015 WWMP's elements were developed on the basis of being flexible to accommodate changes in growth patterns. The projects are developed to a planning level only; they are conceptual in nature and subject to refinement as they are implemented.

Table 13. Soldotna Wastewater Collection System Recommended Projects

Project #	Project Name	Implementation Year	Description	Estimated Cost (2015 Dollars)
S1	Sewer System I&I Study	2016-2017	This project will conduct an inflow and infiltration (I&I) study of the system to identify if excessive infiltration or inflow exists and if any identified sources are severe enough to warrant repairs.	$31,000
S2	LS 7 Upgrades	2017	This project would regrade the road, add storm drainage inlet, and replace the station access hatch in order to reduce inflow into the station.	$310,000
S3	Kalifornsky Beach Road Manhole Upgrades	2017	This project would upgrade manholes and regrade the area surrounding them to reduce the inflow	$16,000
S4	I&I Reduction Program Phase 1	2017-2020	This project will systematically repair I&I sources identified through the Sewer System I&I Study	$70,000
S5	LS 4 Upgrades	2018	This project would regrade the road, raise the entrance, and replace the station access hatch in order to reduce inflow into the station.	$39,000
S6	LS 2 Upgrades	2020	This project would replace the station access hatch in order to reduce inflow into the station.	$349,000
S7	LS 9 Replacement	2022	This project will replace the lift station should be replaced with a larger station with more capacity, better access, and a redundant power source so it operates during power outages.	$310,000
S8	I&I Reduction Phase 2	2021-2025	This project will systematically repair I&I sources identified through the Sewer System I&I Study.	$116,000
S9	I&I Reduction Phase 3	2026-2030	This project will systematically repair I&I sources identified through the Sewer System I&I Study.	$116,000
S10	I&I Reduction Phase 4	2031-2035	This project will systematically repair I&I sources identified through the Sewer System I&I Study.	$116,000

7.5 Staffing

7.5.1 Current Workload

The Soldotna utilities system, the combined water supply and distribution system, wastewater collection system, and wastewater treatment plant are operated and maintained by the same staff pool. Operators are cross trained between water and wastewater operations, and the staff works between each utility component. Therefore, staffing must be discussed in the context of the entire water and wastewater utility.

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

- Inspection of new water and sewer service connections installed by developers;
- Fulfillment of water and sewer pipe location requests;
- Operation and maintenance of the water supply and distribution systems, including cross-connection surveillance;
- Twice-annual water main flushing;
- Fire hydrant maintenance;
- Operation, cleaning, and maintenance of the sanitary sewer collection system;
- Operation and maintenance of the wastewater treatment plant;
- Sampling and monitoring to meet all regulatory requirements, including:
- Water supply sampling,
- Wastewater plant influent and effluent sampling, and
- Dewatered wastewater sludge sampling;
- Reporting as required by water and wastewater regulations and permits;
- Development and implementation of computerized maintenance management system for all utility equipment;
- Oversight of contractors hired to construct projects;
- Development and management of budgets and staff; and
- Maintenance of grounds, including snowplowing, at all water and wastewater utility sites.

The facility plan that addressed utilities operation was completed in 2001. Table 14 presents a comparison of general water, sewer, and wastewater treatment plant components operated by the utilities staff in 2001 and 2014. In general, systems and services have grown about 30% between 2001 and 2014. Several components decreased in size or complexity (e.g., the number of active wells), but the vast majority increased in operational requirements. Some system components, such as the number of water meters and lift stations, have increased quite significantly. Also, the system is now 13 years older, so some mechanical components of the treatment plant are now more than 30 years old. These increases in the utilities' system size, complexity, and age have resulted in additional work for staff.

Table 14. Soldotna Water and Sewer General System Changes, 2001 to 2014

Water System			Change	
Year	2001	2014	13	years
Customers	2700	3350	24%	increase
Average demand, MGD	0.6	0.71	18%	increase
Peak demand, MGD	0.9	0.88	-2%	decrease
Wells	5	4	-20%	decrease
Reservoir sites	1	2	100%	increase
Reservoirs	2	2	0%	change
Booster/PRV station	0	1		increase
Pipe length, miles	32	38	19%	increase
Hydrants	240	315	31%	increase
Service connections	1200	1810	51%	increase
Meters	30	377	1157%	increase
SCADA	limited	extensive		increase

Sewer System			Change	
Year	2001	2014	13	years
Customers	2700	3400	26%	increase
Pipe length, miles	24	29.5	23%	increase
Manholes	393	483	23%	increase
Lift stations	10	16	60%	increase
Vactor truck	1	1	0%	change
SCADA	none	In each LS		increase

WWTP			Change	
Year	2001	2014	13	years
Customers	2700	3400	26%	increase
Average flow, MGD	0.51	0.56	10%	increase
Maximum month, MGD	0.59	0.78	32%	increase
Aeration Basins	2	2	0%	change
Clarifiers	2	3	50%	increase
Disinfection	Cl	UV		
SCADA	limited	extensive		increase
Equipment age				
Clarifiers, years	19	32, 10		increase
Aeration Basins	19	32	79%	increase
Belt Press	19	32	79%	increase

7.5.2 Current Staffing

In 2014, the operations and maintenance staff for the water and wastewater utility consisted of one manager and four operators. Additional labor for utility-related tasks and special projects in 2014 was obtained from the following:

- Staff overtime (approximately 400 hours per year);
- Local contractors (about 80% of all electrical work and 90% of all mechanical work);
- City maintenance shop (approximately 80 hours per year); and
- Summer hire staff (approximately 475 hours annually).

The labor from the city maintenance shop, overtime, and temporary employees totals 960 hours annually. Using the EPA criteria of 1,500 hours per year of productive time (productive time is defined as normal full-time work year, 2,080 hours, excluding vacation, sick leave, and holidays) the borrowed labor, overtime, and temporary staff equals the equivalent of 0.65 full-time equivalent (FTE) employee.

Combining the current full-time staff of five with the borrowed, overtime, and temporary labor FTE of 0.65 results in a total equivalent staff of 5.65 people in the utility operation.

7.5.3 Staffing Analysis

The most recent utility staff analysis was completed in 2001 for the *City of Soldotna Wastewater Facilities Master Plan* (HDR Alaska, 2001). The 2001 *Wastewater Facility Plan* staffing analysis reported that the utilities' staff consisted of four full-time staff and one FTE consisting of 1,300 hours borrowed City maintenance shop staff and the remainder of utilities staff overtime. The 2001 report concluded that the utilities operations was understaffed by approximately one FTE based on the size of the systems operated, staff duties, and comparison with other similar utilities.

In 2003, Soldotna utilities operations added another operator, increasing the number of operators to four. Hiring the fourth operator allowed for reduced use of City maintenance shop staff, which was experiencing increased workloads as the city grew and had less time available to loan to the utilities maintenance.

With no staff additions since 2003, in 2014 the utilities had five full-time staff and used some summer hire staff. A comparison of the staffing between 2001 and 2014 is shown in Table 15.

Table 15. Soldotna Utilities Staff Levels

Year	FTEs	Employees	Staff OT FTE	Temporary or borrowed city staff FTE
2001	5	4	0.35	0.65
2014	5.43	5	0.18	0.25

WWTP Staff

HDR used the *Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants* (2008) developed by New England Interstate Water Pollution Control Commission (NEIWPCC). This guide was developed to build upon the U.S. Environmental Protection Agency reference guide titled *Estimated Staffing for Municipal Wastewater Treatment Facilities* (1973). Using this guidance, a 2015 analysis of plant staffing recommends 3.8 full-time staff at the WWTP. This is higher than the staff estimate developed in 2001 of 3.1 FTE and in line with the current plant's treatment processes and discharge requirements.

As a comparison, AWWU's Eagle River WWTP is a slightly larger plant with a design capacity of 2.5 MGD and an average daily flow of 1.5 MGD. They have a tertiary filter, but otherwise a fairly comparable process, size, age, and treatment requirements to the Soldotna WWTP. This plant is staffed with six people: one WWTP Superintendent, one Operations Foreman, and four Operators. The AWWU Eagle River WWTP staff is dedicated to the plant. They may occasionally address FOG issues (e.g., visit a FOG offender regarding pretreatment), but generally the Eagle River WWTP staff is dedicated to the job of operating and maintaining the plant. Eagle River WWTP staffing indicates that the estimated staffing for the Soldotna WWTP is reasonable.

Water and Sewer System Staff

Based on the water distribution and sewer collection system growth, operating staff have not increased proportionally. The general system has grown in complexity and extents since 2001. Factors that would increase staff requirements include more customers (about 25% increase); pipe in the ground, hydrants, and manholes (ranging from 20 and 30% increase); adding a remote reservoir, booster station, and PRV; adding six sewage pump stations (60% increase); system age increasing by 13 years, and other related factors increase operation and maintenance work load for the system. These indicate that additional staff may be required to operate these systems effectively and meet regulatory requirements.

Soldotna has mitigated the increased work load through labor saving changes instituted by the utilities operations. These include installing SCADA at all pump stations, wells, reservoirs, and booster stations; cross training all utility staff in operating water and sewer systems; WWTP upgrades of additional clarifier capacity, changing from chlorine to UV disinfection; advocating for pipe insulation to reduce freezing risk in water pipes; and other measures. These measures have added labor efficiencies (e.g., not needing to inspect lift stations as often), and have allowed existing staff to keep pace with increasing workload from system expansion and aging. However, after 10 years of no staff increases while the system size and complexity increased, the workload to operate the utilities system should be considered.

The 2001 staffing analysis estimated that the maintenance of the water distribution and sewer collection system would require 2.9 FTEs. This was based on the miles of pipe in the ground, the number of lift stations, and the water supply and storage methods. In the past 13 years, the pipe length has increased by about 25%, lift stations increased by

60%, and a booster and PRV statin was added to the system. Because of these additions to the distribution and collection system, it is reasonable to assume that additional labor is required to operate the system. Maintenance of these systems generally increases with size, so a system increase of approximately 30% would represent a need of approximately 30% more labor to operate the system. This would equate to a labor need of 3.7 FTEs dedicated to the operation of the combined water supply and distribution system and the sewage collection system.

7.5.4 Total Staffing

The results of the individual staff analyses are presented in Table 16. Also shown is the current staffing level as evaluated in Section 7.5.2. The previous analysis indicates that the utility operation should have a staff of 7.5 people.

Table 16. Staff Analyses Results

Staff	Staffing Level
Water supply and distribution and sewage collection FTEs	3.7
Wastewater treatment plant FTEs	3.8
Total estimated FTE requirement	7.5
Current FTE total	5.4
Estimated staff deficit	2.0

7.5.5 Staffing Recommendations

The existing staff consists of one full-time supervisor and four operators plus borrowed, overtime, and temporary labor help for an equivalent full-time staff of 5.4 employees. The staffing analysis presented above recommends considering increasing utilities staff by one or two FTEs. As the system expands to serve additional customers and when the APDES permit is renewed, staff requirements should be reevaluated.

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Appendix A

Sewer System Capacity Analysis

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City of Soldotna Utility Department

2015 City of Soldotna Wastewater Master Plan

Sewer Pipe Capacity Analysis

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Sewer Pipe Capacity Analysis

INTRODUCTION

Understanding the design and evaluation of pipe capacity is an important part of operating an effective and efficient wastewater collection system. As part of the 2015 City of Soldotna Wastewater Master Plan several issues associated with pipe capacity management were evaluated. The issues included:

- Pipe design criteria;
- Pipe capacity evaluation criteria;
- System peak sewer flow factors;
- System capacity and potential capacity issues; and
- Recommendations for capacity analysis and management.

These issues were analyzed in a technical memorandum which was reviewed with City of Soldotna Utility Department and Public Works staff. The completed memorandum is compiled in this document.

RECOMMENDATIONS

The preparation of the technical memorandum evaluating with sewer system capacity issues resulted in several recommendations for the City to consider implementing with respect to the sewer system. These recommendations are summarized below.

1. Consider adopting criteria to use for the design of new gravity sewer pipes.
2. Consider adopting specific criteria for use in evaluating the capacity of existing pipes.
3. Consider adopting the peak factor method to estimate rainfall derived I&I peak flow conditions for large pipes for use in capacity analysis.
4. Develop an asset management program for the sewer collection system.

MEMORANDUM ORGANIZATION

This memorandum contains the following sections:

Section 1 covers the development of design and capacity criteria for the pipe network.

Section 2 covers recommended peak factors for the larger pipes.

Section 3 presents the results of the sewer system capacity evaluation

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Section 1 – Design and Capacity Analysis Criteria for Gravity Sewer Pipes

1.0 INTRODUCTION

The City of Soldotna currently does not have published design or capacity analysis criteria for gravity sewer pipe. Pipe design appears to be based on the 10 States Standards design practices and the engineer's best judgment. The 10 States Standards design criteria are intended to be used for the design and installation of new pipes. The 10 States Standard Manual has other criteria for capacity assessment of existing gravity sewers.

To better understand plan for the capacity of sewer pipes, the City should consider adopting specific new pipe design criteria and specific assessment criteria for capacity analyses of existing gravity sewer pipes. Adopting different criteria for new and existing pipes will allow the City to maintain conservative design criteria for new installations while maximizing the useful capacity of existing system pipes.

Generally design criteria are selected to be conservative and to provide reserve capacity for unexpected future changes in the land use. Adopting system-wide design criteria will help ensure system expansion is systematic and uniform with adequate capacity for proposed and planned development.

The conservative nature of design criteria, when used for the system capacity assessment, may have unintended consequences and lead to unnecessary projects, projects that are implemented before they are needed, or not allowing proposed connections that could be served by the existing sewers. To avoid this situation the City should consider adopting Capacity Analysis Criteria (CAC). These are specific criteria used to evaluate the capacity of existing pipes and the areas based on the area they serve, estimated actual flows, and theoretical pipe capacity. CAC can help the city maximize the useful life of existing assets and plan for their timely replacement or upgrades.

This section outlines the need for design criteria and CAC, briefly discusses the components of both, and proposes possible criteria for the City's use. The section is organized as follows. The first section describes recommend design criteria for new gravity sewer pipes. The next part discusses different components of typical gravity sewers assessment criteria and outlines possible ways the City can define the CAC, followed by an overview of assessment and design criteria used by different jurisdictions to analyze gravity sewers. The final section proposes criteria for use by the City with the assumptions associated with the criteria and outlines some practical considerations when a hydraulic model is used to apply the criteria.

2.0 DESIGN CRITERIA

Currently, the City does not have established design criteria for the construction of new sewer main development. Not having adopted criteria means that the City has to review and approve the design criteria used by each project, increasing review times and the possibility that proposed project may not have the future capacity the City will need. To promote more uniform designs, better system integration, decrease staff workload, and speed the review and approval process, the City should consider adopting specific design criteria for new pipe built for connection to the City's sewer system.

To simplify design criteria selection, it is recommended that the City adopt the Anchorage Water and Wastewater Utility's (AWWU's) design criteria for new sewer pipe. This is contained in AWWU's Design and Construction Practices Manual (DCPM). The AWWU DCPM provides a consistent, conservative approach for estimated generated flows from future development and designing pipe diameter and slope. AWWU has used the DCPM over a long period of time with good results in a sewer system of similar age, design, and climatic conditions as Soldotna's system. AWWU continues to refine their DCPM, which the City can benefit from at no cost. Finally, the AWWU DCPM is understood and used by engineers, contractors, and suppliers in Alaskan industry, so its implementation will streamline the design and construction process of new development.

2.1 Criteria Description

Section 30 of the AWWU DCPM outlines requirements for the design and construction of wastewater facilities. Specifically section 30.020.01 provides recommendations for design flow of new development and sewer main slope. The AWWU DCPM estimates the flow volume per acre of future development based on the zoning and estimated density. The table uses a peaking factor of 2 to calculate future peak design flow from the calculated runoff per acre.

The DCPM also outlines a table of minimum slope and minimum number of homes at approximate design capacity (2/3 full) and a minimum velocity of 2 feet per second. This table, combined with the peak design flow estimation, is used to provide design criteria for both pipe size and slope. The table is derived from 10 States Standards.

Another criterion in the AWWU DCPM the City can consider is the minimum depth for pipes. The AWWU DCPM requires 5½ feet of cover for freezing protection without insulation.

2.2 Recommendations

It is recommended that the City use AWWU's DCPM requirements for the design of new sewer mains. The approach used by AWWU has proven effective of many years of implementation and should serve Soldotna's needs. Adopting the design criteria will have some consequences and some criteria modified for Soldotna's specific situation as described below.

Soldotna sits on a generally level, gravel plain with deep groundwater levels whereas Anchorage generally has more loping ground, fine grained soils, and shallow groundwater. Anchorage's physical situation means that steeper pipe slopes are possible and pipes are buried below groundwater or in wet soil conditions which inhibit deep frost penetration. Because of Soldotna's generally deeper groundwater and drier, more porous soils sewer pipes will need deeper minimum burial to protect them from freezing unless insulation is used.

Future development design flow calculations from the AWWU DCPM are based on data collected in past decades. The increasing code requirements for low flow fixtures have resulted in a decreasing per capita sewer output in many jurisdictions. Future flow estimation using the AWWU DCPM may result in some oversized pipes. However, sewer flow data for Soldotna does not indicate that per capita flow is decreasing. Therefore the reserve capacity inherent in using the AWWU DCPM method for flow estimation is a benefit that outweighs the possibility of oversizing the pipe.

The pipe slope table from the AWWU DCPM provides minimum slopes that are slightly steeper than a full pipe flowing at 2 feet per second, the other slope criteria identified in 10 States Standards. This conservative approach (steeper pipe slope resulting in attaining scour velocity more frequently) can result more lift stations being required if the system expands beyond the edges of the current pipe network. The pipe slope requirements in the table will result in scouring flows earlier in pipe life, which will result in less frequent cleaning and a lower SSO risk. Implementing a consistent approach to sewer main design with the AWWU DCPM recommendations will result in conservative design that provides capacity for future growth.

The model analysis of the Soldotna shows that pump station discharges can combine together to create higher than anticipated flows. The model result was verified by Soldotna staff field observations. The AWWU DCPM does contain specific criteria for the analysis of numerous pump stations which concentrate flows when running simultaneously. Where a lift stations are needed, the City should require an analysis of how the pump station discharge effects gravity sewer capacity downstream of the pump station and whether the discharge could combine with other system pump statin discharges and cause over capacity pipes. The analysis should be added to design criteria adopted by the City.

The AWWU DCPM sections recommended for adoption, with the suggested modifications, are attached in Appendix A.

3.0 CAPACITY ANALYSIS CRITERIA

Pipe assessment criteria, also called Capacity Analysis Criteria (CAC), are a set of quantitative measures used to define the effectiveness and the ability of a constructed and operating gravity collection system and its individual components to covey sewer flows. CAC are sometimes confused with the pipe design criteria and many utilities do not differentiate between the two criteria. Both criteria define the conditions in a system to be examined and specify the required system response. However, design criteria are used for sizing new system components and typically include larger safety margins than what is necessary for CAC. Consequently, an existing system component that does not fully meet a design criterion might still meet the desired Capacity Analysis Criteria. For example, a pipe that is designed to flow 2/3 full could still provide the desired service even if it is flowing 80% full. Thus, using the design criteria for system evaluation could produce to overly conservative results that could lead to:

- Falsely identifying system components as below the desired capacity even if they can meet a desired Capacity Analysis Criteria and meet required level of service,
- Constructing unnecessary projects to increase such pipe capacity,
- Implementing too aggressive capacity improvement project phasing, and
- Limiting system growth due to the overly conservative remaining capacity estimates.

To be complete, CAC must define the critical system driving forces and system conditions to be examined and the desired system performance. For a gravity sewer collection system that is influenced by rainfall derived infiltration and inflow (RDII), CAC might be somewhat difficult to define. CAC for such system must include (1) critical storm, (2) storm runoff, (3) system conditions and (4) the desired evaluation criteria. Each of these components is examined in the following sections with pros and cons of the traditional approach to the definition of CAC.

3.1 Critical Storm

In a system that has significant RDII the primary defining force of the peak system flows will be the critical storm. The key parameter of the critical storm is (1) the rainfall intensity. However, other parameters will also influence the system response to the storm, including: (2) storm duration, (3) storm temporal distribution, (4) storm spatial distribution and storm/wind direction. When analyzing the future system behavior, (5) climate change effects might also need to be examined, especially for the long-term forecasts.

3.1.1 Rainfall Intensity

It is typical for collection system planning to define CAC rainfall intensity in terms of the storm return interval that should be conveyed through the system while satisfying the evaluation criteria. Rainfall intensity can be defined directly in inches of total rainfall depth or as system response using an average dry weather flow (DWF) peaking factor (PF).

3.1.2 Storm Duration

Traditional approaches to CAC define a single storm duration to be evaluated for the whole system, often a 6-hour, 12-hour, 24-hour or 48-hour storm. The reason for the selection of 6-, 12-, 24, or 48-hour storm durations is based on the fact that these are the only durations with standard rainfall distributions available (US Soil Conservation Service, U.S. Department of Agriculture, Technical Release 55 (TR-55): Urban Hydrology for Small Watersheds, June 1986).

A problem with this approach is that it assumes that all parts of the system will experience the critical conditions for the same storm duration. In reality, this is rarely the case. Smaller, upstream system components are often more affected by short-duration, high-intensity storms while the larger, downstream components might be more affected by longer-duration, high-volume storms. This problem is further aggravated because the temporal distribution of shorter storms can be significantly different from the temporal distribution of the larger storms. 6-hour storm duration, the shortest storm duration with an available standard hyetograph, might be too long to capture the most stressful conditions for upstream smaller, system components.

There are several alternative approaches to remedy storm duration problem. One possibility is to use a long historic record of observed rainfalls for the system analysis instead of a single critical storm. However, this approach can be extremely computationally intensive and should be used only if necessary. Another approach is to define a conservative hyetograph that would incorporate the peak intensity storms for desired shorter-duration storms within the longer-duration storm. Finally, an adjustable peaking factor (PF) approach can allow a higher RDII repose in upstream portion of the system and lower in downstream portions of the system.

3.1.3 Rainfall Temporal Distribution

SCS TR-55 defines only four standard rainfall distributions for the US for 6-hour, 12-hour, 24-hour and 48-hour storms. TR-55 further assumes that rainfall for the whole US can be described by four characteristic storm types, representative of the regions given in Figure 1 (Type I, IA, II and III). The characteristic storm hyetograph for the City based on TR-55 map would be Type I hyetograph.

Figure 1 SCS Storm Types (reproduced from TR-55)

It is typical to assume that single rainfall distribution or a combination of a few rainfall distributions will produce the critical conditions in all system components. Since PF method is a steady state method, it does not need to define the temporal distribution of the assessment storm.

3.1.4 Rainfall Spatial Distribution

Rainfalls with different spatial distribution can produce different system response for the same rainfall temporal distribution. For example, a storm that is moving from upstream to downstream of the system might produce significantly higher peak flows that the same storm moving from downstream to upstream, due to the phasing of peak flows from system branches.

It is typical for collection system assessment to ignore the issue of the temporal rainfall distribution when defining CAC because it is not trivial to define the critical or characteristic storm spatial distribution. CAC typically assumes a uniform rainfall across the whole system.

CAC also often ignores the reduction in the point rainfall intensity due to the size of the catchment basin. Rainfall intensities are measured at specific points and the data derived for such measurements are representative of point-rainfall intensity. The likelihood of having a rainfall exceeding certain depth over an area will decrease as the area increases. Thus, assuming constant rainfall intensity over the whole service area is a conservative assumption.

3.1.5 Climate Change

Even when historical rainfall record of sufficient temporal and spatial accuracy is available to define the critical storm, it cannot be always assumed that the past record of rainfall is the best predictor of the future storms. For systems that need to ensure compliance for long-term forecasts (20-50 years and larger), the effects of the client change on rainfall intensity, temporal and spatial distribution should be examined.

For the short-horizon system planning (<10-20 years), as in the case for the City's system planning, with a representative historic rainfall information CAC can ignore the climate change effects on the rainfall forecasts. Climate change effects on the future weather and system boundary conditions should however be reexamined in each subsequent planning cycle.

3.2 Runoff Parameters

Once the critical storm is defined, system analysis needs to evaluate how much of the rainfall will be captured by the system. This is somewhat less important for sanitary systems that were not designed to capture the rainfall runoff. Also, the amount of runoff captured by the sanitary sewer system does not increase in proportional to increasing storm intensity. This is because runoff capture is often limited by the inlet capacity and capture of longer duration or greater duration rainfall events becomes limited by system inlet capacity. This is especially true for sanitary sewer systems, like the City's, that are not combined sewers. These systems are specifically designed to restrict rainfall infiltration and restrict its capture.

Rainfall-runoff response is defined by two sets of parameters, constant parameters that do not change between the storms and time-varying parameters that might change between the storms. Constant parameters include the contributing catchment area, percent of catchment contributing direct runoff, runoff coefficients, catchment time of concentration, etc. These parameters are defined by the system and do not need to be specified in the CAC. CAC might need to define the variable rainfall-runoff parameters, including: (1) antecedent conditions, (2) snow and ice cover, (3) groundwater levels and (4) inlet conditions. Finally, for long-term forecasts (5) the changes of the constant rainfall-runoff parameters should also be evaluated.

For evaluations that use PF methods to define RDII, rainfall and runoff parameters will be combined in the definition of the peaking factor.

3.2.1 Antecedent Conditions

Depending on the amount of moisture in the ground and the amount of the water in ponds and surface depressions before a storm, the runoff response can be different for two otherwise identical storms. The difference will be in the amount of the rainfall that will be stored before the runoff begins. Traditional approaches to CAC typically assume the worst-case conditions. If there is another storm prior to the critical storm, which is large and close enough to completely saturate the catchment and eliminate the initial rainfall losses, than the initial losses will be negligible for the critical storm and can be ignored.

3.2.2 Snow and Ice Cover

A storm that falls on frozen ground or ice can contribute significantly more runoff than the same storm that would fall on ground that is not covered. In worst-case scenario, runoff coefficient for a storm that falls on frozen/ice covered catchment can be 100%. Thus, a small winter storm can produce higher runoff than a larger summer storm. However, for systems that are not designed to capture direct rainfall runoff, such as the City's system, snow and ice cover typically reduce the amount of RDII. The traditional approach to the definition of CAC for sanitary sewer systems typically ignore the issue of rainfall falling on ice or ice covered ground. However, the

City could examine historic flow records to determine if winter rainfalls that fall on frozen ground or ice produce the critical system response.

3.2.3 Snow Breakup

Snowmelt is typically not as critical for producing sanitary sewer flows in the City's system. However, the City should consider evaluating peak flow records at the plant to evaluate the influence of the snowmelt to peak system flows.

3.2.4 Groundwater Level

Groundwater level can contribute to both dry weather flow and RDII. Traditional CAC defines the critical base flow and includes the groundwater contribution in the definition of rainfall-runoff response.

3.2.5 Catchment Changes

Catchment parameters that do not change between individual storms might change over longer time. It is general trend that urban catchments have increasing runoff coefficient and percent of impervious area with time. However, the implementation of infiltration and inflow (I&I) reduction schemes, green infrastructure, etc. could be changing and possibly reversing this trend. For systems that need to ensure compliance for long-term forecasts, the effects of catchment changes on rainfall-runoff response should be examined.

For sanitary systems, long-term trends are typically balanced between I&I increase due to pipe deterioration and reduction due to I&I management practices. The City should include appropriate I&I values in the model for existing and future conditions but does not necessary need to include I&I changes in the CAC.

3.3 System Conditions

The response of the system to the critical storm, given the appropriate rainfall-runoff parameters, will also depend on the system initial and boundary conditions: (1) pipe conditions, (2) system redundancy, (3) boundary conditions and (4) RDII and DWF peak timing.

3.3.1 Pipe Conditions

Pipe capacity during the critical storm might be limited by pipe conditions, such as the level of sediment in the pipe, root intrusion or other pipe defects. CAC used for system capacity assessment typically assumes clean pipes in good condition without significant deterioration, breaks or deformations. This way the system evaluation will identify only capacity deficiencies due to undersized pipes and not operation and management (O&M) problems.

3.3.2 System Redundancy

For the analysis of critical system conditions one should consider a failure of a system component during the critical storm. The traditional approach to the definition of CAC assumes the full redundancy of lift stations. This maximizes flow in downstream pipes during the peak event being analyzed.

3.3.3 Boundary Conditions

Boundary conditions, such as the water level of the receiving water bodies and storage/capacity of the treatment plants, can limit the capacity of upstream system components. CAC typically assumes the worst-case scenario for the boundary conditions such as the coincidence of the critical storm with river flood conditions. For the Kenai River, a flood in the river does not significantly impact the discharge capacity of the treatment plant.

3.3.4 Storm and System Peak Flow Timing

For a sanitary system designed to convey dry weather flows (DWF), such as the City's system, the critical storm can produce a larger system response if it coincides with the peak DWF. CAC typically assumes the worst-case scenario in which the peak storm response coincides with the peak DWF.

3.4 Evaluation Criteria

Once the system response to the critical storm is defined, the evaluation criteria are used to examine if the system can provide the desired Capacity Analysis Criteria. The evaluation criteria can include (1) flow depth limits, (2) and overflow and bypass limits, (3) water quality limits.

3.4.1 Flow Depth Limits

CAC can define evaluation criteria as the maximum depth of flow in pipes and manholes. Flow depth limit in pipes is typically expressed as d/D ratio (the depth of flow in a pipe over the pipe diameter) or as the surcharge height over the pipe crown. The other way to limit depth of flow in a pipe is to limit pipe flow to open channel flow and to prevent pipe surcharging ($d/D < 1$). This approach acknowledges that the water surface level in manholes upstream from surcharged pipes needs to increase significantly to add more flow to the downstream, limiting pipe.

Flow depth limit in manholes is typically defined as the minimum difference between the manhole rim and the maximum water level in the manhole. Minimum freeboard in a manhole can sometimes limit the flow depth in a pipe if the pipe cover is smaller than the needed freeboard.

An important factor to consider when defining depth criteria is that the criteria do not need to be the same for all pipes in the system. Smaller pipes that can experience higher flow variably can have more stringent CAC (lower d/D) while larger pipes that experience less flow variability can allow higher flow depths.

3.4.2 Overflow and Bypass Limits

The number, duration, frequency, volume and total system-wide volume limit on overflows and bypasses can be imposed in CAC. These criteria are applicable for combined and storm systems that are designed to carry both sanitary sewage and RDII. For separate sanitary systems, such as the City's, the overflow and bypass limits are typically not used. It is assumed that the City's system will provide the full service with no overflows.

3.4.3 Water Quality Limits

CAC can define the maximum water quality impacts on the receiving water bodies or maximum water quality loading for the discharged flow. This approach is typically not used for sanitary sewer systems. The City must meet its discharge limits at each treatment plant outfall during all plant flow conditions.

3.5 Other Considerations

CAC assume that the data used for the evaluation, including the hydraulic model, is representative of the system's current and future conditions and that it is capable of predicting the systems response to the critical storm. Engineering judgment should be used to balance the uncertainties about system data, conservativeness of the hydraulic model, and the strength of CAC. CAC has to be defined in such a way that it provides a definite answer regarding an individual component's capacity. Conservative model assumptions can be used to balance missing or uncertain system information. Where capacity evaluation results using the system model and CAC appear overly conservative, additional data should be collected at specific locations where the uncertainty exists to improve and recalibrate the model. The recalibrated model would then be used to evaluate the capacity against the CAC.

4.0 RECOMMENDATIONS FOR THE CITY OF SOLDOTNA CAC

As discussed above, three interdependent components need to be considered when defining CAC. The conservativeness of each component must be balanced with the other components as well as the level of accuracy of system data, conservativeness of the hydraulic model used in system assessment, and the operators' understanding of how the system responds to DWF and RDII. Better understanding of the system can allow for less stringent criteria. For this reason, engineering judgment and system knowledge should be used to evaluate each case when the hydraulic model identifies a pipe as failing when evaluated against the CAC.

Since CAC depends on each of the components, having higher standards for one component can allow less stringent standards for other components. For example, if the system is evaluated for a relatively large critical storm, with a high return interval, then the depth criteria for the pipes can be relatively high. Following are proposed CAC to be used for the City's system assessment.

4.1 Critical Storm

It is recommended that the City modify the approach outlined the 10 States Standard by using peaking factor methodology to define RDII. It should be noted that this methodology is conservative and it should be supplemented with real system data whenever it is available. The peaking factor methodology is recommended because system data – storm frequency and response – are not available and represent a considerable financial investment to collect for a small system. Using peak factors can provide the analysis confidence needed to understand and operate the Soldotna system effectively.

The 10 States Standards are designed for states in the middle of the continental United States with rain storms typically of high intensity and low duration, while storms in Southcentral Alaska are generally low intensity and long duration. The peaking factor recommended in the standards should be modified to reflect this.

4.2 System Response

It is recommended that the City assumes the worse-case conditions for the system response modeling with fully saturated anteceded moisture storage at the beginning of the evaluation. Similarly, ground water levels should be assumed to be high and contributing typical high DFW infiltration and inflow (I&I). Additional analysis could determine if snow and ice cover and snowmelt should be considered for the critical system response conditions.

4.3 System Conditions

It is recommended that the City simulate normal operating conditions for the system assessment that assume clean pipes or acceptable level of sediment in pipes, reasonable pipe condition, and full redundancy at lift stations.

It is recommended that RDII peak response be assumed to coincide with DWF peak response because the timing of the critical rainfall during the day cannot be predicted. This is implicitly built into the PF approach. However, when analyzing observed system data to determine more accurate PF, the adjustments should be made to account for coincidence of DWF and RDII peaks.

DWF used for system assessment should include all expected flows for the planning horizon examined, including both existing flows and all proposed flows. System analysis should also assume all pump stations are operating simultaneously in order to determine if simultaneous flows can combine and cause capacity issues.

DWF for future horizons should include future system deterioration or I&I reduction efforts to represent future RDII.

4.4 Evaluation Criteria

It is proposed that the City use full pipe flow (d/D = 1), no surcharging, as the assessment criteria for existing pipe capacity.

Where capacity analysis identifies pipes may be flowing full, it is proposed that the City selects 5 feet freeboard at manholes to define priority in monitoring sewer flows at potentially capacity issue pipes. Manholes with less than 5 feet of freeboard could limit the flow depth in pipes adjacent to relatively shallow manholes. These manholes have a greater potential of overflow under surcharge conditions. It is not recommended the City operate the sewage collection system in peak flow conditions at greater than full pipe flow.

5.0 CONSIDERATIONS WHEN USING CAC

The intent of adopting above-listed capacity analysis criteria is to help the City maximize the use of existing infrastructure, eliminate unnecessary capacity increase projects, support future development, and minimize the cost to customers. To be consistent with this recommendation, any capacity deficiencies identified by the model using these criteria should be carefully examined and field verified. In some instances, surcharged flow in pipes might be acceptable. Large pipes that are burred relatively deep can allow infrequent and short duration surcharged flow on case-by-case bases.

Field investigations must confirm model predicted capacity constraints before a project to eliminate the constraint is executed. Additional flow monitoring near the capacity constraint can provide the data to calibrate and validate the model in this area. This could potentially reduce the model conservativeness and would help to confirm the need for the pipe replacement. Improving the model in the area of the project will also provide a better tool identifying pipes needing replacement and the replacement pipe design.

When CAC are used to evaluate the system capacity to receive additional flows and unused capacity is identified, the City has several options on how to allocate the remaining or excess capacity to undeveloped, redeveloped, annexed areas in the potential sewer basin. Allocation methods include:

- first come, first served,
- reserving capacity for a specific use or project (such as within the City limits versus outside),
- per parcel (split available capacity proportion to parcel size),
- storage and off peak discharges, (this works only for users that do preprocessing of sewage), and
- basin extensions, annexations, and additions.

Implementing any of these is a policy decision by the City and should be done on a case by case basis.

6.0 SUMMARY

It is recommended that the City differentiate between the new pipe design criteria and the existing system evaluation criteria, Capacity Analysis Criteria (CAC).

For design criteria, it is proposed that the City adopt AWWU DCPM, as modified, design criteria of 2/3 full pipe flowing at 2 feet per second for new gravity sewers as outlined in Section 2 of this memoranda.

For CAC is it proposed to modify the use of 10 State Standards' methodology for the critical storm definition using peak factors and select an appropriate for the Soldotna area in order to simulate RDII response. Selection of a peak factor is described in the next section.

For assessment of existing pipe capacity it is proposed to use full pipe flow (d/D=1), no surcharging, when assessing the residual capacity of the gravity pipe system. The criteria would mean that an existing pipe flowing at full during the peak RDII induced flow during peak DWF, either current or future whichever is greater, would be considered to have adequate capacity. If it is flowing less than full under these conditions, the pipe would be defined as having reserve capacity. These recommendations are summarized in Table 1.

Table 1. Recommended City of Soldotna Gravity Flow Pipe Design and Capacity Analysis Criteria

Application	Method	Evaluation Criteria Pipe (d/D)
Design	Flow Generation by Land Use Areas	0.66
Capacity Analysis Criteria	Regional Peaking Factors	1.00

Sewer modeling is based on numerical analysis of pipe data and estimated flows. The City's sewer model has many assumptions with most model data not being field verified, as is the industry standard for such models. Therefore pipes identified through model analysis as flowing near or greater than full during the peak flow conditions should become candidates for field monitoring, not immediate replacement. This is because many of the assumptions in the model are conservative and may be overestimating flow or underestimating capacity. Gathering field measurements of flow conditions in these pipes is required to confirm model estimations and determine is the pipes warrant replacement with larger pipes.

Section 2 – Peaking Factor Analysis for Wastewater Collection System

1.0 INTRODUCTION

This section describes the process to estimate an appropriate peaking factor (PF) for the City's collection system assessment and recommendations for its use in the City's hydraulic model. The resulting peaking factors are intended to be used with the City's current steady-state hydraulic model to identify capacity constraints of the existing system.

The PF evaluation process included data from several different sources which include the peaking factor analysis performed for the AWWU 2014 Wastewater Master Plan, the 10 States Standards Manual's peaking factor estimation, and flow data from the Soldotna Wastewater Treatment Plant.

A more accurate peaking factor could be determined with the installation of flow meters at lift and pump stations and in large diameter gravity trunks. The City should consider installing flow meters in the future to increase the accuracy of the peaking factor analysis.

2.0 PEAKING FACTOR FROM AWWU WASTEWATER MASTER PLAN

AWWU used twelve flow meter stations to collect 15-minute interval flow data in its collection system in 2012. This data was combined to form hourly flow data and used to determine basin and system-wide peaking factors for the AWWU Anchorage system. The hourly data were also used to determine the average dry weather flow by averaging flow over a summer seven day dry period. This average dry weather flow was then used as a basis for determining the peaking factor.

Two periods were examined to evaluate the peaking factor for each metering basin. The first period was the snow breakup period that occurred in March-April. The winter of 2011-2012 had the highest recorded snowfall in Anchorage. The total snowfall was just over twice the average snowfall producing double the normal spring melt snowpack. Melting proceeded normally with temperatures warming normally in late March through April. The melt period was long and produced large runoff because of the snowpack.

The peak flows observed during the breakup time frame were compared with those generated by two significant rain events that occurred in September 2012. The September rainfall events were large for Anchorage. They produced significant floods in the three creeks that flow through Anchorage. Each creek has a major trunk sewer flowing near the creek within the flood plain. As the rainfall events produced large floods in the creeks, it is anticipated that similar inflow event occurred in the sanitary sewer, as seen in the system flow monitoring and treatment plant flows.

The PF for peak hourly flow at each location for each type of event was calculated by dividing the maximum observed hourly flow by the average dry weather flow:

$$PF = \frac{Max\ Hourly\ Flow}{Average\ Dry\ Weather\ Flow}$$

Overall peaking factors ranged from a low of 1.7 to a high of 3.0, depending on the basin. Peak flows in the system were mostly driven by rainfall. Analysis of available flow data has shown that peaking factors, developed for one hour averaged peaks, vary between about 2.0 and 3.0 across the AWWU's system.

The peaking analysis developed for AWWU is applicable to the City of Soldotna area as both systems have many similarities. Both systems are of similar age – large portions were constructed in the early 1970's. The population density of both cities in areas served by the sewer system is similar therefore the per acre sewer flow should be equivalent. Both cities also have similar climates with equivalent precipitation and temperature averages. The burial depths of both systems are similar combined with similar groundwater elevations result in equivalent groundwater infiltration levels.

3.0 10 STATES STANDARD PEAKING FACTOR ESTIMATION

The 10 States Standards design manual defines peaking factor according to the equation:

$\frac{Q_{peak\ hourly}}{Q_{Design\ Average}} = \frac{18+\sqrt{P}}{4+\sqrt{P}}$ with P = population in thousands.

The Soldotna water distribution system serves approximately 3500 residents which equates to a peaking factor of 3.4.

The 10 States Standard design criteria were originally produced for ten states in the central United States. All ten states fall within SCS Type II rainfall distribution compared to a Type I distribution seen in Alaska. The type of storms seen in Type II distribution are shorter duration with more intense rainfall, where Type I distribution consists of longer duration lower intensity rainfall. Thus the peaking factor determined from Type II data would be an overly conservative estimate for the City of Soldotna area. While the 10 State Standard is provides an industry standard, actual data gathered from the area or an area with similar climatic storms would give a more accurate analysis.

4.0 SEPTEMBER 2012 PEAK RAIN EVENT

On September 19th, 2012 the City saw a high intensity rain event which caused a distinct spike in flow to the WWTP. The same storm was also observed in Anchorage, this storm even was used to calibrate the peaking factor determined in the 2014 AWWU Wastewater Master Plan. The flow data to the WWTP showed approximately a doubling of daily flow, indicating a minimum peaking factor of two for the system over this storm.

5.0 SEPTEMBER 2015 PEAK RAIN EVENT

On September 16th, 2015 the City saw another high intensity rain event which caused a distinct spike in flow to the WWTP. The flow data to the WWTP showed an approximately peak hour sustained flow of 1,800 gpm. Soldotna summer average dry weather flow is approximately 450 gpm, indicating a peaking factor of four for the system over this storm. This peak flow and calculated peak factor, however, are heavily influenced by combined pump station discharge flows and not representative of what the peak factor in the system would be if no pump stations were present.

6.0 RECOMMENDATIONS

By combining the knowledge gained from the AWWU system monitoring, an analysis of the 10 States Standard design manual, and the Soldotna September 2012 and 2015 peak rain events, a PF can be recommended. It is recommended that a universal, PF of 2.5 be used for system analysis using the steady-state model. If model results indicate problems in areas where the PF is known to be much significantly lower than 2.5, or downstream from such areas, then the model could be refined to use the location specific PFs estimated in this analysis.

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Section 3 – Wastewater Collection System Capacity Evaluation

1.0 INTRODUCTION

The City of Soldotna Utility Department sewage collection system operates under a range of flow conditions from small flows during the wee hours of the morning to high flows during major precipitation events. The conveyance system must have adequate capacity for this range of flow as well as for increasing flows as population grows and the system expands.

This section discusses the methods used to analyze potential sewage conveyance capacity and identify conveyance deficiencies in the City's system. Based on the results of the analysis, recommendations are made for data gathering, system monitoring, flow analysis, and pipe upgrades to address potential capacity issues for 2015 and 2035 peak hour flow conditions.

2.0 CAPACITY ANALYSIS METHODOLOGY

Analysis of the sewer pipe was done using the sewer system model developed by the City of Soldotna and HDR modeling staff. The sewer model was loaded to represent a summer average dry weather day weather (average day) conditions and set to model steady state flow conditions. This model was used to represent the base condition in 2015 and is referred to as the average day model in this section.

Each parcel with sewer service was assigned an estimated wastewater load based on the zoning, water use (derived for a related water system model), and use of the parcel. Corrections were made for properties with higher than average water usage (e.g. hospitals, high density trailer parks). Each parcel was then assigned to a sewer manhole or cleanout. When parcels were located between manholes, the upstream manhole or cleanout was chosen. The total average dry weather day wastewater load is 0.7 mgd.

The capacity analysis evaluated current and future potential peak-hour wet-weather flow conditions in the collection system. This was done to compare the pipe capacity criteria that was developed in the previous section of the memorandum with the potential flows and modelled pipe capacity. The analysis started by evaluating the current, 2015, average day condition using the average dry weather day model.

For the analysis of system capacity, the average dry weather day model was used to develop the 2015 average day flow conditions and determine whether the model reported any pipe capacity issues under that condition. The average day model used steady state model runs, existing 2015 average day model loading, and all lift and pump stations operating. While the probability of all the lift and pump stations operating simultaneously under this condition is small, it represents the worst case scenario. This was done to observe how pump discharge combined with estimated pipe flows contributes to capacity issues. The steady state model with average day loading was used to evaluate a single flow condition in the pipe system. This model is considered the base condition and has the peak hour factors multiplied to this base condition to estimate peak hour wet weather flows.

The model was also run with the pumps off to determine if there was gravity flow driven issues. No pipes in the model were identified as flowing above 30% full during peak wet weather conditions. Any sewer capacity issues would arise from a combination of gravity flows and pump and lift station flows rather than solely gravity flow.

To evaluate potential 2015 peak flow capacity the average day model was modified with a global peak factor of 2.5 was applied to all loads. Again, the model evaluates the system by considering all pump stations are simultaneously discharging. The 2015 modelled flows at the treatment plant were compared to 2007 to 2014 maximum month average and 2015 estimated peak flows[1] reported at the WWTF. These are presented in Table 2.

Table 2. Comparison of Reported and Modeled WWTF Flows

Reported 2014 Maximum Month ADWF (mgd)	Model ADWF Pumps off (mgd)	Model ADWF Pumps On (mgd)	Reported 2015 Peak Flow (mgd)	Model Peak Hour Flow (mgd)
0.650	0.70	3.81	3.16	3.87

3.0 FUTURE FLOW ESTIMATION

Pipe capacity issues were evaluated for the end of the planning period, 2035. It was assumed that the inflow and infiltration (I&I) component of total wastewater flow would increase at the same rate as sewer flows and no specific increase in I&I was modelled. This assumption was made because the City has a robust trunk and small pipe maintenance program which should maintain current I&I levels. Also, the model assumes that per capita flow will remain the same through the planning period. Due to code changes, prevalence of low flow fixtures, and general water conservation, per capita flow nationwide has been decreasing in the past 10 years, and may continue for some time. This plan recommends a conservative assumption that per capita flow will remain at current levels through the planning period.

Evaluating capacity issues for future flows used a two part methodology. First, average flow loads were increased to reflect projected population growth and land development. Then the model was run to evaluate capacity issues under average day and peak wet weather flow conditions with the 2035 population and associated flow conditions.

Projections of the population of Soldotna were developed for the 2015 Wastewater Master Plan (WWMP). This information is contained in Chapter 2 of the plan. The population served by sewers is expected to grow by 16% over the planning period.

The sewer model loads are applied at manholes. To estimate 2035 average day flow, the flows at each manhole were increased sixteen percent to represent future sewer loads. The same pumps on condition was used to estimate 2035 average day flow and increasing flows with the peaking factor of 2.5 was used to developed 2035 peak flow.

[1] Treatment plant staff report that the September 16, 2015 flow into the treatment plant was the largest they have observed.

The 2015 models were run to estimate average day dry weather flows and peak hour wet weather flows. The resulting modelled flows at the WWTF were compared to the 2015 WWMP estimated flows and are shown in Table 3.

Table 3. 2035 Estimated Flows

WWMP 2035 Maximum Month ADWF Estimate (mgd)	Model 2035 ADWF Pumps off (mgd)	Model 2035 ADWF Pumps on (mgd)	Model 2033 Peak Hour Flow (mgd)
0.927	1.12	3.87	4.45

4.0 CAPACITY ANALYSIS RESULTS

Pipe capacity was evaluated using model output and previously recommended CAC. Based on the CAC recommendations, capacity designations were developed. The designations use the ratio of flow depth, d, to pipe diameter, D to identify whether the pipe has no capacity issue, a medium or high potential issue, or is over theoretical gravity flow capacity. The ratios are listed in Table 4.

Table 4. Sewer Pipe Capacity Designations

Capacity Designation	Numeric Criterion
No Issue	d/D <0.66
Medium Potential	0.66< d/D <0.08
High Potential	0.8< d/D <1.0
Over Capacity	d/D =1*

* The model does not report d/D>1.

Using the pipe flows generated in flow models, capacity designations were generated for each pipe in the City's sewer collection systems. This data was used to identify pipes with potential capacity issues.

The model output was then used to perform several GIS based analyses. These analyses were done to understand capacity issue causes, relationships between identified system issues, and prepare capacity management recommendations. The results of the analyses are presented graphically in maps appended to this memorandum and described below.

In analysis of 2015 and 2035 ADWF with the pumps modeled as a pass through, where flow in is equal to flow out, there were no pipes with issues and no trunk pipes were flowing at greater than 35% full. In both models with the pumps on, pump flows do combine downstream of pump stations and some pipes are estimated to be at or above 100% capacity. Because when pump stations operate at the same time some pipes may have capacity limitations, system capacity analysis was done assuming all pump stations are operating.

<u>Sewer Pipe Capacity Average Day 2015</u> – Figure 1

This map shows the capacity designation of pipes during 2015 average day dry weather flow conditions with all pump stations operating. The map identifies pipes with potential capacity issues. These pipes are all downstream of one or more pump stations.

<u>Sewer Pipe Capacity Peak Hour 2015 and 2035</u> – Figure 2

This map presents the results of the 2015 and 2035 peak hour model runs. These two runs assume a peak factor of 2.5 and all pump stations operating. The 2015 and 2036 results are presented together to allow for direct comparison of how a pipe identified as potentially capacity-limited for current conditions fares under future conditions.

Changes in pipe capacity designation from 2015 to 2035 are relatively minor. This is reasonable because population growth in the planning period, and associated sewer flows, are not large in comparison with the peaking factor.

The pipes identified with issues are trunks leading from lift stations and most notably where two or three pump stations are running in tandem. The capacity issues on Redoubt Avenue and on Kobuk Street south of Bering Street both disappear if one of the lift stations feeding those pipes is off.

<u>Sewer Pipe Capacity and Contributing Parcels</u> – Figure 3

During review of private development projects the City should evaluate whether the proposed development will generate sewage flow that may cause capacity issues. Currently few parcels receive this evaluation because a system-wide model is not available. This map identifies parcels upstream of a pipe designated as Over Capacity for the 2015 peak hour wet weather flow. This data could be incorporated into the City's GIS database and used to screen private development projects for further evaluation.

<u>Sewer Pipe Capacity and Slope < Minimum</u> – Figure 4

This map highlights pipes with a slope less than the minimum required by the 10 State Standards design manual that were designated as Medium Potential, High Potential, or Over Capacity in 2015 or 2035. This map helps to identify pipes that have adequate slope but estimated flows greater than the pipe capacity, and which pipes may be restricted by pipe slope. In the former case a larger pipe can eliminate the capacity issue whereas in the latter case, larger pipes may not be a solution because adequate slope may not be available.

<u>Sewer Pipe Capacity and Line Cleaning</u> – Figure 5

This map compares capacity-issue pipes with the pipes included in the line cleaning program. With few exceptions line cleaning pipes do not correspond to capacity issue pipes.

<u>Line Cleaning, Slope, and Food Service Establishments</u> – Figure 6

While there doesn't appear to be a link between pipe capacity and line cleaning, there appears to be a link between pipes downstream of high and medium risk Food Service Establishments (FSE), pipes with shallow slopes, and pipes that are cleaned yearly to keep from freezing and to prevent clogging from fats, oils, and grease (FOG). This map shows instances where pipes included in the line cleaning program have less than minimum slope. It also shows that frequently cleaned pipes which have adequate slope are often downstream of high and medium risk FSEs. This information could be used to investigate use of grease separators.

5.0 CAPACITY MANAGEMENT RECOMMENDATIONS

This capacity analysis of the City's system was done using a sewer system model prepared by HDR. As is true for all models it is based on simplifying assumptions. It is HDR's opinion that the model is a good tool for identifying pipes with potential capacity issues but it does not have the predictive power to justify pipe replacement. The City should use the model to identify pipes with potential capacity issues and perform pipe inspections, surveys, and flow monitoring of the pipes to determine if a capacity issue does or will occur and what the appropriate countermeasures are. The collected data should also be used to update and refine the model and loading assumptions.

The results of this capacity analysis of the City's system indicate that 99.8% of the pipe segments in the model will flow at less that 80% full during the peak hour wet weather flow condition in 2035. Those that at predicted to flow greater than 80% full are associated with pump stations combined discharges. Capacity in these could be managed by pump station changes instead of pipe upgrades.

Based on the model results and the capacity analysis methods in this memorandum, the following recommendations are made.

1. The City should update the sewer system model when the next master plan is done or when land use or population changes may impact sewer flows dramatically. Such an event may be annexation of a large are into the City. Model refinements at that time will improve its predictive capabilities and the City's confidence in using it to analyze the system.
2. The City should continue to invest in pipe maintenance, I&I reduction, FOG reduction programs, and system cleaning. These will help ensure pipe capacity is available for sewage flows and will reduce potential SSOs.
3. Many capacity issue pipes are downstream of pump and lift stations and most of these are designated as Over Capacity pipes. Because of the number of pipes identified with this condition and associated with pump stations, the City should review the relationship between pump station discharge flows, downstream pipe capacity, and the potential of pumps operating simultaneously and compounding peak flows. Lift Stations 5 and 6 are a good example of the issue of two pumps running into one pipe. Lift Station 7 is a good example of a lift station possibly exceeding the pipe capacity of the pipe downstream.
4. The capacity analyses done for this memorandum indicate that the collection is in good condition, has adequate capacity, and requires average maintenance. The oldest parts of the system are now eclipsing 40 years old. Industry data indicates that the oldest pipes in the system have useful lives of 70 years or more. While pipe replacement due to age or deteriorating is not now recommended, data collection to monitor system condition is an important part of proactively managing a sewage collection system. Collecting and analyzing system condition data will help the City develop a program of timely and economically efficient replacement and repair projects. Recommended data collection should include line cleaning location and frequency records, video inspection of sewers before cleaning, mapping locations of excessive FOG accumulations, and other data relevant to pipe condition. This data can be stored and analyzed in a GIS data format and can be linked to the pipe databases developed for this plan.

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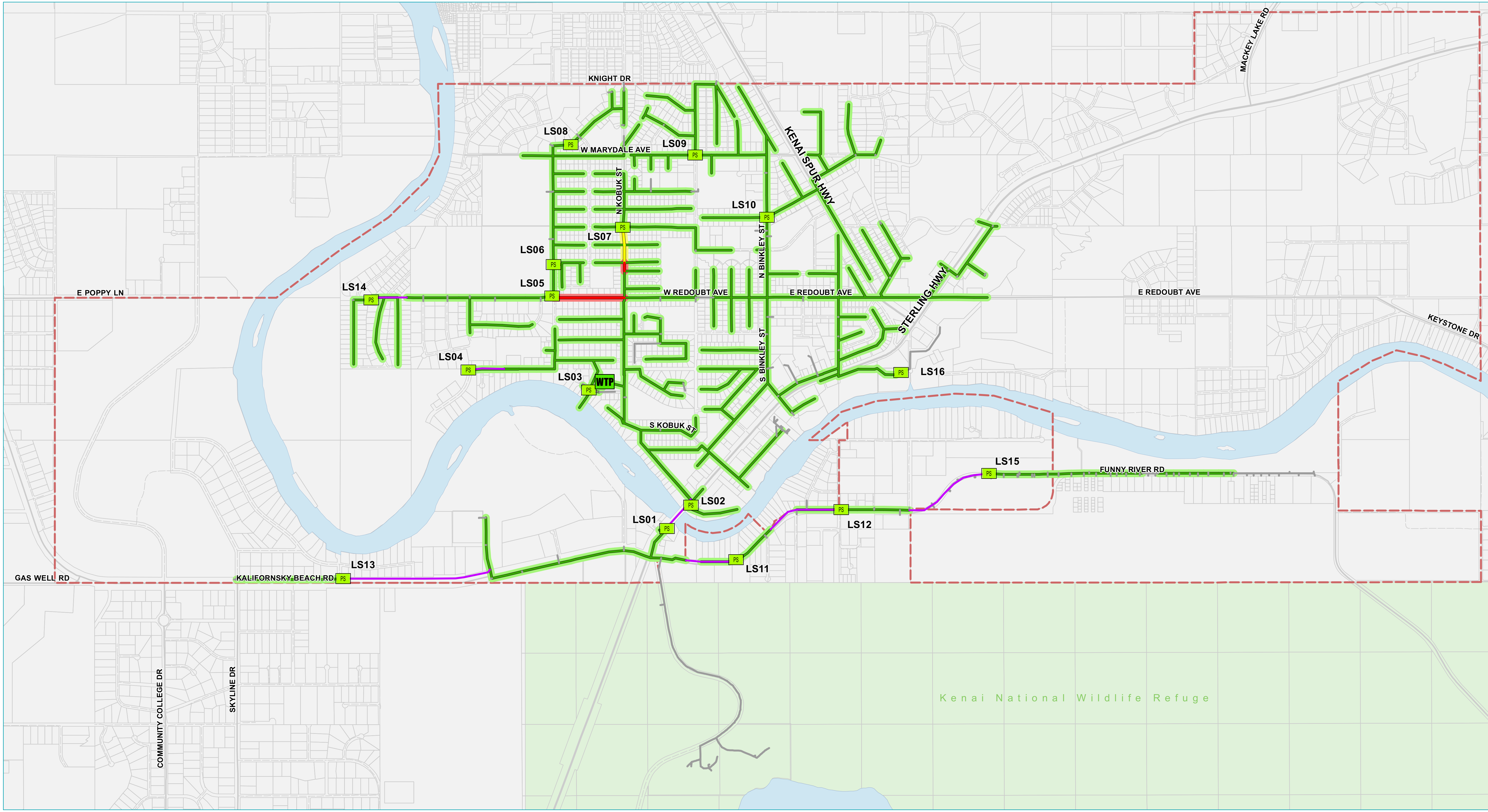


Sewer Gravity Mains - Capacity Status 2015
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1

Sewer Gravity Mains - Capacity Status 2035
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

N

0 1,700
FEET

SOLDOTNA
City of Soldotna, Alaska

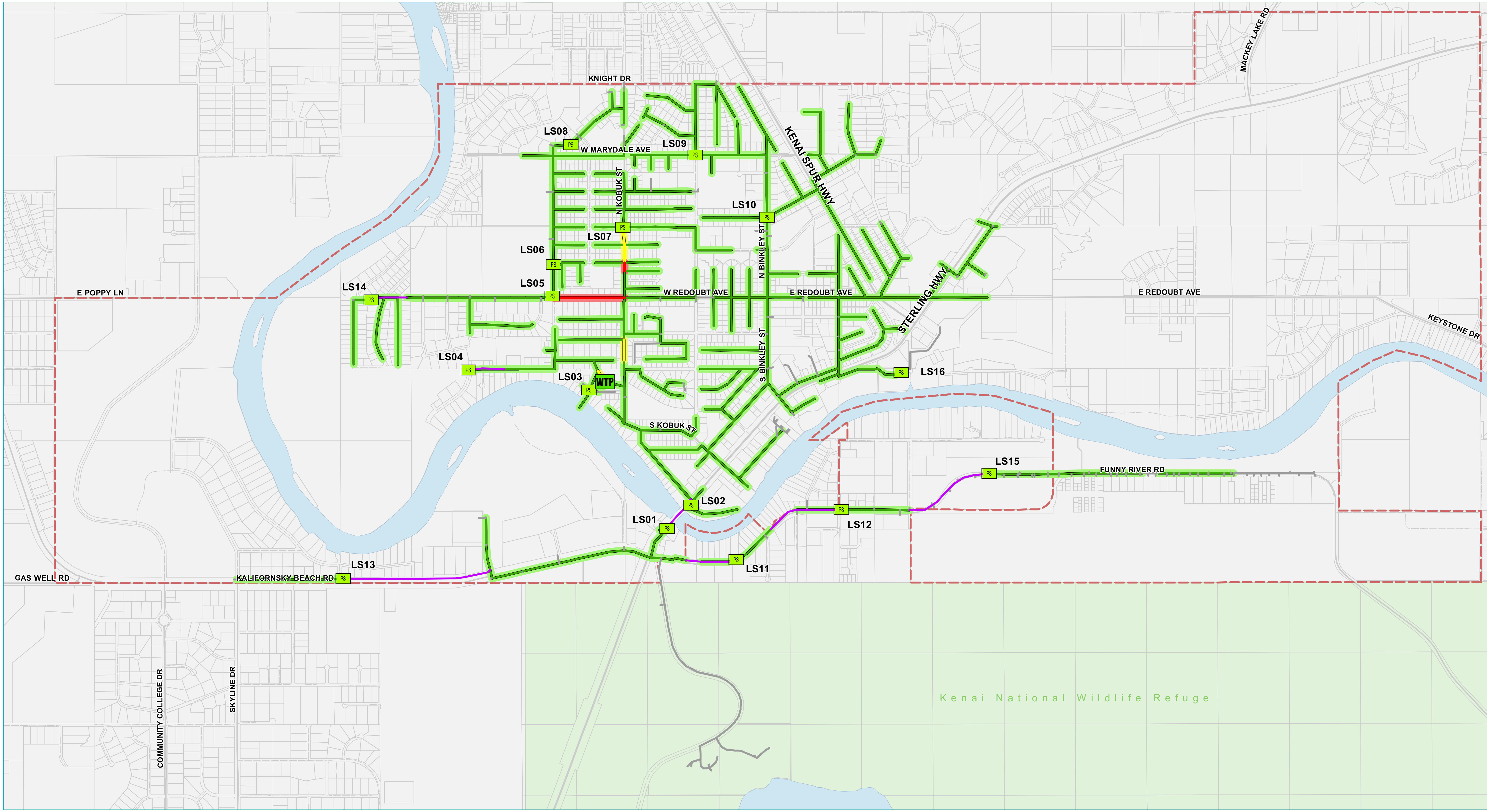
SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity

Average Day 2015 and 2035

Figure 1

HDR



Sewer Gravity Mains - Capacity Status 2015
Peak Hour depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1

Sewer Gravity Mains - Capacity Status 2035
Peak Hour depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

SOLDOTNA
City of Soldotna, Alaska

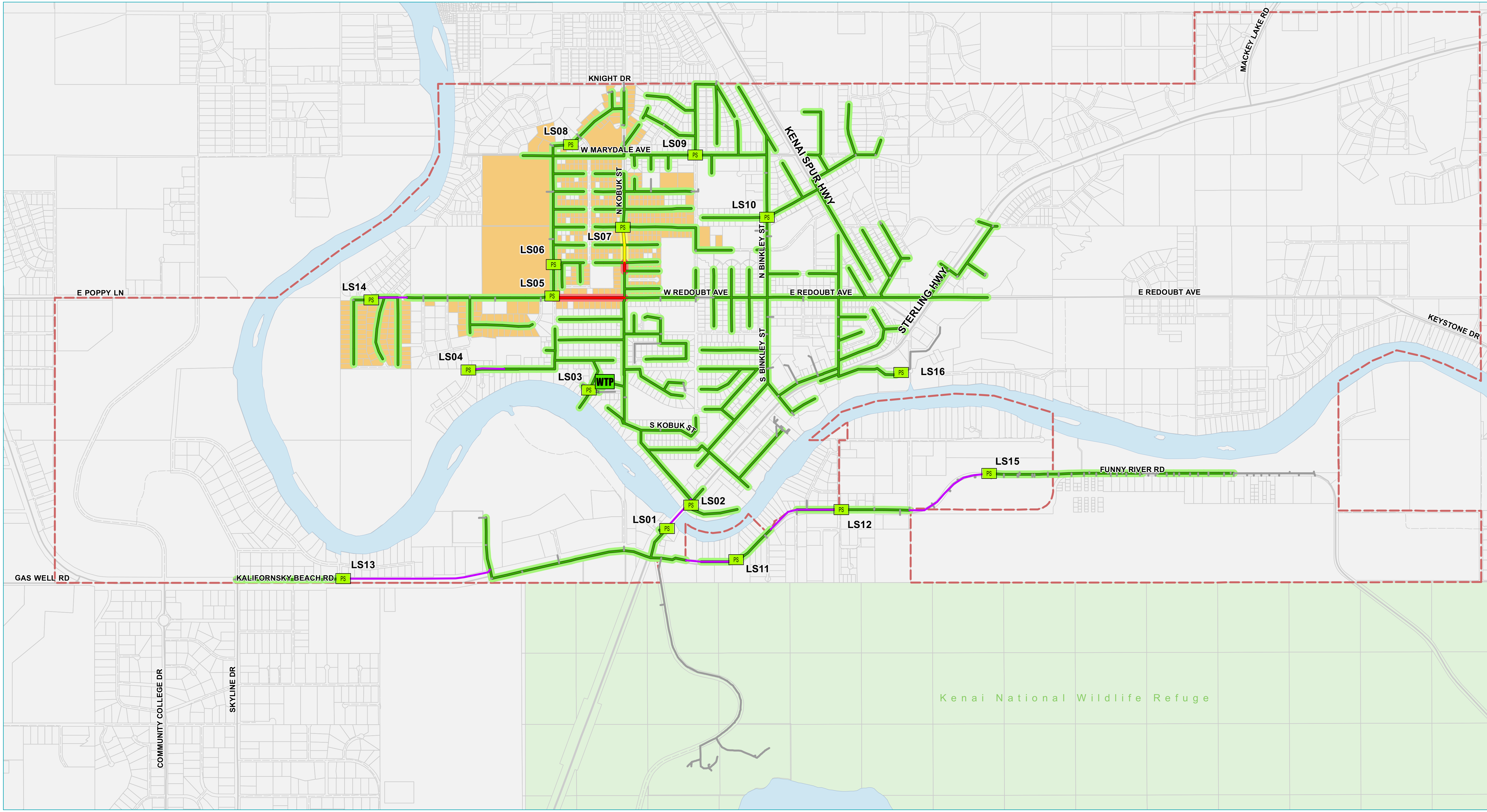
SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity

Peak Hour 2015 and 2035

Figure 2

HDR



SOLDOTNA
City of Soldotna, Alaska

Sewer Gravity Mains - Capacity Status 2015
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1

Sewer Gravity Mains - Capacity Status 2035
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main
- Contributing Parcels Upstream of Capacity Issues

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

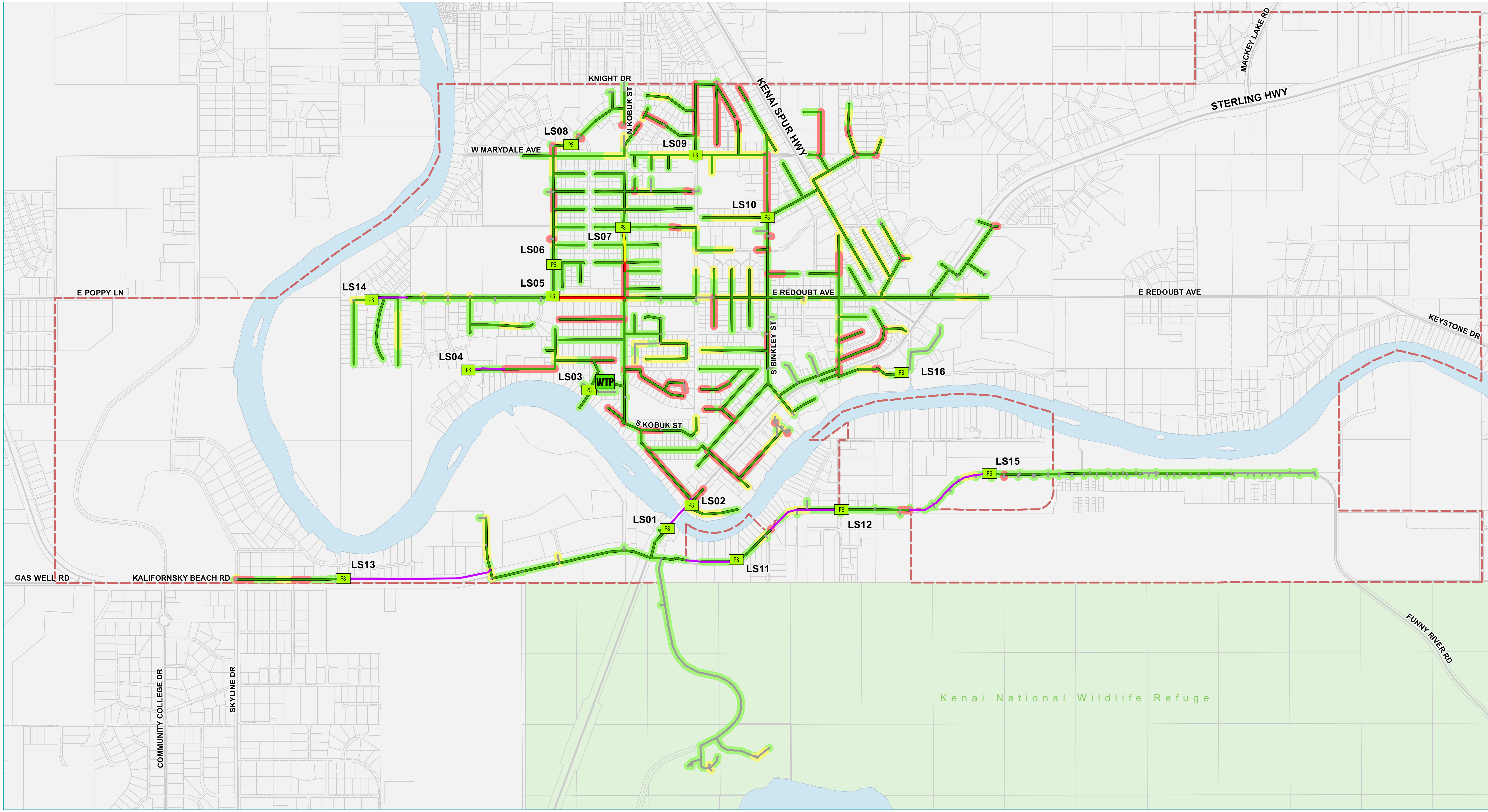
- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity
Contributing Parcels
Figure 3

HDR



Sewer Gravity Mains - Capacity Status 2015
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main

Pipe Slope

- Meets 2 ft/s full pipe flow velocity and 10 State Standard minimum slope table requirements.
- Meets 2 ft/s full pipe flow velocity requirement. Does not meet 10 State Standard minimum slope table requirement.
- Does not meet 2 ft/s full pipe flow velocity or 10 State Standard minimum slope table requirements

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

N

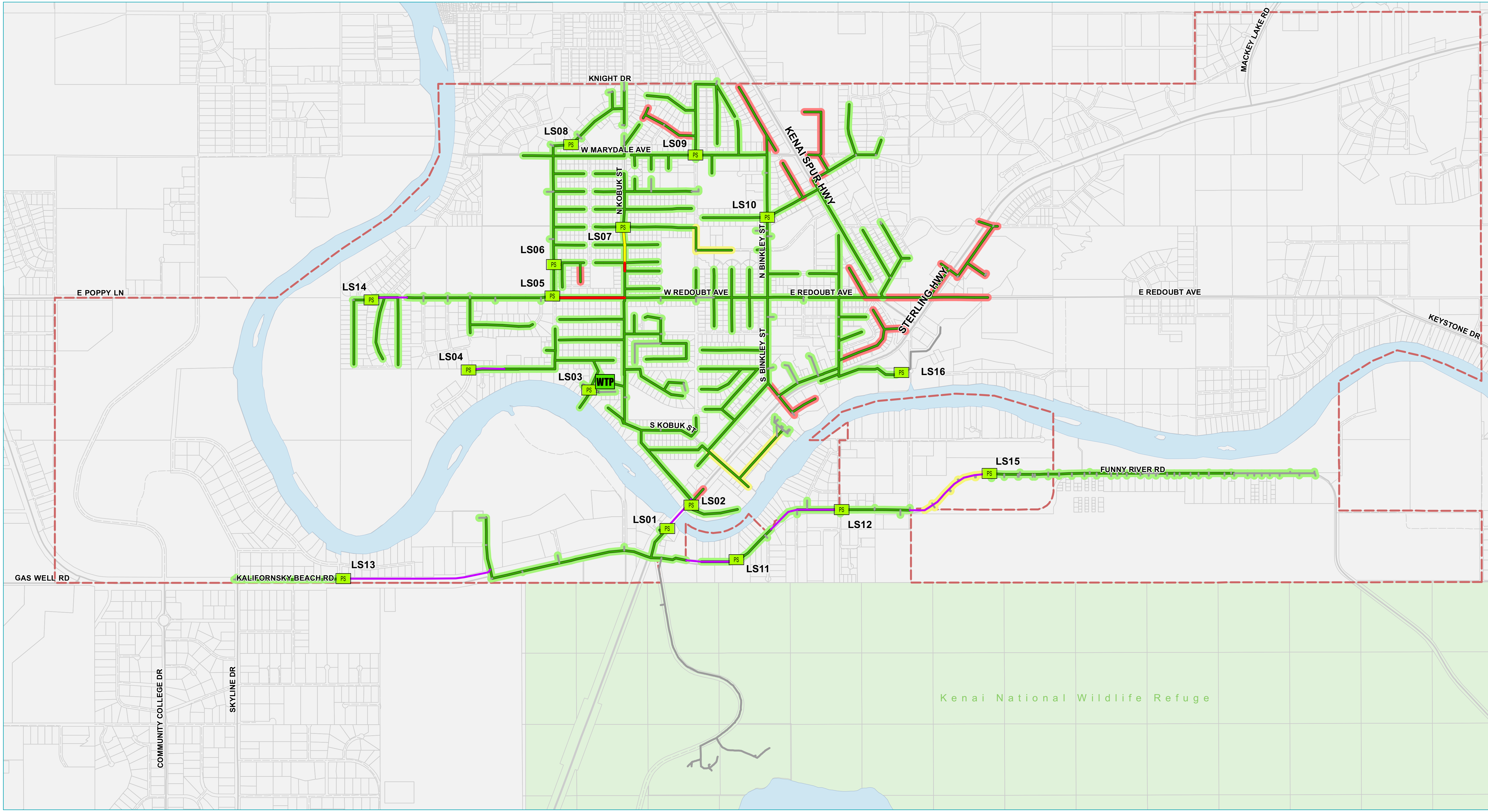
0 1,700
FEET

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity
Average Day 2015 and Pipe Slope
Figure 4

HDR



Sewer Gravity Mains - Capacity Status 2015
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main

Pipe Cleaning Frequency

- Every five years for maintenance
- Winter months to keep from freezing - January through April
- Every year to keep from freezing or plugging with grease

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

SOLDOTNA
City of Soldotna, Alaska

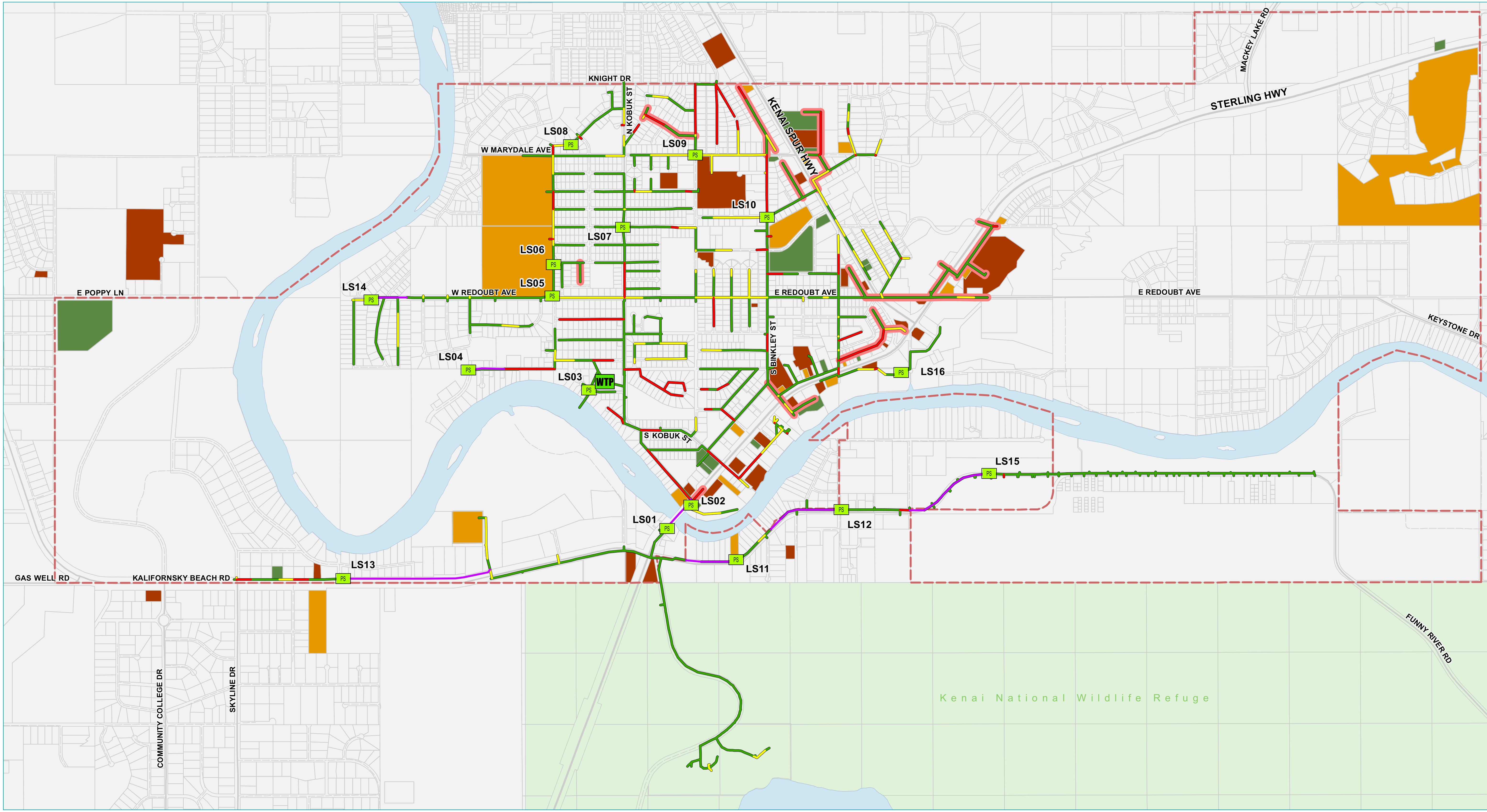
SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity

Average Day 2015 and Cleaning Frequency

Figure 5

HDR



SOLDOTNA
City of Soldotna, Alaska

Pipe Slope

- Meets 2 ft/s full pipe flow velocity and 10 State Standard minimum slope table requirements.
- Meets 2 ft/s full pipe flow velocity requirement. Does not meet 10 State Standard minimum slope table requirement.
- Does not meet 2 ft/s full pipe flow velocity or 10 State Standard minimum slope table requirements

Pipe Cleaning Frequency

- Every year to keep from freezing or plugging with grease
- Sewer Pressurized Main

Food Service Establishment Risk Level

- High
- Medium
- Low

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

SOLDOTNA UTILITY MASTER PLAN

Sewer Collection System

Pipe Slope, Cleaning Frequency, and Food Service Establishments

Figure 6

HDR

Appendix B

Water and Sewer Flow Analysis

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City of Soldotna Utility Department

2015 City of Soldotna Wastewater Master Plan

Sewer Pipe Capacity Analysis

Prepared for:

SOLDOTNA
City of Soldotna, Alaska

City of Soldotna
177 North Birch Street
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February 2016

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Table of Contents

Sewer Pipe Capacity Analysis

INTRODUCTION

Understanding the design and evaluation of pipe capacity is an important part of operating an effective and efficient wastewater collection system. As part of the 2015 City of Soldotna Wastewater Master Plan several issues associated with pipe capacity management were evaluated. The issues included:

- Pipe design criteria;
- Pipe capacity evaluation criteria;
- System peak sewer flow factors;
- System capacity and potential capacity issues; and
- Recommendations for capacity analysis and management.

These issues were analyzed in a technical memorandum which was reviewed with City of Soldotna Utility Department and Public Works staff. The completed memorandum is compiled in this document.

RECOMMENDATIONS

The preparation of the technical memorandum evaluating with sewer system capacity issues resulted in several recommendations for the City to consider implementing with respect to the sewer system. These recommendations are summarized below.

1. Consider adopting criteria to use for the design of new gravity sewer pipes.
2. Consider adopting specific criteria for use in evaluating the capacity of existing pipes.
3. Consider adopting the peak factor method to estimate rainfall derived I&I peak flow conditions for large pipes for use in capacity analysis.
4. Develop an asset management program for the sewer collection system.

MEMORANDUM ORGANIZATION

This memorandum contains the following sections:

Section 1 covers the development of design and capacity criteria for the pipe network.

Section 2 covers recommended peak factors for the larger pipes.

Section 3 presents the results of the sewer system capacity evaluation

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Section 1 – Design and Capacity Analysis Criteria for Gravity Sewer Pipes

1.0 INTRODUCTION

The City of Soldotna currently does not have published design or capacity analysis criteria for gravity sewer pipe. Pipe design appears to be based on the 10 States Standards design practices and the engineer's best judgment. The 10 States Standards design criteria are intended to be used for the design and installation of new pipes. The 10 States Standard Manual has other criteria for capacity assessment of existing gravity sewers.

To better understand plan for the capacity of sewer pipes, the City should consider adopting specific new pipe design criteria and specific assessment criteria for capacity analyses of existing gravity sewer pipes. Adopting different criteria for new and existing pipes will allow the City to maintain conservative design criteria for new installations while maximizing the useful capacity of existing system pipes.

Generally design criteria are selected to be conservative and to provide reserve capacity for unexpected future changes in the land use. Adopting system-wide design criteria will help ensure system expansion is systematic and uniform with adequate capacity for proposed and planned development.

The conservative nature of design criteria, when used for the system capacity assessment, may have unintended consequences and lead to unnecessary projects, projects that are implemented before they are needed, or not allowing proposed connections that could be served by the existing sewers. To avoid this situation the City should consider adopting Capacity Analysis Criteria (CAC). These are specific criteria used to evaluate the capacity of existing pipes and the areas based on the area they serve, estimated actual flows, and theoretical pipe capacity. CAC can help the city maximize the useful life of existing assets and plan for their timely replacement or upgrades.

This section outlines the need for design criteria and CAC, briefly discusses the components of both, and proposes possible criteria for the City's use. The section is organized as follows. The first section describes recommend design criteria for new gravity sewer pipes. The next part discusses different components of typical gravity sewers assessment criteria and outlines possible ways the City can define the CAC, followed by an overview of assessment and design criteria used by different jurisdictions to analyze gravity sewers. The final section proposes criteria for use by the City with the assumptions associated with the criteria and outlines some practical considerations when a hydraulic model is used to apply the criteria.

2.0 DESIGN CRITERIA

Currently, the City does not have established design criteria for the construction of new sewer main development. Not having adopted criteria means that the City has to review and approve the design criteria used by each project, increasing review times and the possibility that proposed project may not have the future capacity the City will need. To promote more uniform designs, better system integration, decrease staff workload, and speed the review and approval process, the City should consider adopting specific design criteria for new pipe built for connection to the City's sewer system.

To simplify design criteria selection, it is recommended that the City adopt the Anchorage Water and Wastewater Utility's (AWWU's) design criteria for new sewer pipe. This is contained in AWWU's Design and Construction Practices Manual (DCPM). The AWWU DCPM provides a consistent, conservative approach for estimated generated flows from future development and designing pipe diameter and slope. AWWU has used the DCPM over a long period of time with good results in a sewer system of similar age, design, and climatic conditions as Soldotna's system. AWWU continues to refine their DCPM, which the City can benefit from at no cost. Finally, the AWWU DCPM is understood and used by engineers, contractors, and suppliers in Alaskan industry, so its implementation will streamline the design and construction process of new development.

2.1 Criteria Description

Section 30 of the AWWU DCPM outlines requirements for the design and construction of wastewater facilities. Specifically section 30.020.01 provides recommendations for design flow of new development and sewer main slope. The AWWU DCPM estimates the flow volume per acre of future development based on the zoning and estimated density. The table uses a peaking factor of 2 to calculate future peak design flow from the calculated runoff per acre.

The DCPM also outlines a table of minimum slope and minimum number of homes at approximate design capacity (2/3 full) and a minimum velocity of 2 feet per second. This table, combined with the peak design flow estimation, is used to provide design criteria for both pipe size and slope. The table is derived from 10 States Standards.

Another criterion in the AWWU DCPM the City can consider is the minimum depth for pipes. The AWWU DCPM requires 5½ feet of cover for freezing protection without insulation.

2.2 Recommendations

It is recommended that the City use AWWU's DCPM requirements for the design of new sewer mains. The approach used by AWWU has proven effective of many years of implementation and should serve Soldotna's needs. Adopting the design criteria will have some consequences and some criteria modified for Soldotna's specific situation as described below.

Soldotna sits on a generally level, gravel plain with deep groundwater levels whereas Anchorage generally has more loping ground, fine grained soils, and shallow groundwater. Anchorage's physical situation means that steeper pipe slopes are possible and pipes are buried below groundwater or in wet soil conditions which inhibit deep frost penetration. Because of Soldotna's generally deeper groundwater and drier, more porous soils sewer pipes will need deeper minimum burial to protect them from freezing unless insulation is used.

Future development design flow calculations from the AWWU DCPM are based on data collected in past decades. The increasing code requirements for low flow fixtures have resulted in a decreasing per capita sewer output in many jurisdictions. Future flow estimation using the AWWU DCPM may result in some oversized pipes. However, sewer flow data for Soldotna does not indicate that per capita flow is decreasing. Therefore the reserve capacity inherent in using the AWWU DCPM method for flow estimation is a benefit that outweighs the possibility of oversizing the pipe.

The pipe slope table from the AWWU DCPM provides minimum slopes that are slightly steeper than a full pipe flowing at 2 feet per second, the other slope criteria identified in 10 States Standards. This conservative approach (steeper pipe slope resulting in attaining scour velocity more frequently) can result more lift stations being required if the system expands beyond the edges of the current pipe network. The pipe slope requirements in the table will result in scouring flows earlier in pipe life, which will result in less frequent cleaning and a lower SSO risk. Implementing a consistent approach to sewer main design with the AWWU DCPM recommendations will result in conservative design that provides capacity for future growth.

The model analysis of the Soldotna shows that pump station discharges can combine together to create higher than anticipated flows. The model result was verified by Soldotna staff field observations. The AWWU DCPM does contain specific criteria for the analysis of numerous pump stations which concentrate flows when running simultaneously. Where a lift stations are needed, the City should require an analysis of how the pump station discharge effects gravity sewer capacity downstream of the pump station and whether the discharge could combine with other system pump statin discharges and cause over capacity pipes. The analysis should be added to design criteria adopted by the City.

The AWWU DCPM sections recommended for adoption, with the suggested modifications, are attached in Appendix A.

3.0 CAPACITY ANALYSIS CRITERIA

Pipe assessment criteria, also called Capacity Analysis Criteria (CAC), are a set of quantitative measures used to define the effectiveness and the ability of a constructed and operating gravity collection system and its individual components to covey sewer flows. CAC are sometimes confused with the pipe design criteria and many utilities do not differentiate between the two criteria. Both criteria define the conditions in a system to be examined and specify the required system response. However, design criteria are used for sizing new system components and typically include larger safety margins than what is necessary for CAC. Consequently, an existing system component that does not fully meet a design criterion might still meet the desired Capacity Analysis Criteria. For example, a pipe that is designed to flow 2/3 full could still provide the desired service even if it is flowing 80% full. Thus, using the design criteria for system evaluation could produce to overly conservative results that could lead to:

- Falsely identifying system components as below the desired capacity even if they can meet a desired Capacity Analysis Criteria and meet required level of service,
- Constructing unnecessary projects to increase such pipe capacity,
- Implementing too aggressive capacity improvement project phasing, and
- Limiting system growth due to the overly conservative remaining capacity estimates.

To be complete, CAC must define the critical system driving forces and system conditions to be examined and the desired system performance. For a gravity sewer collection system that is influenced by rainfall derived infiltration and inflow (RDII), CAC might be somewhat difficult to define. CAC for such system must include (1) critical storm, (2) storm runoff, (3) system conditions and (4) the desired evaluation criteria. Each of these components is examined in the following sections with pros and cons of the traditional approach to the definition of CAC.

3.1 Critical Storm

In a system that has significant RDII the primary defining force of the peak system flows will be the critical storm. The key parameter of the critical storm is (1) the rainfall intensity. However, other parameters will also influence the system response to the storm, including: (2) storm duration, (3) storm temporal distribution, (4) storm spatial distribution and storm/wind direction. When analyzing the future system behavior, (5) climate change effects might also need to be examined, especially for the long-term forecasts.

3.1.1 Rainfall Intensity

It is typical for collection system planning to define CAC rainfall intensity in terms of the storm return interval that should be conveyed through the system while satisfying the evaluation criteria. Rainfall intensity can be defined directly in inches of total rainfall depth or as system response using an average dry weather flow (DWF) peaking factor (PF).

3.1.2 Storm Duration

Traditional approaches to CAC define a single storm duration to be evaluated for the whole system, often a 6-hour, 12-hour, 24-hour or 48-hour storm. The reason for the selection of 6-, 12-, 24, or 48-hour storm durations is based on the fact that these are the only durations with standard rainfall distributions available (US Soil Conservation Service, U.S. Department of Agriculture, Technical Release 55 (TR-55): Urban Hydrology for Small Watersheds, June 1986).

A problem with this approach is that it assumes that all parts of the system will experience the critical conditions for the same storm duration. In reality, this is rarely the case. Smaller, upstream system components are often more affected by short-duration, high-intensity storms while the larger, downstream components might be more affected by longer-duration, high-volume storms. This problem is further aggravated because the temporal distribution of shorter storms can be significantly different from the temporal distribution of the larger storms. 6-hour storm duration, the shortest storm duration with an available standard hyetograph, might be too long to capture the most stressful conditions for upstream smaller, system components.

There are several alternative approaches to remedy storm duration problem. One possibility is to use a long historic record of observed rainfalls for the system analysis instead of a single critical storm. However, this approach can be extremely computationally intensive and should be used only if necessary. Another approach is to define a conservative hyetograph that would incorporate the peak intensity storms for desired shorter-duration storms within the longer-duration storm. Finally, an adjustable peaking factor (PF) approach can allow a higher RDII repose in upstream portion of the system and lower in downstream portions of the system.

3.1.3 Rainfall Temporal Distribution

SCS TR-55 defines only four standard rainfall distributions for the US for 6-hour, 12-hour, 24-hour and 48-hour storms. TR-55 further assumes that rainfall for the whole US can be described by four characteristic storm types, representative of the regions given in Figure 1 (Type I, IA, II and III). The characteristic storm hyetograph for the City based on TR-55 map would be Type I hyetograph.

Figure 1 SCS Storm Types (reproduced from TR-55)

It is typical to assume that single rainfall distribution or a combination of a few rainfall distributions will produce the critical conditions in all system components. Since PF method is a steady state method, it does not need to define the temporal distribution of the assessment storm.

3.1.4 Rainfall Spatial Distribution

Rainfalls with different spatial distribution can produce different system response for the same rainfall temporal distribution. For example, a storm that is moving from upstream to downstream of the system might produce significantly higher peak flows that the same storm moving from downstream to upstream, due to the phasing of peak flows from system branches.

It is typical for collection system assessment to ignore the issue of the temporal rainfall distribution when defining CAC because it is not trivial to define the critical or characteristic storm spatial distribution. CAC typically assumes a uniform rainfall across the whole system.

CAC also often ignores the reduction in the point rainfall intensity due to the size of the catchment basin. Rainfall intensities are measured at specific points and the data derived for such measurements are representative of point-rainfall intensity. The likelihood of having a rainfall exceeding certain depth over an area will decrease as the area increases. Thus, assuming constant rainfall intensity over the whole service area is a conservative assumption.

3.1.5 Climate Change

Even when historical rainfall record of sufficient temporal and spatial accuracy is available to define the critical storm, it cannot be always assumed that the past record of rainfall is the best predictor of the future storms. For systems that need to ensure compliance for long-term forecasts (20-50 years and larger), the effects of the client change on rainfall intensity, temporal and spatial distribution should be examined.

For the short-horizon system planning (<10-20 years), as in the case for the City's system planning, with a representative historic rainfall information CAC can ignore the climate change effects on the rainfall forecasts. Climate change effects on the future weather and system boundary conditions should however be reexamined in each subsequent planning cycle.

3.2 Runoff Parameters

Once the critical storm is defined, system analysis needs to evaluate how much of the rainfall will be captured by the system. This is somewhat less important for sanitary systems that were not designed to capture the rainfall runoff. Also, the amount of runoff captured by the sanitary sewer system does not increase in proportional to increasing storm intensity. This is because runoff capture is often limited by the inlet capacity and capture of longer duration or greater duration rainfall events becomes limited by system inlet capacity. This is especially true for sanitary sewer systems, like the City's, that are not combined sewers. These systems are specifically designed to restrict rainfall infiltration and restrict its capture.

Rainfall-runoff response is defined by two sets of parameters, constant parameters that do not change between the storms and time-varying parameters that might change between the storms. Constant parameters include the contributing catchment area, percent of catchment contributing direct runoff, runoff coefficients, catchment time of concentration, etc. These parameters are defined by the system and do not need to be specified in the CAC. CAC might need to define the variable rainfall-runoff parameters, including: (1) antecedent conditions, (2) snow and ice cover, (3) groundwater levels and (4) inlet conditions. Finally, for long-term forecasts (5) the changes of the constant rainfall-runoff parameters should also be evaluated.

For evaluations that use PF methods to define RDII, rainfall and runoff parameters will be combined in the definition of the peaking factor.

3.2.1 Antecedent Conditions

Depending on the amount of moisture in the ground and the amount of the water in ponds and surface depressions before a storm, the runoff response can be different for two otherwise identical storms. The difference will be in the amount of the rainfall that will be stored before the runoff begins. Traditional approaches to CAC typically assume the worst-case conditions. If there is another storm prior to the critical storm, which is large and close enough to completely saturate the catchment and eliminate the initial rainfall losses, than the initial losses will be negligible for the critical storm and can be ignored.

3.2.2 Snow and Ice Cover

A storm that falls on frozen ground or ice can contribute significantly more runoff than the same storm that would fall on ground that is not covered. In worst-case scenario, runoff coefficient for a storm that falls on frozen/ice covered catchment can be 100%. Thus, a small winter storm can produce higher runoff than a larger summer storm. However, for systems that are not designed to capture direct rainfall runoff, such as the City's system, snow and ice cover typically reduce the amount of RDII. The traditional approach to the definition of CAC for sanitary sewer systems typically ignore the issue of rainfall falling on ice or ice covered ground. However, the

City could examine historic flow records to determine if winter rainfalls that fall on frozen ground or ice produce the critical system response.

3.2.3 Snow Breakup

Snowmelt is typically not as critical for producing sanitary sewer flows in the City's system. However, the City should consider evaluating peak flow records at the plant to evaluate the influence of the snowmelt to peak system flows.

3.2.4 Groundwater Level

Groundwater level can contribute to both dry weather flow and RDII. Traditional CAC defines the critical base flow and includes the groundwater contribution in the definition of rainfall-runoff response.

3.2.5 Catchment Changes

Catchment parameters that do not change between individual storms might change over longer time. It is general trend that urban catchments have increasing runoff coefficient and percent of impervious area with time. However, the implementation of infiltration and inflow (I&I) reduction schemes, green infrastructure, etc. could be changing and possibly reversing this trend. For systems that need to ensure compliance for long-term forecasts, the effects of catchment changes on rainfall-runoff response should be examined.

For sanitary systems, long-term trends are typically balanced between I&I increase due to pipe deterioration and reduction due to I&I management practices. The City should include appropriate I&I values in the model for existing and future conditions but does not necessary need to include I&I changes in the CAC.

3.3 System Conditions

The response of the system to the critical storm, given the appropriate rainfall-runoff parameters, will also depend on the system initial and boundary conditions: (1) pipe conditions, (2) system redundancy, (3) boundary conditions and (4) RDII and DWF peak timing.

3.3.1 Pipe Conditions

Pipe capacity during the critical storm might be limited by pipe conditions, such as the level of sediment in the pipe, root intrusion or other pipe defects. CAC used for system capacity assessment typically assumes clean pipes in good condition without significant deterioration, breaks or deformations. This way the system evaluation will identify only capacity deficiencies due to undersized pipes and not operation and management (O&M) problems.

3.3.2 System Redundancy

For the analysis of critical system conditions one should consider a failure of a system component during the critical storm. The traditional approach to the definition of CAC assumes the full redundancy of lift stations. This maximizes flow in downstream pipes during the peak event being analyzed.

3.3.3 Boundary Conditions

Boundary conditions, such as the water level of the receiving water bodies and storage/capacity of the treatment plants, can limit the capacity of upstream system components. CAC typically assumes the worst-case scenario for the boundary conditions such as the coincidence of the critical storm with river flood conditions. For the Kenai River, a flood in the river does not significantly impact the discharge capacity of the treatment plant.

3.3.4 Storm and System Peak Flow Timing

For a sanitary system designed to convey dry weather flows (DWF), such as the City's system, the critical storm can produce a larger system response if it coincides with the peak DWF. CAC typically assumes the worst-case scenario in which the peak storm response coincides with the peak DWF.

3.4 Evaluation Criteria

Once the system response to the critical storm is defined, the evaluation criteria are used to examine if the system can provide the desired Capacity Analysis Criteria. The evaluation criteria can include (1) flow depth limits, (2) and overflow and bypass limits, (3) water quality limits.

3.4.1 Flow Depth Limits

CAC can define evaluation criteria as the maximum depth of flow in pipes and manholes. Flow depth limit in pipes is typically expressed as d/D ratio (the depth of flow in a pipe over the pipe diameter) or as the surcharge height over the pipe crown. The other way to limit depth of flow in a pipe is to limit pipe flow to open channel flow and to prevent pipe surcharging (d/D <1). This approach acknowledges that the water surface level in manholes upstream from surcharged pipes needs to increase significantly to add more flow to the downstream, limiting pipe.

Flow depth limit in manholes is typically defined as the minimum difference between the manhole rim and the maximum water level in the manhole. Minimum freeboard in a manhole can sometimes limit the flow depth in a pipe if the pipe cover is smaller than the needed freeboard.

An important factor to consider when defining depth criteria is that the criteria do not need to be the same for all pipes in the system. Smaller pipes that can experience higher flow variably can have more stringent CAC (lower d/D) while larger pipes that experience less flow variability can allow higher flow depths.

3.4.2 Overflow and Bypass Limits

The number, duration, frequency, volume and total system-wide volume limit on overflows and bypasses can be imposed in CAC. These criteria are applicable for combined and storm systems that are designed to carry both sanitary sewage and RDII. For separate sanitary systems, such as the City's, the overflow and bypass limits are typically not used. It is assumed that the City's system will provide the full service with no overflows.

3.4.3 Water Quality Limits

CAC can define the maximum water quality impacts on the receiving water bodies or maximum water quality loading for the discharged flow. This approach is typically not used for sanitary sewer systems. The City must meet its discharge limits at each treatment plant outfall during all plant flow conditions.

3.5 Other Considerations

CAC assume that the data used for the evaluation, including the hydraulic model, is representative of the system's current and future conditions and that it is capable of predicting the systems response to the critical storm. Engineering judgment should be used to balance the uncertainties about system data, conservativeness of the hydraulic model, and the strength of CAC. CAC has to be defined in such a way that it provides a definite answer regarding an individual component's capacity. Conservative model assumptions can be used to balance missing or uncertain system information. Where capacity evaluation results using the system model and CAC appear overly conservative, additional data should be collected at specific locations where the uncertainty exists to improve and recalibrate the model. The recalibrated model would then be used to evaluate the capacity against the CAC.

4.0 RECOMMENDATIONS FOR THE CITY OF SOLDOTNA CAC

As discussed above, three interdependent components need to be considered when defining CAC. The conservativeness of each component must be balanced with the other components as well as the level of accuracy of system data, conservativeness of the hydraulic model used in system assessment, and the operators' understanding of how the system responds to DWF and RDII. Better understanding of the system can allow for less stringent criteria. For this reason, engineering judgment and system knowledge should be used to evaluate each case when the hydraulic model identifies a pipe as failing when evaluated against the CAC.

Since CAC depends on each of the components, having higher standards for one component can allow less stringent standards for other components. For example, if the system is evaluated for a relatively large critical storm, with a high return interval, then the depth criteria for the pipes can be relatively high. Following are proposed CAC to be used for the City's system assessment.

4.1 Critical Storm

It is recommended that the City modify the approach outlined the 10 States Standard by using peaking factor methodology to define RDII. It should be noted that this methodology is conservative and it should be supplemented with real system data whenever it is available. The peaking factor methodology is recommended because system data – storm frequency and response – are not available and represent a considerable financial investment to collect for a small system. Using peak factors can provide the analysis confidence needed to understand and operate the Soldotna system effectively.

The 10 States Standards are designed for states in the middle of the continental United States with rain storms typically of high intensity and low duration, while storms in Southcentral Alaska are generally low intensity and long duration. The peaking factor recommended in the standards should be modified to reflect this.

4.2 System Response

It is recommended that the City assumes the worse-case conditions for the system response modeling with fully saturated anteceded moisture storage at the beginning of the evaluation. Similarly, ground water levels should be assumed to be high and contributing typical high DFW infiltration and inflow (I&I). Additional analysis could determine if snow and ice cover and snowmelt should be considered for the critical system response conditions.

4.3 System Conditions

It is recommended that the City simulate normal operating conditions for the system assessment that assume clean pipes or acceptable level of sediment in pipes, reasonable pipe condition, and full redundancy at lift stations.

It is recommended that RDII peak response be assumed to coincide with DWF peak response because the timing of the critical rainfall during the day cannot be predicted. This is implicitly built into the PF approach. However, when analyzing observed system data to determine more accurate PF, the adjustments should be made to account for coincidence of DWF and RDII peaks.

DWF used for system assessment should include all expected flows for the planning horizon examined, including both existing flows and all proposed flows. System analysis should also assume all pump stations are operating simultaneously in order to determine if simultaneous flows can combine and cause capacity issues.

DWF for future horizons should include future system deterioration or I&I reduction efforts to represent future RDII.

4.4 Evaluation Criteria

It is proposed that the City use full pipe flow (d/D = 1), no surcharging, as the assessment criteria for existing pipe capacity.

Where capacity analysis identifies pipes may be flowing full, it is proposed that the City selects 5 feet freeboard at manholes to define priority in monitoring sewer flows at potentially capacity issue pipes. Manholes with less than 5 feet of freeboard could limit the flow depth in pipes adjacent to relatively shallow manholes. These manholes have a greater potential of overflow under surcharge conditions. It is not recommended the City operate the sewage collection system in peak flow conditions at greater than full pipe flow.

5.0 CONSIDERATIONS WHEN USING CAC

The intent of adopting above-listed capacity analysis criteria is to help the City maximize the use of existing infrastructure, eliminate unnecessary capacity increase projects, support future development, and minimize the cost to customers. To be consistent with this recommendation, any capacity deficiencies identified by the model using these criteria should be carefully examined and field verified. In some instances, surcharged flow in pipes might be acceptable. Large pipes that are burred relatively deep can allow infrequent and short duration surcharged flow on case-by-case bases.

Field investigations must confirm model predicted capacity constraints before a project to eliminate the constraint is executed. Additional flow monitoring near the capacity constraint can provide the data to calibrate and validate the model in this area. This could potentially reduce the model conservativeness and would help to confirm the need for the pipe replacement. Improving the model in the area of the project will also provide a better tool identifying pipes needing replacement and the replacement pipe design.

When CAC are used to evaluate the system capacity to receive additional flows and unused capacity is identified, the City has several options on how to allocate the remaining or excess capacity to undeveloped, redeveloped, annexed areas in the potential sewer basin. Allocation methods include:

- first come, first served,
- reserving capacity for a specific use or project (such as within the City limits versus outside),
- per parcel (split available capacity proportion to parcel size),
- storage and off peak discharges, (this works only for users that do preprocessing of sewage), and
- basin extensions, annexations, and additions.

Implementing any of these is a policy decision by the City and should be done on a case by case basis.

6.0 SUMMARY

It is recommended that the City differentiate between the new pipe design criteria and the existing system evaluation criteria, Capacity Analysis Criteria (CAC).

For design criteria, it is proposed that the City adopt AWWU DCPM, as modified, design criteria of 2/3 full pipe flowing at 2 feet per second for new gravity sewers as outlined in Section 2 of this memoranda.

For CAC is it proposed to modify the use of 10 State Standards' methodology for the critical storm definition using peak factors and select an appropriate for the Soldotna area in order to simulate RDII response. Selection of a peak factor is described in the next section.

For assessment of existing pipe capacity it is proposed to use full pipe flow (d/D=1), no surcharging, when assessing the residual capacity of the gravity pipe system. The criteria would mean that an existing pipe flowing at full during the peak RDII induced flow during peak DWF, either current or future whichever is greater, would be considered to have adequate capacity. If it is flowing less than full under these conditions, the pipe would be defined as having reserve capacity. These recommendations are summarized in Table 1.

Table 1. Recommended City of Soldotna Gravity Flow Pipe Design and Capacity Analysis Criteria

Application	Method	Evaluation Criteria Pipe (d/D)
Design	Flow Generation by Land Use Areas	0.66
Capacity Analysis Criteria	Regional Peaking Factors	1.00

Sewer modeling is based on numerical analysis of pipe data and estimated flows. The City's sewer model has many assumptions with most model data not being field verified, as is the industry standard for such models. Therefore pipes identified through model analysis as flowing near or greater than full during the peak flow conditions should become candidates for field monitoring, not immediate replacement. This is because many of the assumptions in the model are conservative and may be overestimating flow or underestimating capacity. Gathering field measurements of flow conditions in these pipes is required to confirm model estimations and determine is the pipes warrant replacement with larger pipes.

Section 2 – Peaking Factor Analysis for Wastewater Collection System

1.0 INTRODUCTION

This section describes the process to estimate an appropriate peaking factor (PF) for the City's collection system assessment and recommendations for its use in the City's hydraulic model. The resulting peaking factors are intended to be used with the City's current steady-state hydraulic model to identify capacity constraints of the existing system.

The PF evaluation process included data from several different sources which include the peaking factor analysis performed for the AWWU 2014 Wastewater Master Plan, the 10 States Standards Manual's peaking factor estimation, and flow data from the Soldotna Wastewater Treatment Plant.

A more accurate peaking factor could be determined with the installation of flow meters at lift and pump stations and in large diameter gravity trunks. The City should consider installing flow meters in the future to increase the accuracy of the peaking factor analysis.

2.0 PEAKING FACTOR FROM AWWU WASTEWATER MASTER PLAN

AWWU used twelve flow meter stations to collect 15-minute interval flow data in its collection system in 2012. This data was combined to form hourly flow data and used to determine basin and system-wide peaking factors for the AWWU Anchorage system. The hourly data were also used to determine the average dry weather flow by averaging flow over a summer seven day dry period. This average dry weather flow was then used as a basis for determining the peaking factor.

Two periods were examined to evaluate the peaking factor for each metering basin. The first period was the snow breakup period that occurred in March-April. The winter of 2011-2012 had the highest recorded snowfall in Anchorage. The total snowfall was just over twice the average snowfall producing double the normal spring melt snowpack. Melting proceeded normally with temperatures warming normally in late March through April. The melt period was long and produced large runoff because of the snowpack.

The peak flows observed during the breakup time frame were compared with those generated by two significant rain events that occurred in September 2012. The September rainfall events were large for Anchorage. They produced significant floods in the three creeks that flow through Anchorage. Each creek has a major trunk sewer flowing near the creek within the flood plain. As the rainfall events produced large floods in the creeks, it is anticipated that similar inflow event occurred in the sanitary sewer, as seen in the system flow monitoring and treatment plant flows.

The PF for peak hourly flow at each location for each type of event was calculated by dividing the maximum observed hourly flow by the average dry weather flow:

$$PF = \frac{Max\ Hourly\ Flow}{Average\ Dry\ Weather\ Flow}$$

Overall peaking factors ranged from a low of 1.7 to a high of 3.0, depending on the basin. Peak flows in the system were mostly driven by rainfall. Analysis of available flow data has shown that peaking factors, developed for one hour averaged peaks, vary between about 2.0 and 3.0 across the AWWU's system.

The peaking analysis developed for AWWU is applicable to the City of Soldotna area as both systems have many similarities. Both systems are of similar age – large portions were constructed in the early 1970's. The population density of both cities in areas served by the sewer system is similar therefore the per acre sewer flow should be equivalent. Both cities also have similar climates with equivalent precipitation and temperature averages. The burial depths of both systems are similar combined with similar groundwater elevations result in equivalent groundwater infiltration levels.

3.0 10 STATES STANDARD PEAKING FACTOR ESTIMATION

The 10 States Standards design manual defines peaking factor according to the equation:

$$\frac{Q_{peak\ hourly}}{Q_{Design\ Average}} = \frac{18+\sqrt{P}}{4+\sqrt{P}} \text{ with P = population in thousands.}$$

The Soldotna water distribution system serves approximately 3500 residents which equates to a peaking factor of 3.4.

The 10 States Standard design criteria were originally produced for ten states in the central United States. All ten states fall within SCS Type II rainfall distribution compared to a Type I distribution seen in Alaska. The type of storms seen in Type II distribution are shorter duration with more intense rainfall, where Type I distribution consists of longer duration lower intensity rainfall. Thus the peaking factor determined from Type II data would be an overly conservative estimate for the City of Soldotna area. While the 10 State Standard is provides an industry standard, actual data gathered from the area or an area with similar climatic storms would give a more accurate analysis.

4.0 SEPTEMBER 2012 PEAK RAIN EVENT

On September 19th, 2012 the City saw a high intensity rain event which caused a distinct spike in flow to the WWTP. The same storm was also observed in Anchorage, this storm even was used to calibrate the peaking factor determined in the 2014 AWWU Wastewater Master Plan. The flow data to the WWTP showed approximately a doubling of daily flow, indicating a minimum peaking factor of two for the system over this storm.

5.0 SEPTEMBER 2015 PEAK RAIN EVENT

On September 16th, 2015 the City saw another high intensity rain event which caused a distinct spike in flow to the WWTP. The flow data to the WWTP showed an approximately peak hour sustained flow of 1,800 gpm. Soldotna summer average dry weather flow is approximately 450 gpm, indicating a peaking factor of four for the system over this storm. This peak flow and calculated peak factor, however, are heavily influenced by combined pump station discharge flows and not representative of what the peak factor in the system would be if no pump stations were present.

6.0 RECOMMENDATIONS

By combining the knowledge gained from the AWWU system monitoring, an analysis of the 10 States Standard design manual, and the Soldotna September 2012 and 2015 peak rain events, a PF can be recommended. It is recommended that a universal, PF of 2.5 be used for system analysis using the steady-state model. If model results indicate problems in areas where the PF is known to be much significantly lower than 2.5, or downstream from such areas, then the model could be refined to use the location specific PFs estimated in this analysis.

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Section 3 – Wastewater Collection System Capacity Evaluation

1.0 INTRODUCTION

The City of Soldotna Utility Department sewage collection system operates under a range of flow conditions from small flows during the wee hours of the morning to high flows during major precipitation events. The conveyance system must have adequate capacity for this range of flow as well as for increasing flows as population grows and the system expands.

This section discusses the methods used to analyze potential sewage conveyance capacity and identify conveyance deficiencies in the City's system. Based on the results of the analysis, recommendations are made for data gathering, system monitoring, flow analysis, and pipe upgrades to address potential capacity issues for 2015 and 2035 peak hour flow conditions.

2.0 CAPACITY ANALYSIS METHODOLOGY

Analysis of the sewer pipe was done using the sewer system model developed by HDR modeling staff. The sewer collection system was modeled using the InfoSewer modeling software developed by Innovyze. InfoSewer integrates advanced hydraulic and hydrologic modeling functionality in a GIS-based program used for planning, design, analysis, and expansion of sanitary, storm and combined sewer collection systems. InfoSewer performs comprehensive hydraulic calculations of steady-state analysis using various peaking factors.

Sewer loads in the model are parcel based. Each parcel with sewer service was assigned an estimated wastewater load based on the zoning, water use (derived for a related water system model), and use of the parcel. Corrections were made for properties with higher than average water usage (e.g. hospitals, high density trailer parks). Each parcel was then assigned to a sewer manhole or cleanout. When parcels were located between manholes, the upstream manhole or cleanout was chosen.

The InfoSewer model accumulates the load at each node, calculates flow depth and velocity for the pipe downstream of each loaded node and then sums the loads at downstream nodes before starting the calculation process again for the next downstream pipe.

Pump stations were modeled in the pump discharge curves and force main hydraulic considerations.

The system model evaluated only a steady state flow condition. Under this condition flow attenuation from storage was not considered. Pump stations were assumed to be continuously operating creation the maximum downstream flow conditions at the discharge manhole. Steady state flow is a conservative assumption and is used to estimate maximum flows in the pipe for the assigned load condition.

The sewer model was loaded to represent a summer average dry weather day weather (average day) conditions and set to model steady state flow conditions. This model was used to represent the base condition in 2015 and is referred to as the average day model in this section. The total average dry weather day wastewater load is 0.7 mgd.

The capacity analysis evaluated current and future potential peak-hour wet-weather flow conditions in the collection system. This was done to compare the pipe capacity criteria that was developed in the previous section of the memorandum with the potential flows and modelled pipe capacity. The analysis started by evaluating the current, 2015, average day condition using the average dry weather day model.

For the analysis of system capacity, the average dry weather day model was used to develop the 2015 average day flow conditions and determine whether the model reported any pipe capacity issues under that condition. The average day model used steady state model runs, existing 2015 average day model loading, and all lift and pump stations operating. While the probability of all the lift and pump stations operating simultaneously under this condition is small, it represents the worst case scenario. This was done to observe how pump discharge combined with estimated pipe flows contributes to capacity issues. The steady state model with average day loading was used to evaluate a single flow condition in the pipe system. This model is considered the base condition and has the peak hour factors multiplied to this base condition to estimate peak hour wet weather flows.

The model was also run with the pumps off to determine if there was gravity flow driven issues. No pipes in the model were identified as flowing above 30% full during peak wet weather conditions. Any sewer capacity issues would arise from a combination of gravity flows and pump and lift station flows rather than solely gravity flow.

To evaluate potential 2015 peak flow capacity the average day model was modified with a global peak factor of 2.5 was applied to all loads. Again, the model evaluates the system by considering all pump stations are simultaneously discharging. The 2015 modelled flows at the treatment plant were compared to 2007 to 2014 maximum month average and 2015 estimated peak flows[1] reported at the WWTF. These are presented in Table 2.

Table 2. Comparison of Reported and Modeled WWTF Flows

Reported 2014 Maximum Month ADWF (mgd)	Model ADWF Pumps off (mgd)	Model ADWF Pumps On (mgd)	Reported 2015 Peak Flow (mgd)	Model Peak Hour Flow (mgd)
0.650	0.70	3.81	3.16	3.87

3.0 FUTURE FLOW ESTIMATION

Pipe capacity issues were evaluated for the end of the planning period, 2035. It was assumed that the inflow and infiltration (I&I) component of total wastewater flow would increase at the same rate as sewer flows and no specific increase in I&I was modelled. This assumption was made because the City has a robust trunk and small pipe maintenance program which should maintain current I&I levels. Also, the model assumes that per capita flow will remain the same

[1] Treatment plant staff report that the September 16, 2015 flow into the treatment plant was the largest they have observed.

through the planning period. Due to code changes, prevalence of low flow fixtures, and general water conservation, per capita flow nationwide has been decreasing in the past 10 years, and may continue for some time. This plan recommends a conservative assumption that per capita flow will remain at current levels through the planning period.

Evaluating capacity issues for future flows used a two part methodology. First, average flow loads were increased to reflect projected population growth and land development. Then the model was run to evaluate capacity issues under average day and peak wet weather flow conditions with the 2035 population and associated flow conditions.

Projections of the population of Soldotna were developed for the 2015 Wastewater Master Plan (WWMP). This information is contained in Chapter 2 of the plan. The population served by sewers is expected to grow by 16% over the planning period.

The sewer model loads are applied at manholes. To estimate 2035 average day flow, the flows at each manhole were increased sixteen percent to represent future sewer loads. The same pumps on condition was used to estimate 2035 average day flow and increasing flows with the peaking factor of 2.5 was used to developed 2035 peak flow.

The 2015 models were run to estimate average day dry weather flows and peak hour wet weather flows. The resulting modelled flows at the WWTF were compared to the 2015 WWMP estimated flows and are shown in Table 3.

Table 3. 2035 Estimated Flows

WWMP 2035 Maximum Month ADWF Estimate (mgd)	Model 2035 ADWF Pumps off (mgd)	Model 2035 ADWF Pumps on (mgd)	Model 2033 Peak Hour Flow (mgd)
0.927	1.12	3.87	4.45

4.0 CAPACITY ANALYSIS RESULTS

Pipe capacity was evaluated using model output and previously recommended CAC. Based on the CAC recommendations, capacity designations were developed. The designations use the ratio of flow depth, d, to pipe diameter, D to identify whether the pipe has no capacity issue, a medium or high potential issue, or is over theoretical gravity flow capacity. The ratios are listed in Table 4.

Table 4. Sewer Pipe Capacity Designations

Capacity Designation	Numeric Criterion
No Issue	d/D <0.66
Medium Potential	0.66< d/D <0.08
High Potential	0.8< d/D <1.0
Over Capacity	d/D =1*

* The model does not report d/D>1.

Using the pipe flows generated in flow models, capacity designations were generated for each pipe in the City's sewer collection systems. This data was used to identify pipes with potential capacity issues.

The model output was then used to perform several GIS based analyses. These analyses were done to understand capacity issue causes, relationships between identified system issues, and prepare capacity management recommendations. The results of the analyses are presented graphically in maps appended to this memorandum and described below.

In analysis of 2015 and 2035 ADWF with the pumps modeled as a pass through, where flow in is equal to flow out, there were no pipes with issues and no trunk pipes were flowing at greater than 35% full. In both models with the pumps on, pump flows do combine downstream of pump stations and some pipes are estimated to be at or above 100% capacity. Because when pump stations operate at the same time some pipes may have capacity limitations, system capacity analysis was done assuming all pump stations are operating.

<u>Sewer Pipe Capacity Average Day 2015</u> – Figure 1

This map shows the capacity designation of pipes during 2015 average day dry weather flow conditions with all pump stations operating. The map identifies pipes with potential capacity issues. These pipes are all downstream of one or more pump stations.

<u>Sewer Pipe Capacity Peak Hour 2015 and 2035</u> – Figure 2

This map presents the results of the 2015 and 2035 peak hour model runs. These two runs assume a peak factor of 2.5 and all pump stations operating. The 2015 and 2036 results are presented together to allow for direct comparison of how a pipe identified as potentially capacity-limited for current conditions fares under future conditions.

Changes in pipe capacity designation from 2015 to 2035 are relatively minor. This is reasonable because population growth in the planning period, and associated sewer flows, are not large in comparison with the peaking factor.

The pipes identified with issues are trunks leading from lift stations and most notably where two or three pump stations are running in tandem. The capacity issues on Redoubt Avenue and on Kobuk Street south of Bering Street both disappear if one of the lift stations feeding those pipes is off.

<u>Sewer Pipe Capacity and Contributing Parcels</u> – Figure 3

During review of private development projects the City should evaluate whether the proposed development will generate sewage flow that may cause capacity issues. Currently few parcels receive this evaluation because a system-wide model is not available. This map identifies parcels upstream of a pipe designated as Over Capacity for the 2015 peak hour wet weather flow. This data could be incorporated into the City's GIS database and used to screen private development projects for further evaluation.

<u>Sewer Pipe Capacity and Slope < Minimum</u> – Figure 4

This map highlights pipes with a slope less than the minimum required by the 10 State Standards design manual that were designated as Medium Potential, High Potential, or Over Capacity in 2015 or 2035. This map helps to identify pipes that have adequate slope but estimated flows greater than the pipe capacity, and which pipes may be restricted by pipe slope. In the former case a larger pipe can eliminate the capacity issue whereas in the latter case, larger pipes may not be a solution because adequate slope may not be available.

<u>Sewer Pipe Capacity and Line Cleaning</u> – Figure 5

This map compares capacity-issue pipes with the pipes included in the line cleaning program. With few exceptions line cleaning pipes do not correspond to capacity issue pipes.

<u>Line Cleaning, Slope, and Food Service Establishments</u> – Figure 6

While there doesn't appear to be a link between pipe capacity and line cleaning, there appears to be a link between pipes downstream of high and medium risk Food Service Establishments (FSE), pipes with shallow slopes, and pipes that are cleaned yearly to keep from freezing and to prevent clogging from fats, oils, and grease (FOG). This map shows instances where pipes included in the line cleaning program have less than minimum slope. It also shows that frequently cleaned pipes which have adequate slope are often downstream of high and medium risk FSEs. This information could be used to investigate use of grease separators.

5.0 CAPACITY MANAGEMENT RECOMMENDATIONS

This capacity analysis of the City's system was done using a sewer system model prepared by HDR. As is true for all models it is based on simplifying assumptions. It is HDR's opinion that the model is a good tool for identifying pipes with potential capacity issues but it does not have the predictive power to justify pipe replacement. The City should use the model to identify pipes with potential capacity issues and perform pipe inspections, surveys, and flow monitoring of the pipes to determine if a capacity issue does or will occur and what the appropriate countermeasures are. The collected data should also be used to update and refine the model and loading assumptions.

The results of this capacity analysis of the City's system indicate that 99.8% of the pipe segments in the model will flow at less that 80% full during the peak hour wet weather flow condition in 2035. Those that at predicted to flow greater than 80% full are associated with pump stations combined discharges. Capacity in these could be managed by pump station changes instead of pipe upgrades.

Based on the model results and the capacity analysis methods in this memorandum, the following recommendations are made.

1. The City should update the sewer system model when the next master plan is done or when land use or population changes may impact sewer flows dramatically. Such an event may be annexation of a large are into the City. Model refinements at that time will improve its predictive capabilities and the City's confidence in using it to analyze the system.
2. The City should continue to invest in pipe maintenance, I&I reduction, FOG reduction programs, and system cleaning. These will help ensure pipe capacity is available for sewage flows and will reduce potential SSOs.
3. Many capacity issue pipes are downstream of pump and lift stations and most of these are designated as Over Capacity pipes. Because of the number of pipes identified with this condition and associated with pump stations, the City should review the relationship between pump station discharge flows, downstream pipe capacity, and the potential of pumps operating simultaneously and compounding peak flows. Lift Stations 5 and 6 are a good

example of the issue of two pumps running into one pipe. Lift Station 7 is a good example of a lift station possibly exceeding the pipe capacity of the pipe downstream.

4. The capacity analyses done for this memorandum indicate that the collection is in good condition, has adequate capacity, and requires average maintenance. The oldest parts of the system are now eclipsing 40 years old. Industry data indicates that the oldest pipes in the system have useful lives of 70 years or more. While pipe replacement due to age or deteriorating is not now recommended, data collection to monitor system condition is an important part of proactively managing a sewage collection system. Collecting and analyzing system condition data will help the City develop a program of timely and economically efficient replacement and repair projects. Recommended data collection should include line cleaning location and frequency records, video inspection of sewers before cleaning, mapping locations of excessive FOG accumulations, and other data relevant to pipe condition. This data can be stored and analyzed in a GIS data format and can be linked to the pipe databases developed for this plan.

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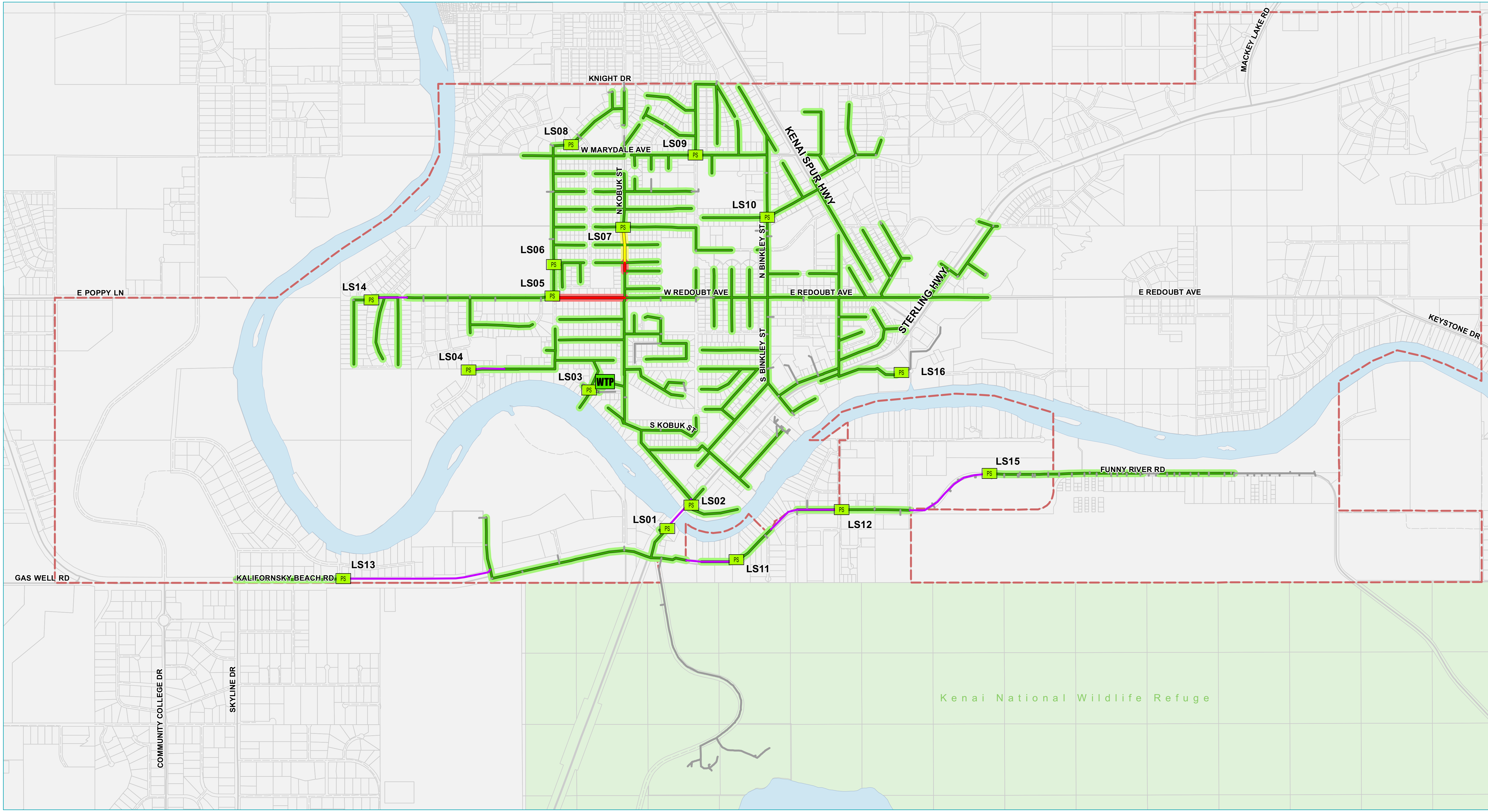


Sewer Gravity Mains - Capacity Status 2015
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1

Sewer Gravity Mains - Capacity Status 2035
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

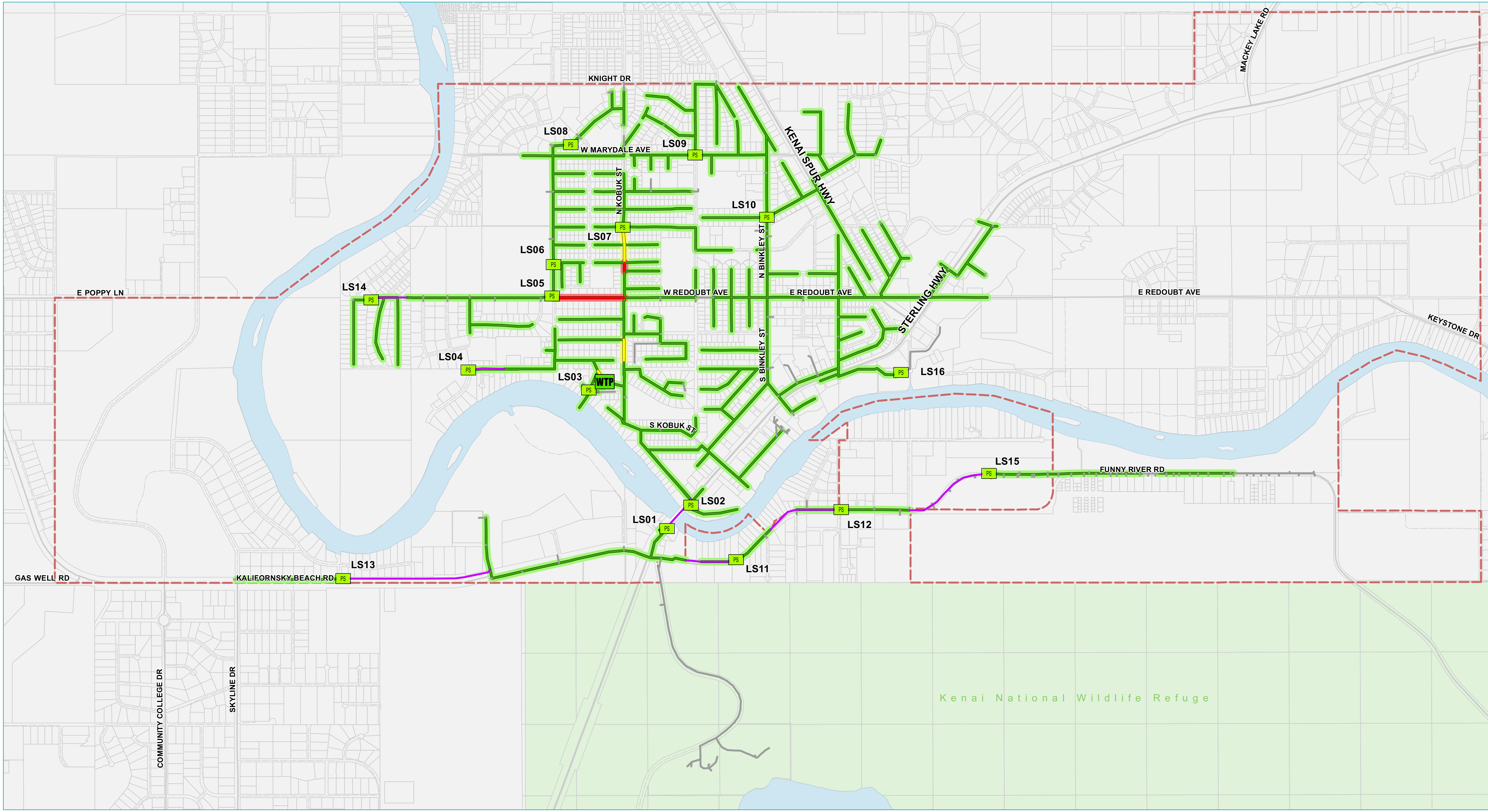
0 1,700
FEET

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity
Average Day 2015 and 2035
Figure 1

HDR



Sewer Gravity Mains - Capacity Status 2015
Peak Hour depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1

Sewer Gravity Mains - Capacity Status 2035
Peak Hour depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

N

0 1,700
FEET

SOLDOTNA
City of Soldotna, Alaska

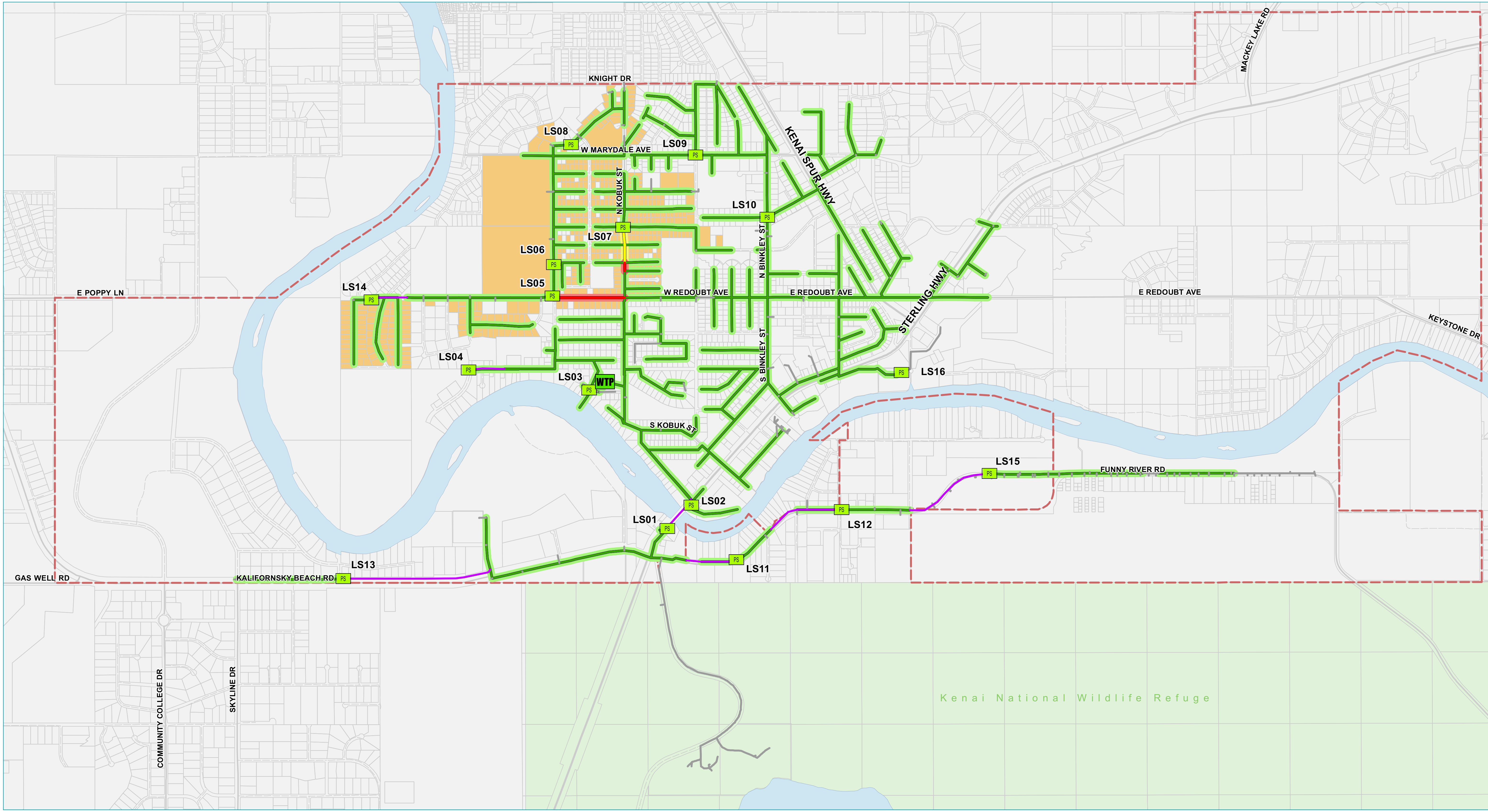
SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity

Peak Hour 2015 and 2035

Figure 2

HDR



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Sewer Gravity Mains - Capacity Status 2015
Average Day depth over Diameter of Pipe
- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1

Sewer Gravity Mains - Capacity Status 2035
Average Day depth over Diameter of Pipe
- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main
- Contributing Parcels Upstream of Capacity Issues

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets
- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

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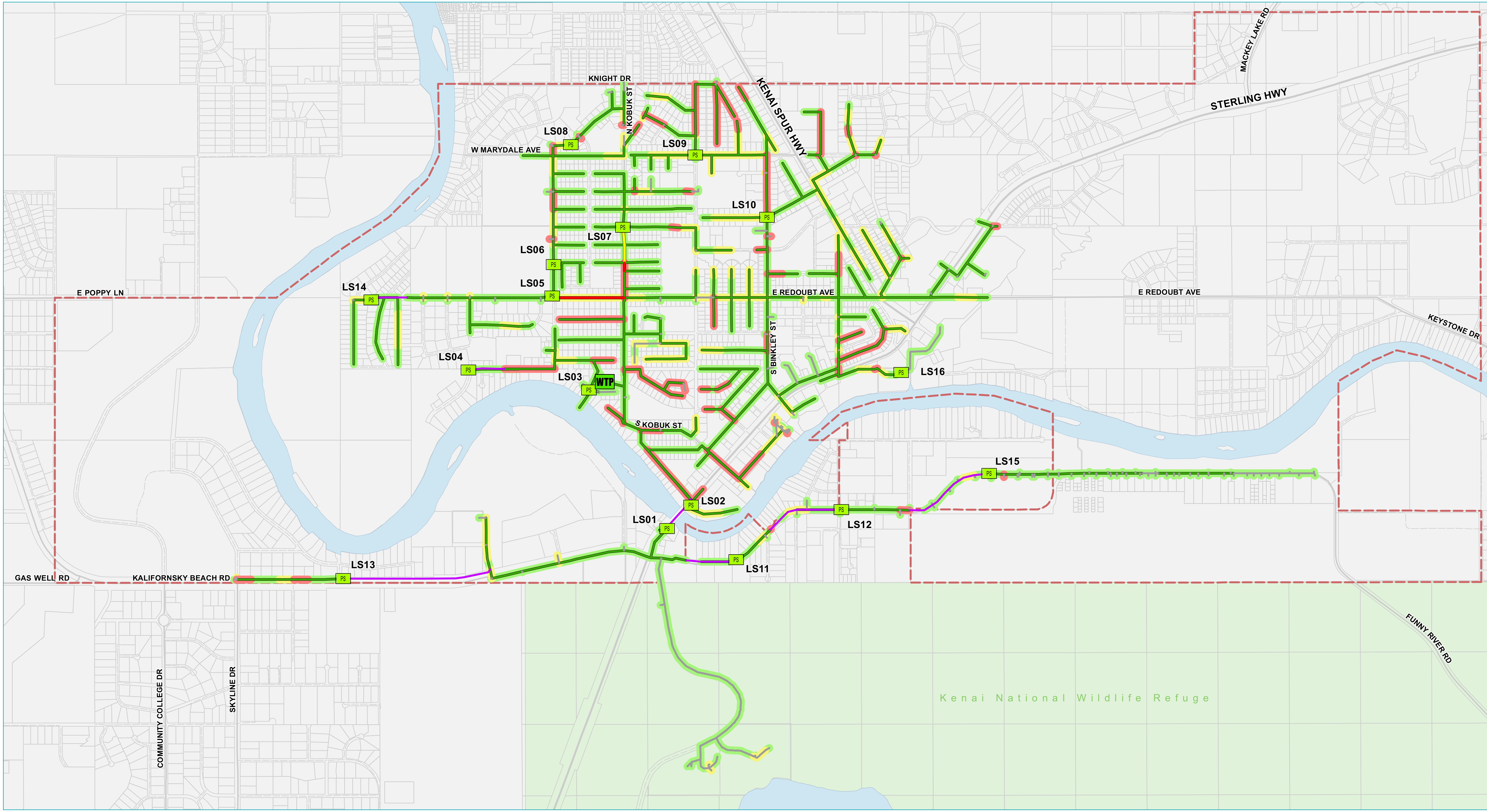
SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity
Contributing Parcels
Figure 3

HDR



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Sewer Gravity Mains - Capacity Status 2015
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main

Pipe Slope

- Meets 2 ft/s full pipe flow velocity and 10 State Standard minimum slope table requirements.
- Meets 2 ft/s full pipe flow velocity requirement. Does not meet 10 State Standard minimum slope table requirement.
- Does not meet 2 ft/s full pipe flow velocity or 10 State Standard minimum slope table requirements

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

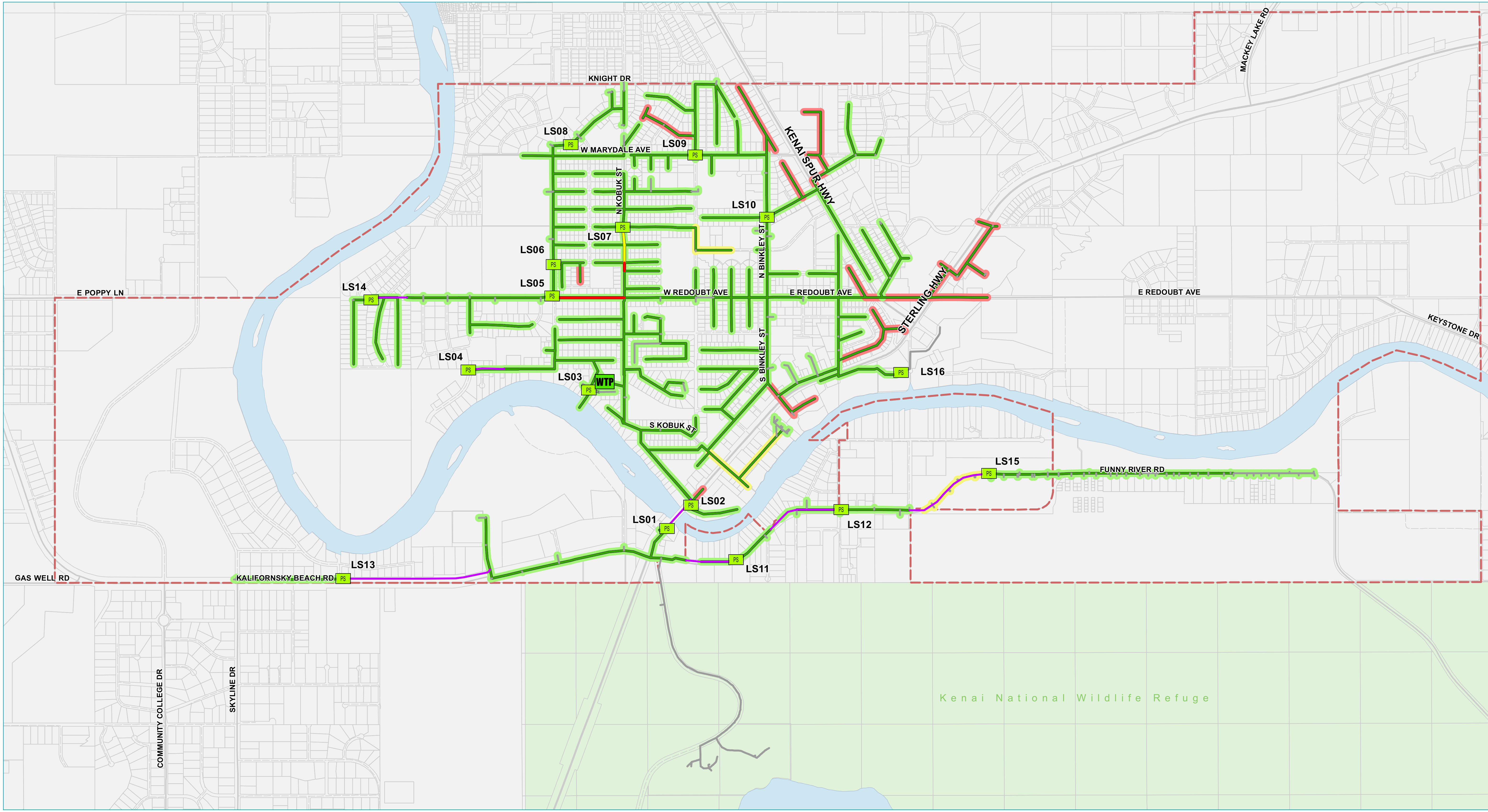
- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity
Average Day 2015 and Pipe Slope
Figure 4

HDR



Sewer Gravity Mains - Capacity Status 2015
Average Day depth over Diameter of Pipe

- No Issue - d/D = 0 - 0.66
- Medium Potential - d/D = 0.66 - 0.8
- Over Capacity - d/D = 1
- Zero Flow or Not in Model
- Sewer Pressurized Main

Pipe Cleaning Frequency

- Every five years for maintenance
- Winter months to keep from freezing - January through April
- Every year to keep from freezing or plugging with grease

- PS Lift Station
- WTP Treatment Plant
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

SOLDOTNA
City of Soldotna, Alaska

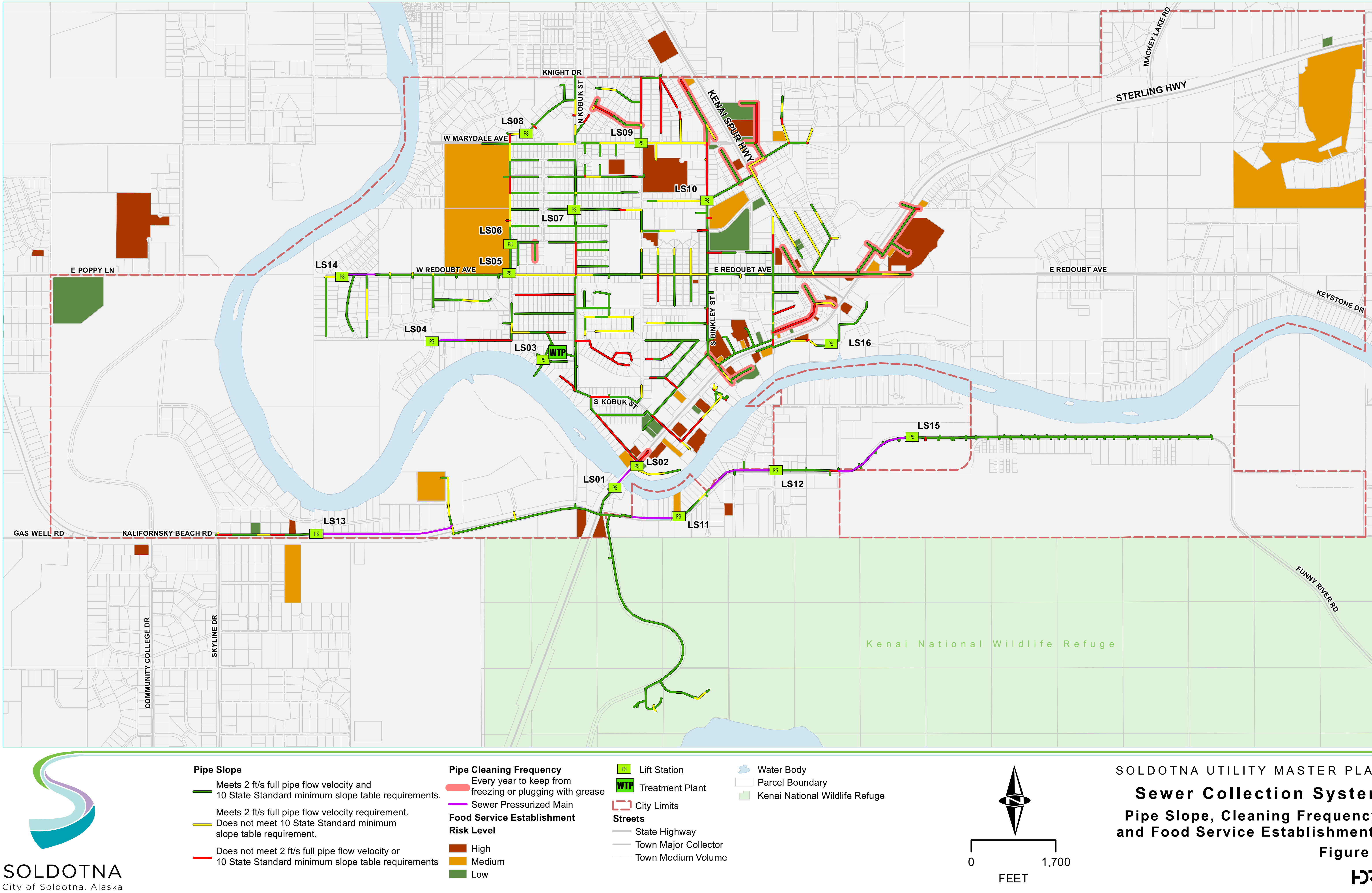
SOLDOTNA UTILITY MASTER PLAN

Sewer Pipe Capacity

Average Day 2015 and Cleaning Frequency

Figure 5

HDR



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SOLDOTNA UTILITY MASTER PLAN

Sewer Collection System

Pipe Slope, Cleaning Frequency, and Food Service Establishments

Figure 6

HDR

Appendix C

Expansion Capacity Analysis

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To: Kyle Kornelis, Lee Fry, City of Soldotna

Copy: Rick Wood, City of Soldotna

From: Dan Billman, HDR

Date: October 7, 2015

Subject: Sewer System Expansion to Serve Future Development

Soldotna's sanitary sewer system serves the core of the City on the north side of the Kenai River as well as the south side of the river along Kalifornsky Beach and Funny River Roads. Growth within the city limits and adjacent areas during the master planning period, 2016 to 2035, could be served by the existing system with limited extensions. This memorandum assesses the potential impacts from this growth on the sewer collection system capacity.

Model Used

HDR prepared a model of the sewer collection system. The sewer system model developed is a steady state model. A steady state model assumes flow conditions do not change over time and is used to evaluate pipe and pump station capacity. The four flow conditions evaluated are:

- 2015 Average Dry Weather Day
- 2015 Peak Hour
- 2035 Average Dry Weather Day
- 2035 Peak Hour

The model is based on record drawing information provided by the City. Information from the drawings was input into an Arc GIS database and was used to create the pipe network in InfoSewer model. The pipe model is shown on the attached figure.

The model was loaded by assigning sewage production to each parcel served. The parcel sewer loads were based on a percentage of water demands used in an existing water model system and were adjusted on individual parcels as needed to better reflect the sewage collection system. These flows were used to create a base model of 2015 Average Dry Weather Day.

The base model of 2015 Average Dry Weather Day was used to create a 2015 Peak Hour model by using a peaking factor of 2.5. This peaking factor came from recent work done on Anchorage Water and Wastewater's (AWWU's) sewage collection system. As the Soldotna's and AWWU's systems are approximately the same age, condition, and in similar climates, the peaking factor is appropriate for planning purposes.

An estimate of 2035 Average Dry Weather Day was made by multiplying 2015 Average Dry Weather Day by 1.16, the estimated increased in the population served by sewer. Finally 2035 Average Dry Weather Day was multiplied by the peaking factor of 2.5 to estimate 2035 Peak Hour.

The sewer collection system contains 15 lift stations. The lift stations were added to the model by through a three point pump curve and a wet well. The model uses the curve to estimate the discharge flow from each pump station. This discharge flow is incorporated into the model downstream of each pump station.

For each steady state flow condition the model is used to estimate flow in each pipe. Flow is derived from accumulated parcel flows or pump stations discharge flows plus parcel flows. To test system capacity the model assumes that all pumps stations area operating. This is done to understand how the possible combination of pump station discharges my impact pipe capacity. While simultaneous pump station operation may be remote, it can and does occur, especially during peak hour wet weather condition. This occurrence is often a limiting factor in system capacity.

Model Results

The system model results show that generally those pipes that are not downstream of pump stations are flowing less than one third full, even in 20 years and during peak conditions. This is because the system is oversized for the current and projected population. This may be an artifact of the 1968 sewer master plan, likely the one used to plan and design the core system, where the estimated service population in 2000 was 10,000. Because of the likely historic basis of design and current use of minimum pipe sizes, many pipes have unused capacity.

Downstream of pump stations pipes are fuller, with the model estimating some over 100% full where two pump stations discharge into the same pipe. The pipes show these flow rates under all model conditions for 2015 and 2035 because the pump station discharge rate is the driving factor, which is not changed by the flow rate into the lift station. These pipes are now at or over capacity and increasing pump station discharges from what they currently are should be carefully evaluated.

Excess Capacity

Growth in the population served by sewer is estimated to be 16% during the planning period. This estimate accounts for both parcels abutting sewer laterals but are not connected connecting and new parcels connecting to serve the estimated population and commercial growth in the city limits. These flows are captured in the 2035 Average Dry Weather Day model.

Excess capacity is defined as the pipe capacity beyond what is needed to serve anticipated growth during a planning period. For the Soldotna system model this would be the theoretical pipe flowing full capacity minus the estimated 2035 Peak Hour flow. Using this definition maintains capacity of the existing system for within the city limits while identifying excess capacity available to serve areas beyond the current system extents limits without needing to enlarge the collection system.

Analysis

System extension and expansion was looked at for 5 places at the periphery of the sewer collection system. The locations are shown on the attached figure. They were selected because they represent the likely places where the system could be extended to serve growth beyond the current system.

An analysis to find the limiting excess capacity point between the upstream connection point and the wastewater treatment plant was done. For those pipe routes with pump stations, one of the pump statins was the limiting point in all cases. For the gravity trunk that serves the eastern Sterling Highway, the limiting section was one of the gravity pipes. This gravity trunk has no pump stations.

Table 1 below shows the limiting excess capacity flow amount in cfs, as estimated by the sewer system model. This flow is converted to an equivalent number of acres of single family residences by the flow of 0.0037 cfs/acre of single family residential homes. This value came from the AWWU Design Criteria and Practices Manual. This conversion factor is used by AWWU for the design of new sewer pipes.

Table 1 System Extension

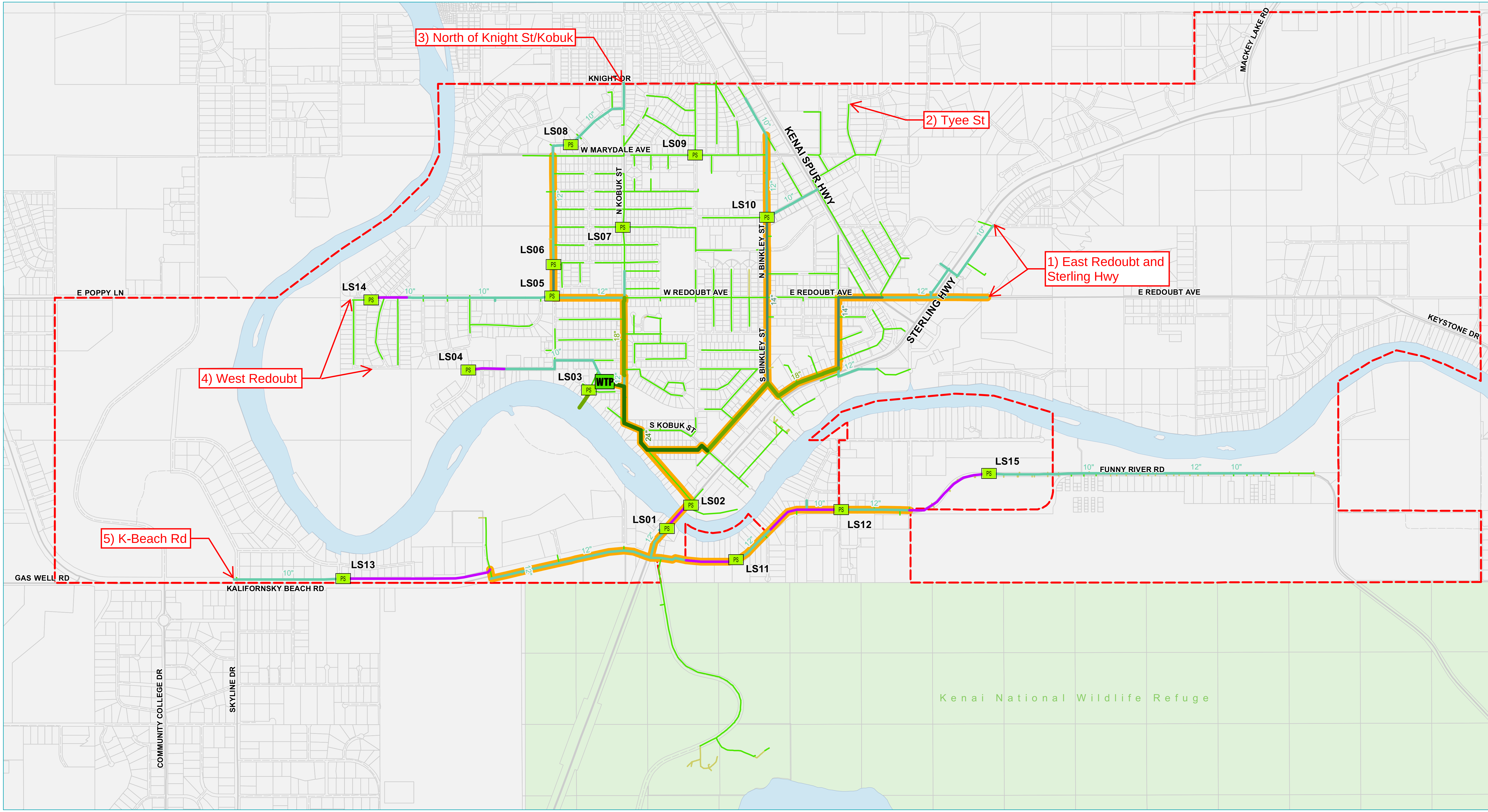
	Connection Location	**Excess Capacity, (cfs)**	**Equivalent Single Family Residences, acres**
1	**E Redoubt**	1.67	452
2	**Tyee**	0.30	81
3	**Knight**	0.53	143
4	**W Redoubt**	0.29	77
5a	**K-Beach 1**	0.16	43
5b	**K-Beach 2**	0.57	155

Note: 5a and 5b represent excess capacity for each of the two pumps in the limiting pump station. 5a is the smaller pump, 5b the larger.

Conclusions

The existing sewer collection system has the capacity to serve projected growth in the City of Soldotna and excess capacity for extension of the system beyond its current extents.

If more capacity is needed to serve system extension, the limiting segments of collection system could be enlarged. The cost associated with enlarging the system capacity could be spread over the entire rate base of the system, assigned to the expansion area causing the increase in capacity, paid for through grants, or a combination of these. Which method is appropriate for funding system capacity increases to serve expansion beyond the systems current capacity should be discussed by the City of Soldotna.



SOLDOTNA
City of Soldotna, Alaska

Sewer Gravity Mains by Diameter
- 4" - 6"
- 8"
- 10" - 12"
- 14" - 15"
- 18" - 21"
- 24"
- Sewer Pressurized Main
- Interceptors

- Lift Station
- Treatment Plant
- City Limits

Streets
- State Highway
- Town Major Collector
- Town Medium Volume

- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

SOLDOTNA UTILITY MASTER PLAN

Sewer Collection System

Figure xx

HDR

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SOLDOTNA
City of Soldotna, Alaska

City of Soldotna

2015 Soldotna Water Master Plan

City of Soldotna, Alaska
February 15, 2016

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Tables

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List of Acronyms

The following is a list of acronyms and short forms used in this plan.

ADEC	Alaska Department of Environmental Conservation
CBD	Central business district
CDP	Census Designated Place
CIP	Capital Improvement Program
CPCN	Certificate of Public Convenience and Necessity
DLWD	Alaska Department of Labor and Workforce Development
gpcd	gallons per capita per day
gpm	gallons per minute
HGL	Hydraulic grade line
HPD	Habitat Protection District
KPB	Kenai Peninsula Borough
KROD	Kenai River Overlay District
LGIM	Local Government Information Model
MG	Million Gallons
MGD	Million Gallons per Day
OHW	Ordinary High Wastewater Mark
O&R	Operation and Redundancy
PRV	Pressure Reducing Valve
psi	pounds per square inch
RCA	Regulatory Commission of Alaska
T&S	Transmission and Supply
UP	Upgrade
USFWS	United States Fish and Wildlife Service
WMP	Water Master Plan (preceded by relevant date of publication)
WWTF	Wastewater Treatment Facility

1 Introduction

1.1 Authorization

The City of Soldotna (City) has authorized HDR Alaska, Inc. to prepare the *2015 Soldotna Water Master Plan* (2015 WMP). Preparation of this plan was authorized by a contract between the City and HDR Alaska, Inc., under City Project Utility Master Plans SOLP 14-02.

1.2 Purpose

The objective of the 2015 WMP is to prepare a water distribution system master plan and associated Capital Improvement Program (CIP) to implement the plan's recommendations. The plan will evaluate a projected 20 year time horizon (i.e., 2016–2035) for the system and develop capital and operational improvements to the system to provide the City with adequate water supply to support its residents and future growth. This plan provides a description and justification for each plan recommendation, as well as the recommended implementation sequence and year.

This document presents information describing the existing condition of Soldotna's water system, projections of future water needs, analysis of system deficiencies, discussion of system improvement recommendations, and schedule implementation of a capital improvement program to meet projected needs and to rectify system deficiencies.

1.3 Background

Soldotna is the commercial and recreational hub of the central Kenai Peninsula. Because of its location on the highway system and availability of developable land, the City has experienced both commercial business and residential growth. To manage the growth and develop a clear vision for a larger, livable Soldotna, the City prepared the *Envision Soldotna 2030 Comprehensive Plan*, adopted by the Soldotna City Council in January 2011. This plan noted that Soldotna will continue to infill with residential and commercial properties through the planning period. An important requirement to maintain and support this growth will be a robust water system. Therefore a key recommendation of the comprehensive plan was that the City update its utility master plans. This plan fulfills the comprehensive plan recommendation for the water system (DOWL HKM and Kevin Waring Associates 2011).

With growth in the 1960s planning for community-wide water and wastewater systems was needed. A combined water and wastewater master plan for Soldotna was prepared in the late 1960s (Adams Corthell Lee Wince, and Associates 1968). This planning effort developed the core system layout for the City, which was based on a projected service population of approximately 10,000 people in the year 2000.

The core water distribution system the City now operates was constructed in the early 1970s as part of United States Department of Housing and Urban Development work in the city. This project also installed a stormwater collection and drainage systems and wastewater treatment plant (analysis of these is covered in separate master plans).

With subdivision and street extensions growth in the 1970s and 1980s planning for water system expansion was needed. A water master plan for Soldotna was prepared in the mid-1980s (Emmett F. Lowery Engineers International, Inc. 1989). This planning effort developed a system layout and locations for a reservoir on the south side of the Kenai River.

Soldotna has grown substantially since the last water planning effort with new water supply wells, reservoir, booster station, and pipes being incorporated into the water system. Also, water and wastewater treatment requirements and regulations have changed and may change further in the future. With this backdrop the City authorized work on preparing a water system master plan. Key planning issues included:

- Completion of the City's *Envision Soldotna 2030 Comprehensive Plan,* and policies for charting growth within it, contained implications on Soldotna's water system and required upgrades and expansion.
- Water demands in Soldotna will continue to grow.
- Growth in the City, including areas not presently served by public water supplies.
- Regulatory changes for lead and copper, arsenic, and other regulations affecting Soldotna changed or will do so in the near future.
- Soldotna's system is aging and has many pipes approaching over 40 years old. Repair and rehabilitation of these pipes will become a higher priority as the system continues to age.

1.4 Scope

The Scope of Work statement for preparing the 2015 WMP is generalized as follows:

- Update and add information to the City's adopted ESRI Local Government Information Model (LGIM) for organizing its geospatial data. The data will be used for analyses preformed during the water and sewer system and drainage planning work.
- Prepare population and community growth estimates and calculate water demands. Population and community growth will be projected for a 20 year time horizon. These flow projections will be used to evaluate the water system upgrades.
- Prepare a water distribution system master plan and associated CIP to implement the plan's recommendations. The plan will evaluate a projected 20 year time horizon.
- Prepare map products for use with the 2015 WMP update and clearly display the plan to the general public.
- Present the final master plan and recommendations to the Soldotna City Council.
- Publish the final plan for distribution to the general public and Soldotna's future use.

1.5 Study Areas

The 2015 WMP study area includes lands within the City of Soldotna water service area as defined in the Certificate of Public Convenience and Necessity No. 133. The certificate generally covers the City of Soldotna city limits and lands within a mile to one and one half miles of the city boundary in the Ridgeway Census Designated Place (CDP) and the Kalifornsky CDP. The study area includes the Oberts Riverview Estates Property Owners Association Water Utility, which is excluded from the City of Soldotna water service area. The study and surrounding areas are shown in Figure 1.

The portion of the study area within the City limits is consistent with *Envision Soldotna 2030 Comprehensive Plan*. Implementation strategies listed in chapter 4 of the plan were considered in the development of the recommendations contained in this master plan.

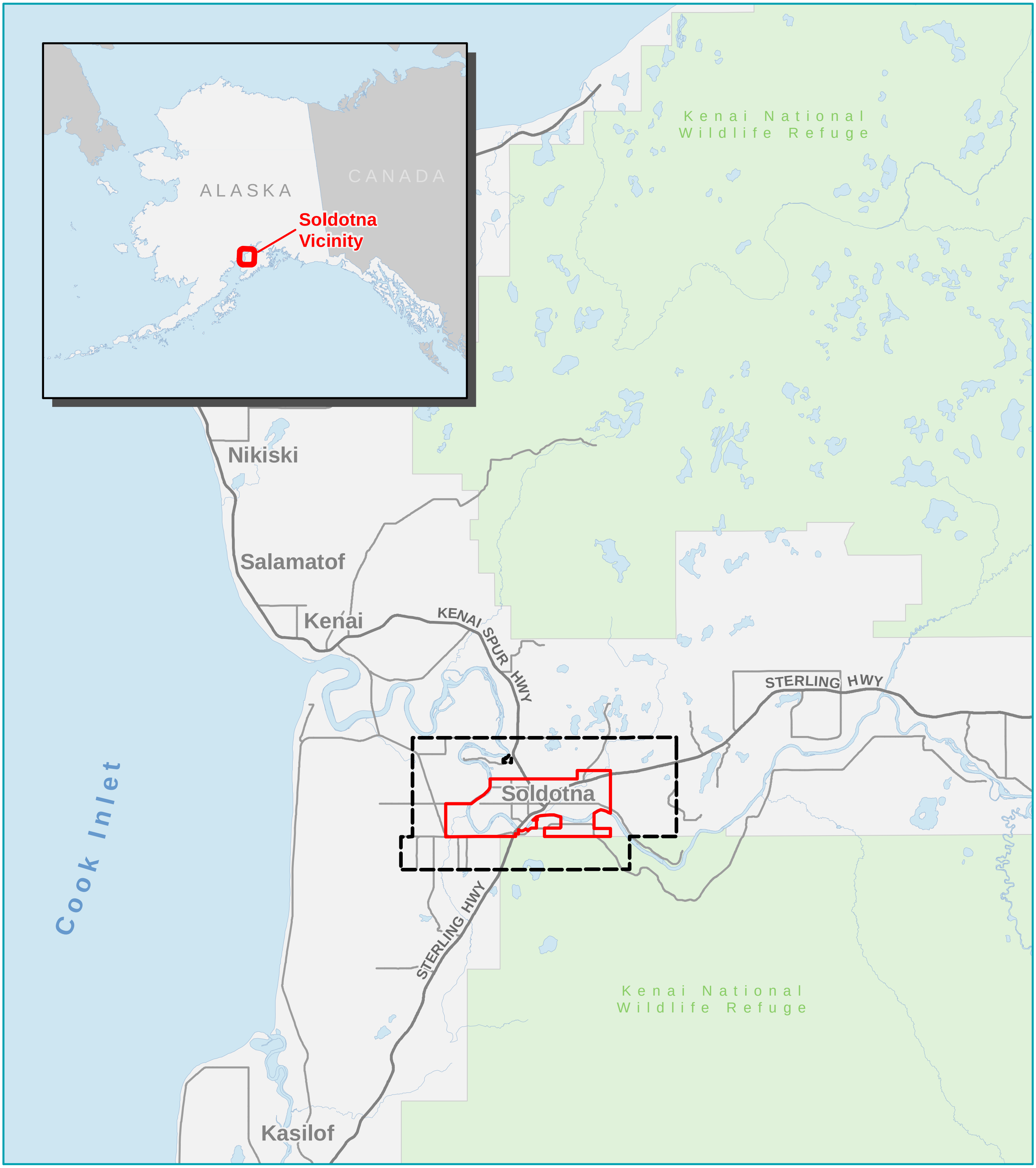
Surrounding the City are areas cited in the *2005 Kenai Peninsula Borough Comprehensive Plan* (KPB Comprehensive Plan) as rapidly growing and having a significant proportion of the population in the borough. The KPB Comprehensive Plan states that “according to 2003 population data, over half of the residents (about 55 percent [%]) of the Borough … live in the central peninsula area in the vicinity of Kenai, Soldotna, Sterling, Nikiski, Kasilof and Funny River….The number of parcels [in these areas] occupied by residential uses has increased significantly during the last decade and at a much faster rate than the population” (page 6-25 of KPB 2005).

The study areas outside the City boundary were selected because they represent areas of rapid growth potential, some of which could have the City water service extended into them during the planning period. Including these is consistent with the KPB Comprehensive Plan goals, objectives, and implementation actions listed in chapter 4 of the plan. These strategies were considered in the development of the recommendations contained in this master plan.

The study area includes the City of Soldotna’s Kenai River Overlay District (KROD). This district “is a special zoning district designed to provide opportunities for the development and use of land along the Kenai River, while also safeguarding and enhancing riparian habitat, controlling erosion, and protecting ground and surface water. The district includes all lands within 100 feet of the ordinary high water mark (OHW) of the Kenai River, or 25 feet back from a cut bank, whichever is greater” (Soldotna 2015).

The study area includes areas within the KPB Habitat Protection District (HPD), which “includes all lands within 50 horizontal feet of the waters set forth in KPB 21.18.025. This shall be measured from the OHW” (KPB 2011). The HDP places additional requirements on property development within the District.

Requirements of the KROD and HPD were considered in the development of the recommendations contained in this master plan.



Water Service Area Boudary
Soldotna City Limits

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MILES

SOLDOTNA UTILITY MASTER PLAN

City of Soldotna Vicinity

Figure 1

SOLDOTNA
City of Soldotna, Alaska

HDR

2 Population Projections and Land Use

2.1 Introduction

To estimate future water demand, population projections and the expected geographic distribution of the population were developed. For purposes of population analysis in the 2015 WMP, the study area has been divided into three geographic areas that correspond to Soldotna’s current and potential future service areas (Figure 1). The areas are:

- The City of Soldotna
- The Ridgeway CDP outside the City limits
- The Kalifornsky CDP outside the City limits

Within each of the three geographic regions of study, estimates of population distribution and extent of commercial development were made for purposes of establishing water demand projections on a small-area basis. These small area population projections were then used in modeling the water system to plan specific extensions or improvements. The following sections address the procedures used to develop population estimates for use in water demand analyses and modeling described in Section 3.

2.2 Current Population

2.2.1 Total Planning Area Population

The City of Soldotna had a total population of 3,750 in 2000 (Alaska Department of Labor and Workforce Development (DLWD)). In the 2010 census, the City grew to a total population of 4,163. The City experienced a growth of 11% for this ten-year period. Population estimates continue to indicate growth in the City with an estimated 2014 population of 4,311. Table 1 summarizes the historical population of the City and the geographic areas of interest for the 2015 WMP (Soldotna, Ridgeway CDP, and Kalifornsky CDP).

Table 1. Historic Population

Year	City of Soldotna	Ridgeway CDP	Kalifornsky CDP
1960[1]	332		
1970	1202	500 (estimated)[4]	
1980	2320		
1990[2]	3,482	2,018	285
2000	3,750	1,932	5,846
2010[3]	4,163	2,022	7,850
2014	4,311	2,187	8,441

[1]Data from 1960 and 1980 from *Envision Soldotna 2030 Comprehensive Plan*.
[2]Years 1990 and 2000 data from http://laborstats.alaska.gov/pop/popest.htm Historical Data: Places.
[3]Years 2010 to 2014 data from http://laborstats.alaska.gov/pop/popest.htm Cities and Census Designated Places, 2000 to 2014.
[4]Adams Corthell Lee Wince, and Associates. City of Soldotna Water System and Sewer System. June 1968

While the City grew rapidly in this period, the surrounding areas showed different growth patterns. The Ridgeway CDP has exhibited low growth between 1990 and 2014, while the Kalifornsky CDP has grown dramatically and surpassed the City in population.

2.2.2 Population served

Developing an estimate of the population served by the City wastewater collection system was a two part process. First the population served in 2010 was determined and then this estimate was systematically increased to estimate the population served in 2015. The following described the process and data sets used.

To determine the 2010 population for which City provided water service, the 2010 Census data, KPB parcel database, City water connection data, and City water customer data sets were analyzed. These data sets were used to first determine which parcels were connected to the water system in 2010 and how many people were living in the connected parcels. Adding up the people at each parcel served provided an estimate of the total population served by the wastewater collection system.

Next the water service connection data was used to determine the parcels that were added to the system between 2011 and 2014 and how may people this added to the water system. These new customers were added to the 2010 estimate to develop the population served estimate for 2014.These values were increased by estimated population growth rates described in the next section to estimate the population served 2015. Table 2 provides estimates of the City population and the estimated population served by the City water system. Those City residents not served by the City water system use private water systems.

Table 2. Total Population Served by City Water System

Year	City Population	City Served Population (number)	City Served Population (percentage)
2015	4,375	3,349	77%

2.3 Population Projections

2.3.1 Future Resident Planning Area Population

The Soldotna Planning Department made future population estimates for the City in the *Envision Soldotna 2030 Soldotna Comprehensive Plan.* The comprehensive plan estimates were completed in 2009. These projections were based on growth of 7% per decade, or 0.70% per year, through 2030.

The DLWD Research and Analysis Section prepared populations projections for Alaska and Boroughs. Most recently updated in 2012 this data projects population from 2012 through 2042. DLWD population projections only cover the State of Alaska and KPB. DLWD does not prepare projections for areas smaller than boroughs. The portion of the DLWD projected growth rates applicable to this plan's planning period are shown in Table 3. These projections show a declining growth rate through the planning period.

Table 3. DLWD Estimated Annual Population Growth Rates 2012-2037

Year	Alaska	KPB
2012-2016	1.01%	0.85%
2017-2021	0.91%	0.72%
2022-2026	0.80%	0.55%
2028-2031	0.70%	0.38%
2032-2037	0.64%	0.24%

To evaluate issues related to water planning population projections for the City and adjacent Ridgeway CDP and Kalifornsky CDP are needed. However, because of the differences between the Soldotna Comprehensive Plan and DLWD population projections, neither of these is directly applicable for this water plan. To prepare population estimates for this plan the following assumptions were made.

- The City of Soldotna will continue to grow at a greater rate than the KPB as a whole, as has been the case for the past decade.
- The Kalifornsky CDP will continue to grow at a faster rate than the City of Soldotna, as has been the case for the past decade.
- The Ridgeway CDP will continue to grow at a similar rate as the City of Soldotna, as has been the case for the past decade.
- Growth rates over the planning period will slow at the rate indicated for KPB by DLWD projections.
- The City of Soldotna, Ridgeway CDP, and Kalifornsky CDP will continue to be the fastest growing areas in the KPB and will receive a greater proportion of the total projected KPB population growth during the planning period.
- The total population growth projected by DLWD for the KBP will hold for the planning period. That is to say, the growth rates selected for the City, Ridgeway CDP and Kalifornsky CDP could not result in a larger KPB population than estimated by the DLWD. Adopting this criterion allowed for higher growth rates in

the planning area but maintained the total KPB population equivalent to DLWD projections.

These criteria were used to develop growth rates and population estimates for use in this plan. The selected growth rates that provided the best fit estimate to the available data are show in Table 4.

Table 4. Estimated Annual Population Growth Rates 2012-2035

Year	KPB	City of Soldotna	Ridgeway CDP	Kalifornsky CDP
2012-2016	0.85%	1.00%	1.00%	1.20%
2017-2021	0.72%	0.87%	0.87%	1.07%
2022-2026	0.55%	0.70%	0.70%	0.90%
2027-2032	0.38%	0.53%	0.53%	0.73%
2032-2035	0.24%	0.39%	0.39%	0.59%

The selected growth rates in Table 4 were used to prepare population estimates for the planning area through the planning period. These are presented in Table 5. The selected growth rates project a slightly greater population in the City in 2030 than is projected in the comprehensive plan, 4,881 versus 4,674.

Table 5. Estimated Planning Area Population 2016-2035

Year	KPB	City of Soldotna	Ridgeway CDP	Kalifornsky CDP
2016	58,721	4,419	2,146	8,432
2017	59,220	4,458	2,165	8,523
2018	59,646	4,496	2,184	8,614
2019	60,076	4,535	2,203	8,706
2020	60,508	4,575	2,222	8,799
2021	60,944	4,615	2,241	8,893
2022	61,383	4,647	2,257	8,973
2023	61,720	4,680	2,273	9,054
2024	62,060	4,712	2,289	9,136
2025	62,401	4,745	2,305	9,218
2026	62,744	4,779	2,321	9,301
2027	63,090	4,804	2,333	9,369
2028	63,329	4,829	2,346	9,437
2029	63,570	4,855	2,358	9,506
2030	63,811	4,881	2,371	9,575
2031	64,054	4,906	2,383	9,645
2032	64,297	4,926	2,392	9,702
2033	64,452	4,945	2,402	9,759
2034	64,606	4,964	2,411	9,817
2035	64,761	4,983	2,421	9,875

2.4 Service Areas Land Use

Soldotna is certificated to provide water service the entire City and an area surrounding the City. The following section describes these service areas and assumptions made on how they may change during the planning period.

2.4.1 Certificated Service Area

On November 8, 1971, the Alaska Public Utilities Commission, now the Regulatory Commission of Alaska (RCA), granted a Certificate of Public Convenience and Necessity (CPCN) Number 133 to the City of Soldotna for operation of a water utility within a specified boundary area. The CPCN area is shown in Figure 2. As agreed to in the CPCN, the City of Soldotna makes no commitment to the RCA or area residents as to when it may extend services within this area in the future.

In 2004, Oberts Riverview Estates Property Owners Association announced to the RCA their intent to upgrade their existing Class C water system to a Class A Water system. Although the Oberts Riverview Estates Subdivision was located within the City's CPCN area, the property lies approximately one mile from the existing City water distribution mains. At that time, the City stated they had no plans for extending the water mains to the subdivision given the cost and lack of sufficient customers to pay for the extension. No two utilities are allowed to operate within an area at the same time according to statute 42.05.

In 2005 the parties reached an agreement to transfer water service authority from the City to the Oberts Riverview Estates Property Owners Association. The subdivision operates their water utility within Section 19, Tracts A, C, D, and E, and Lots 5 through 12.

2.4.2 Land Use Pattern

To project future water demands throughout the three geographical areas of study, assumptions about future land use were required. Land use for the years 2015 through 2030 was analyzed to develop a recommended CIP for the period. The City and KPB comprehensive planning process establishes land use patterns in each area of study and these patterns were used as the basis for the 2015 WMP. Goals, objectives, policies, and strategies from the *Envision Soldotna 2030 Comprehensive Plan* and the KPB KPB Comprehensive Plan developed during the community planning process were used to project water use during the planning period and to evaluate potential system expansion.

City of Soldotna

For future water use planning, growth patterns and land uses presented in the *Envision Soldotna 2030 Comprehensive Plan* were used for evaluating future water needs. The plan provides for further development of commercial properties on the Sterling and Kenai Spur Highway corridors with additional mixed use development around the hospital. Higher density single and multi-family residential areas requiring city water will generally remain the same and will infill the remaining parcels with development. Rural residential areas are assumed to not require city water in the planning period. These projected land uses were used in modeling both residential and commercial demands as well as fire flow needs.

Ridge Census Designated Places

Bordering the City limits to the north is the Ridgeway CDP. This area contains the Kenai Spur Highway commercial corridor and a higher density residential area. Adjacent to the northern City limit and beyond this are rural residential areas and vacant land. Commercial and residential growth in this area is projected to continue through the planning period. Because of the adjacent commercial district of the City, commercial growth will likely be greater nearer to the City limit. Residential growth will be slower than the Kalifornsky CDP because there is less available land for such development. Rural residential areas are assumed to not require city water in the planning period. Some connection of adjacent parcels to the water distribution network is possible at the outer edge of the system but will likely be limited by the cost of pipe extensions.

Kalifornsky Census Designated Places

Bordering the City limits on the west and south is the Kalifornsky CDP. This area contains Kalifornsky Beach Road commercial corridor and a small area of higher density residential area near the western City limit. Beyond these are rural residential areas and vacant land. This was the fastest growing area in the KPB in the past decade and is projected to continue to grow rapidly through the planning period. Residential growth will be greater than the Ridgway CDP because there is more available land for such development and will be primarily single family homes. Rural residential areas are assumed to not require city water in the planning period. Some connection of adjacent parcels to the water distribution system is possible at the outer edge of the system but will likely be limited by the cost of pipe extensions.

Finally, areas served community wells that are experiencing water quality issues may be connected to the system to be compliant with Alaska Department of Environmental Conservation (ADEC) regulations. These, however, will require significant funding support from outside Soldotna to pay for the lengthy main extension required to reach these areas from the existing system.

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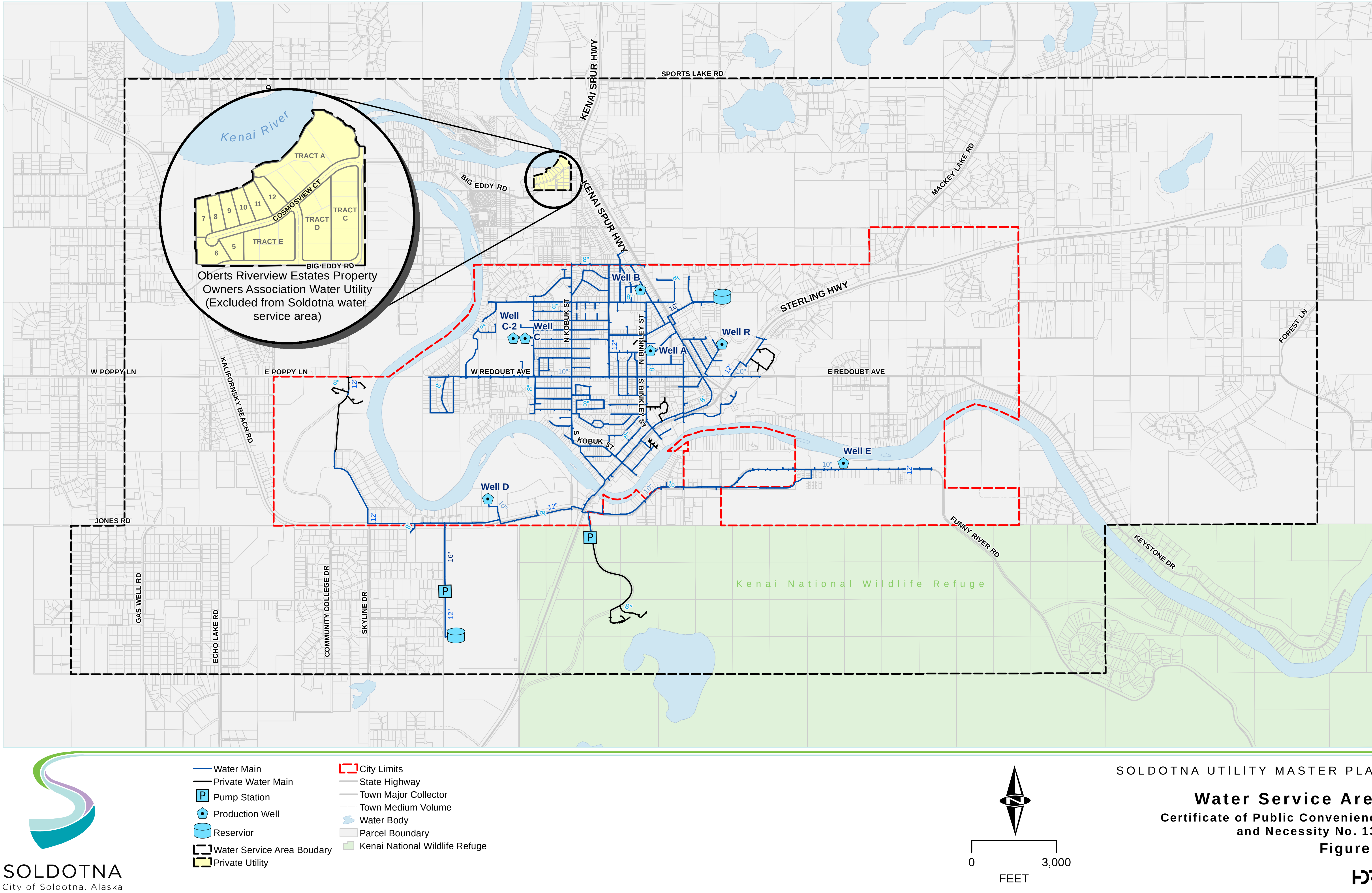

SOLDOTNA UTILITY MASTER PLAN

Water Service Area

Certificate of Public Convenience and Necessity No. 133

Figure 2

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2.5 Future Population Served

The 2015 served population by the water system was estimated using the methodology previously discussed in Section 2.2.2. Some portion of the future development and population growth within the City limits will be in areas outside the water service area. For planning purposes, it is assumed that 75% of the population growth in the City will be in areas currently serviced by water. The remaining 25% of the City's growth in the planning period will use private water systems.

Not all buildings adjacent to the City water system are connected to it. Analysis of KPB parcel data and City water service data shows that approximately 40 parcels with buildings, either residences or other properties, are adjacent to the water system but not connected to it. Owners of these buildings can connect to the water system, and do, for various reasons. It is assumed that this will continue during the planning period. For planning purposes it is assumed that those properties that currently front water mains but do not have a service connection will become connected sometime over the next 20 years. It is assumed that the same number of parcels, and people, will be added to the system each year and all parcel residents will be connected by the end of the planning period.

The water system will continue to serve parcels outside the city limits. It is assumed that the parcels served by water will increase but only those parcels fronting the existing system or by areas very close to the system will connect. This assumption is made because the cost of connecting to the system is high compared to on-site wells, if adequate lot size is available, and the desire by many outside the city limits to remain on on-site systems and have a rural residential neighborhood.

The served population growth from population increase was added to the additions to the system from parcel connections. Table 6 shows the projected population served by water in the City through 2035.

Table 6. Projected City of Soldotna Population Served by Sewer, 2016 to 2035

Year	Total City Population	Projected Annual Population Growth	Served Population, 75% of Population Growth	Projected Served Population Through Connecting Existing Fronting Parcels	Projected Population Served (number)	Projected Population Served (percentage)
2016	4,419	44	33	7	3,389	77%
2017	4,458	38	29	7	3,425	77%
2018	4,496	39	29	7	3,461	77%
2019	4,535	39	29	7	3,497	77%
2020	4,575	39	30	7	3,534	77%
2021	4,615	40	30	7	3,571	77%
2022	4,647	32	24	7	3,602	78%
2023	4,680	33	24	7	3,633	78%
2024	4,712	33	25	7	3,665	78%
2025	4,745	33	25	7	3,697	78%
2026	4,779	33	25	7	3,729	78%
2027	4,804	25	19	7	3,755	78%
2028	4,829	25	19	7	3,781	78%
2029	4,855	26	19	7	3,807	78%
2030	4,881	26	19	7	3,833	79%
2031	4,906	26	19	7	3,859	79%
2032	4,926	19	14	7	3,880	79%
2033	4,945	19	14	8	3,902	79%
2034	4,964	19	14	8	3,924	79%
2035	4,983	19	15	8	3,947	79%

3 Existing System and Water Use

Water demands are the fundamental criteria on which the sizing and design of water supply facilities are based. This section presents a description of the existing water distribution system and water use information and includes projections of future water requirements based upon population planning and land use information presented in Section 2.

3.1 Existing System

3.1.1 Distribution Network

The City operates the public water system serving a portion of the City of Soldotna and several individual parcels adjacent to the City water pipe network located outside the City limits. The City also provides water to the Kenai National Wildlife Refuge visitor's center on Ski Hill Road through a private booster station and water main from the City system on Funny River Road to the visitor's center. The water system is shown in Figure 3.

Water pipes and system components have been divided into two asset classes. The first class is transmission mains. These are generally the larger diameter pipes, wells, reservoirs, booster station and Pressure Reducing Valve (PRV). These larger components provide the primary network for carrying water supplies from production and storage to the distribution network. In the pipe network the transmission mains are the 10-inch and larger diameter and are shown in Figure 3.

The second asset class is the distribution pipes. These pipes' primary purpose is to directly serve water customers. They also serve to distribute water and produce water to fire hydrants throughout the system.

3.1.2 Water Supply and Treatment

The City has five groundwater wells in its water system and does not use surface water supplies. Table 7 identifies the wells and the approximate rates of water supplied by them. Wells B, C, and C-2 are used as primary supplies because they have acceptable water quality. Well E has lower water quality because of elevated arsenic levels if pumped more than a certain amount, approximately 15,000 gallons per day. This well meets all water quality parameters for use as a potable water supply, and is used as a backup supply. If all four wells are operating they can produce 1.9 million gallons (MG) a day.

The City's three main production wells, Wells B, C, C-2, can supply a combined 1,340 gallons per minute (gpm) or 1.9 million gallons per day (MGD). Adding Well E to the total daily production for customer use would increase it by about 1%; however, for fire fighting capability Well E will increase the available well flow by 30% to make the total well production 1,880 gpm.

Well water supplies are currently treated with a combination of a chemical sequesterant and sodium hypochlorite at each wellhead prior to the groundwater entering the distribution system. The chemical sequesterant used is AQUA MAG, a blended phosphate compound for iron and manganese sequestration. The agent is added to keep the iron and manganese in solution to maintain a more appealing water, free from iron color and staining of fixtures. Occasionally water resided in the system long enough that the sequestration agent looses effectiveness and some fixture staining can occur. The City is working to improve reservoir cycling, line flushing, and water manage to reduce these occurrences.

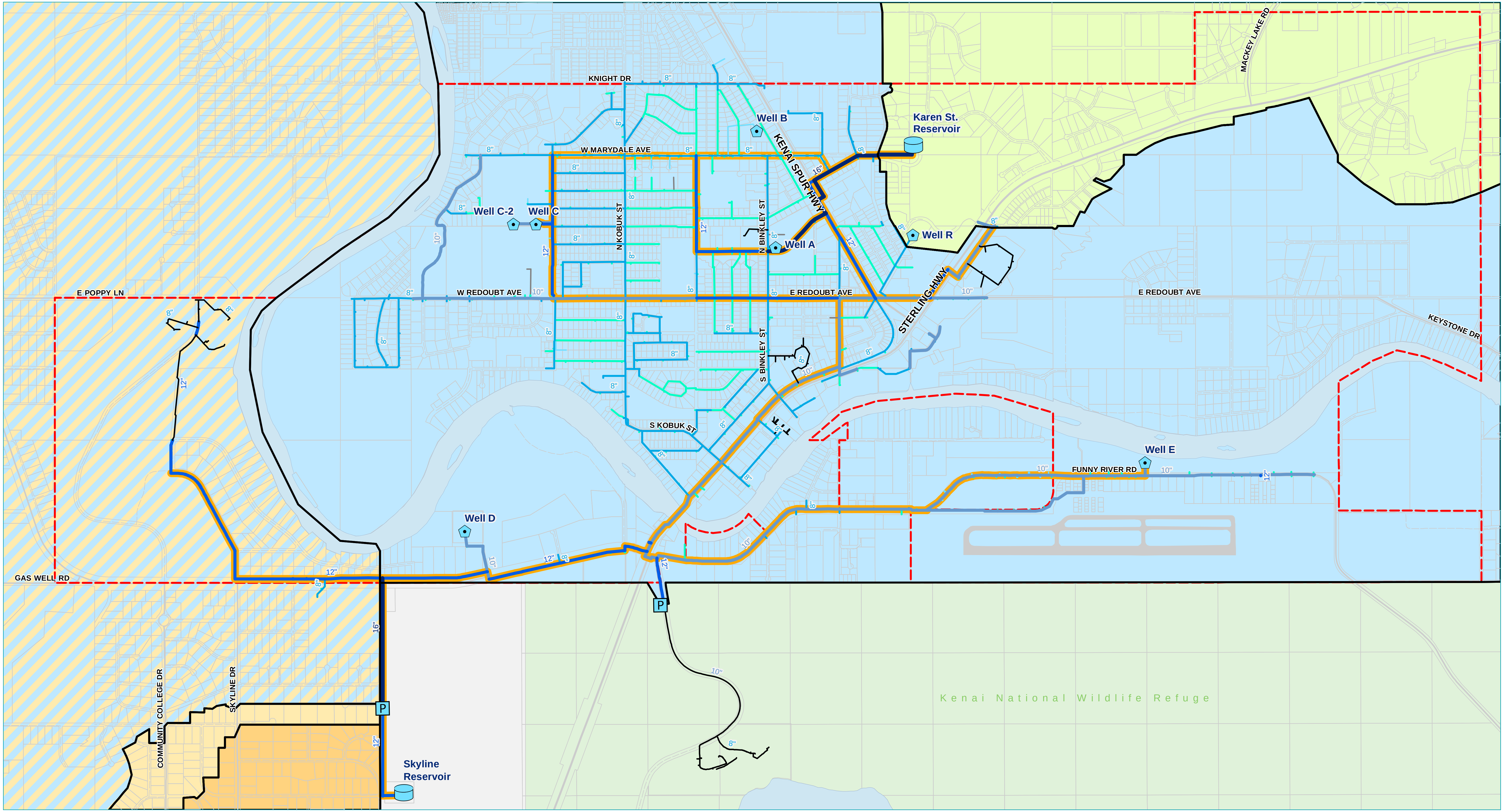
Well water supplies are currently treated with sodium hypochlorite at each wellhead prior to the groundwater entering the distribution system. The sodium hypochlorite is to maintain a disinfection residual throughout the distribution system

Table 7. Soldotna Water Supply Wells

Well	Location	Approximate Volume of Water Supplied (gpm)	Status	Redundant Power Supply
B	N Aspen Drive	420	Major supply well	100 kW Natural Gas Generator
C	High School	460	Major supply well	50 kW Diesel Generator for Well Operation Only
C-2	High School	460	Major supply well	None
E	Funny River Road	500	Minor supply well, major fire fighting supply well	None
R	N Soldotna Avenue	Not applicable	Emergency only	None

3.1.3 Transmission System

Water is delivered through the City distribution system in a transmission pipe network, shown in Figure 3. The transmission main system connects the two reservoirs and creates a loop in the core area of the city's system to which three wells connect. Two legs branch off on the south side of the system. One leg follows Funny River Road and serves the airport and connects to Well E and the second leg extends west along Kalifornsky Beach Road to the college. Wells and reservoirs on both sides of the Kenai River are connected and serve both portions of the City.



SOLDOTNA
City of Soldotna, Alaska

Water Main by Diameter
- 3/4" - 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- Unknown
- Transmission
- Private Water Main
- Pump Station
- Production Well
- Reservoir
- City Limits

Streets
- State Highway
- Town Major Collector
- Town Medium Volume
- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

Proposed Pressure Zone Boundaires
- Karen Street Reservoir Gravity Pressure Zone
- Karen Steet or Skyline Reservoir Gravity Pressure Zone
- Skyline Reservoir Gravity Pressure Zone
- Skyline Reservoir with In-Home Boosters Pressure Zone
- Future Pressure Zone

N

0 1,700
FEET

SOLDOTNA UTILITY MASTER PLAN

Water Distribution System

Figure 3

HDR

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3.1.4 Pressure Zones

The City water system operates two gravity storage reservoirs, Karen Street and Skyline Reservoir. All City customers are served on a on a single pressure zone with the service pressure set by the Karen Street Reservoir, approximately 242 hydraulic grade line (HGL). The system-wide pressure is operated within the range of 40 and 80 pressure per square inch (psi). The Skyline Reservoir provides water to this pressure zone through a PRV.

The Skyline Reservoir could be used to provide operating pressure to another pressure zone, but does not at this time.

The City provides water to the United States Fish and Wildlife Service (USFWS) operated system that serves its complex on Ski Hill Road. This complex operates at a higher pressure than the City system. The USFWS operated booster station on Ski Hill Road pumps water from the City system to the higher service pressure required by the USFWS.

3.1.5 System Storage

The reservoir storage system for the City consists of two reservoirs, which provide emergency, operational, and fire storage. Reservoir information is shown in Table 8. To serve these needs, the City operates reservoirs with gravity and pumped service. Gravity fill or discharge, also commonly termed a floating reservoir, means the reservoir is physically located at and elevation equal to the pressure zone HGL. The reservoir can be filled by and drain into the pressure zone without pumping and reservoir level fluctuates with changes in the pressure zone pressure. A gravity fill and discharge reservoir also provides system sustaining pressure.

Pumped service means that the reservoir is located at an elevation above the operating HGL and requires pumps to fill the reservoir. but provides water to the system by gravity flow through pressure reducing valves.

The Karen Street Reservoir operates by gravity and discharge. Skyline Reservoir operates through a booster station – pressure reducing valve system. Skyline Reservoir maintains system pressure through pressure reducing valve settings. Both reservoirs have the ability to add chlorine to the water to maintain disinfection levels in the stored water.

Table 8. Soldotna Reservoirs

Reservoir	Location	Maximum Volume (mg)	Service
1	Karen Street	1	Gravity fill/gravity discharge
2	Skyline	1	Pump fill/gravity discharge

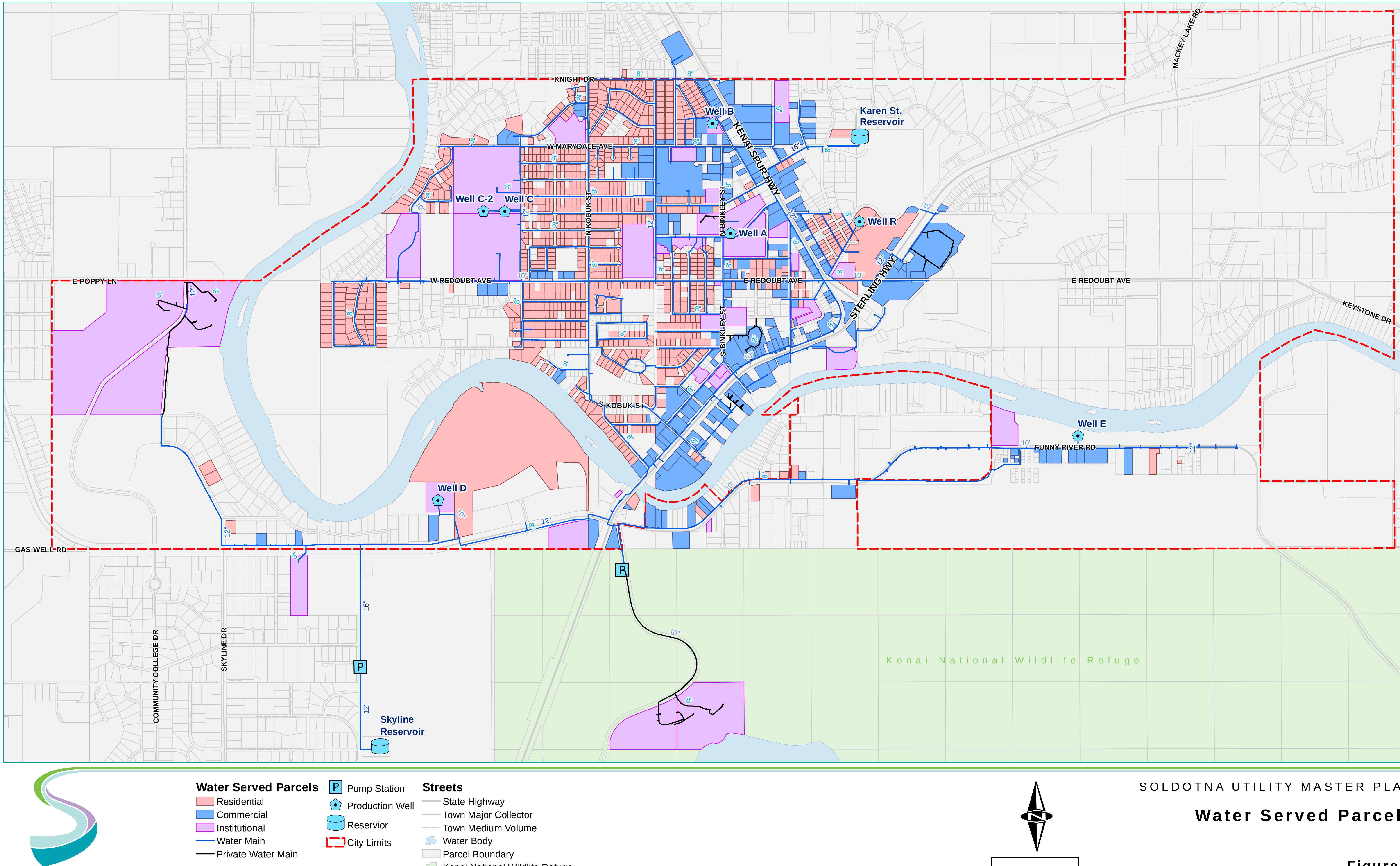
3.1.6 Booster Station – Pressure Reducing Valves

The City water system has one booster station – pressure reducing vault. This single building contains pumps that pump water up to Skyline Reservoir for storage and releases it back into the system through the pressure reducing valves.

3.1.7 Distribution Mains

The water distribution system serves the portion of the City generally adjacent to and west of the Kenai Spur and Sterling Highways on the north side of the Kenai River and adjacent to Funny River and Kalifornsky Beach Road. Water is provided to the Soldotna Municipal Airport on Funny River Road. The distribution system is shown in Figure 3.

The distribution system serves some parcels outside the city limits. The City provides water to the Kenai National Wildlife Refuge visitor’s center on Ski Hill Road through a private booster station and water main. Also some parcels outside the city limits along Funny River Road, Kalifornsky Beach Road and the Kenai Spur Highway are served. All these locations are within the City’s CPCN area. Parcels served by the City are shown in Figure 4.



SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Water Served Parcels

Figure 4

HDR

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3.1.8 Existing Pipe Network Summary

The water distribution system contains transmission mains and distribution pipes of various ages and materials as well as valves and fire hydrants. The water system installation started in the early 1970s and has continued since. The system contains approximately 199,970 feet of pipe, 750 valves, and 315 hydrants. Figure 5 shows the length and type of pipe constructed in each year since system construction began. Figure 6 shows the length and type of pipe length by pipe diameter. The locations of pipe types and ages are shown in Figure 7. This information is based on record drawings from the City utility archives.

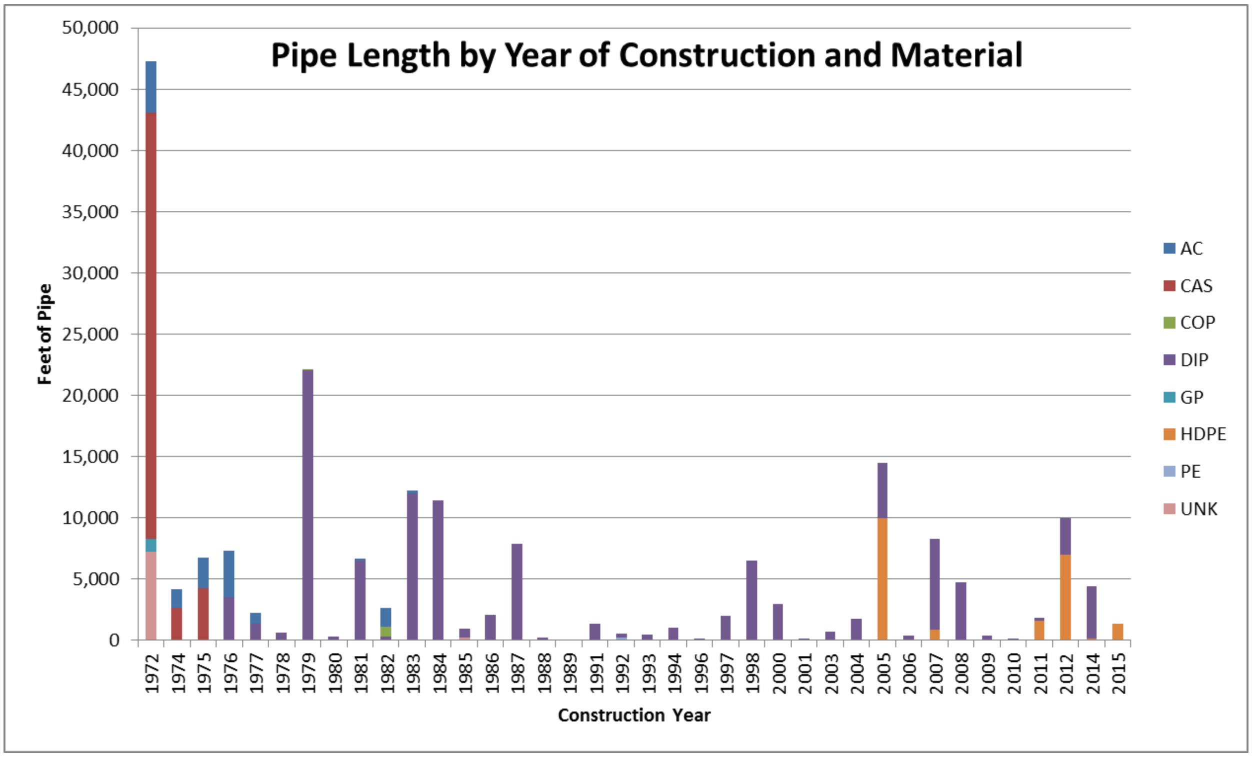


Figure 5 Pipe Length and Type by Year Constructed

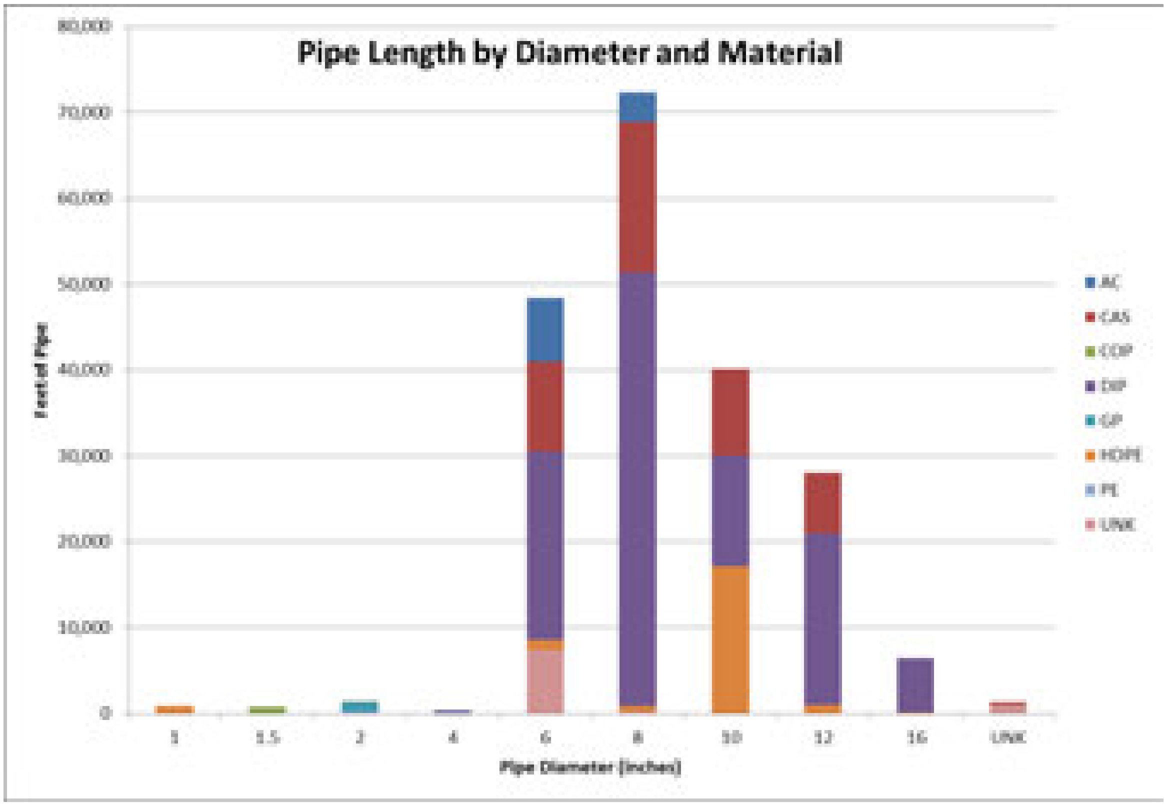
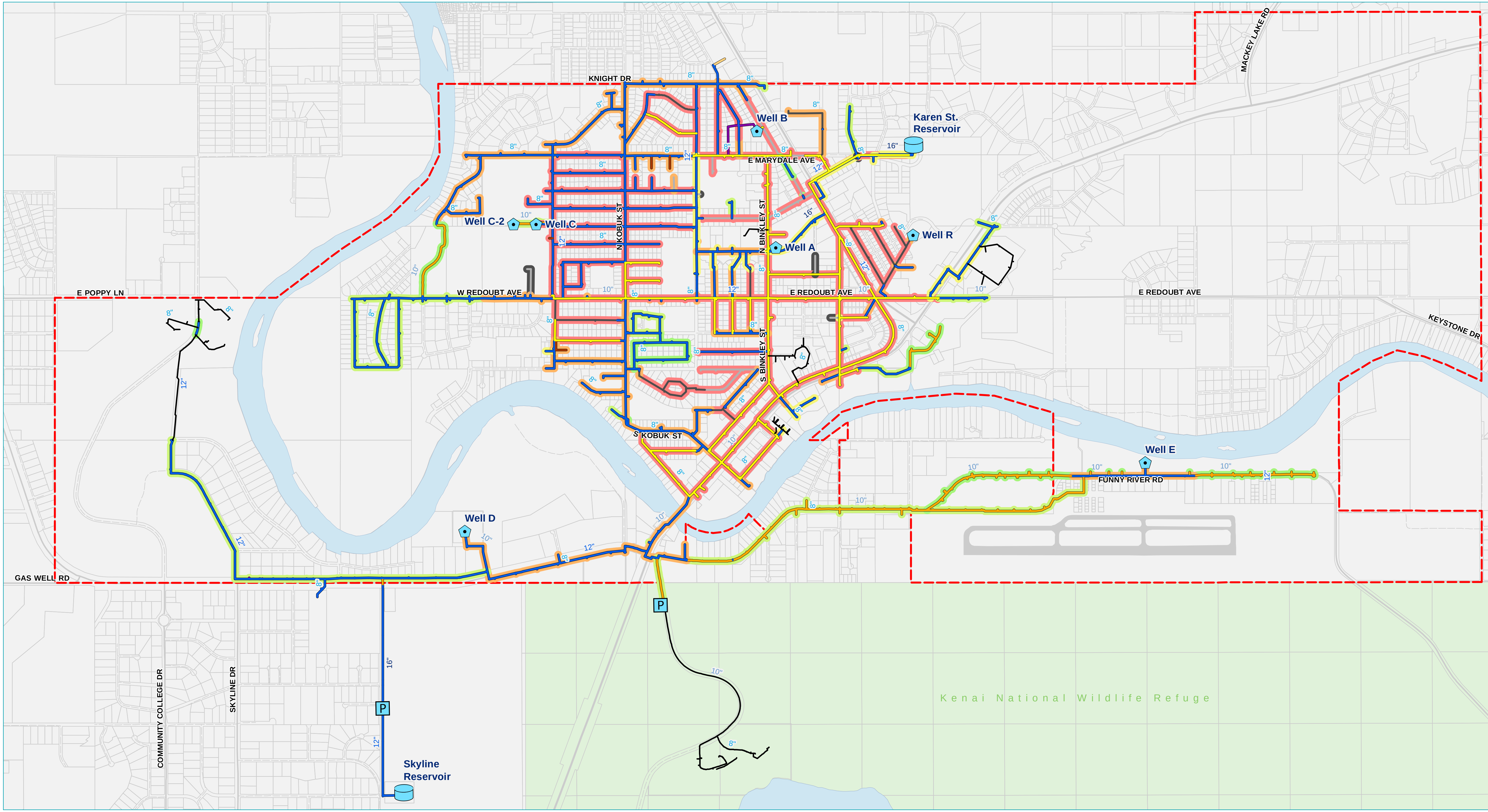


Figure 6 Pipe Length and Type by Pipe Diameter



Water Main Material
- Asbestos Cement
- Cast Iron
- Copper
- Ductile Iron
- Galvanized Pipe
- High Density Polyethylene
- Polyethylene
- Unknown

Water Main by Install Date
- 1970s
- 1980s
- 1990s
- 2000s
- 2010s
- Date Unknown

- Private Water Main
- Pump Station
- Production Well
- Reservoir
- City Limits

Streets
- State Highway
- Town Major Collector
- Town Medium Volume
- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

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SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Water Distribution System Pipe Material and Install Date

Figure 7

HDR

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3.1.9 System Operations

The City water system is operated to maintain water pressures between 40 and 80 psi. Pressure is maintained through the operating level in Karen Street Reservoir, PRV settings at the Skyline Reservoir booster station – pressure reducing valve system, and through well discharge settings. The system is managed such that during fire flow conditions the system pressure does not drop below 20 psi.

Water supply well operation is rotated between wells to maintain equipment. Wells B, C, and C-2 are the primary supply wells and are operated in rotating pairs through the week with the third well coming on line if the demand is greater than the lead two wells can supply. Well E, the fourth well, is operated to provide up to 15,000 gallons per day. The production volume restriction on Well E is to maintain arsenic levels in the produced water below regulatory limits. Under fire demand situations, the volume of water from Well E is not restricted to ensure the well is available to meet fire fighting demands.

Well operation is controlled by reservoir levels and flow rates in and out of the two reservoirs. Wells are turned on in response to both reservoir levels reaching certain levels. If well production is greater than demand, the Karen Street Reservoir fills through the wells pumping into the system, this reservoir floats on the system, while the Skyline Reservoir is filled by pumps that draw from the pipe network and discharge into the reservoir. If demand is greater than well production, both reservoirs are drained to meet the demand.

To meet large demands all four wells operate and both reservoirs discharge into the system. This is likely to only occur during a large fire fighting operation.

A fifth well, Well R, is not used for ordinary demands, however, it could be used in an extreme emergency. The well is physically locked out of the system with a valve and the power turned off to the well. The City has permission from ADEC to use the well in an extreme emergency like a large, long lasting fire but the City would have to physically open a valve at the well and turn on the power at the Karen Street Reservoir building.

The City maintains reservoir levels for emergencies and fire fighting. Reservoirs are operated above minimum levels to hold a volume in reserve for fire fighting purposes and other emergencies.

To maintain system water quality the City undertakes a pipe flushing program to remove accumulated iron and manganese precipitates from the pipe network. Pipe flushing is done twice yearly, in spring just after break up and in fall just before freeze up. Flushing starts at the north end of town and works to the south, normally taking about seven to eight days to complete. Also reservoirs are operated to maintain a mixed condition through cycling and operating the system to minimize water residence time and maintain water quality.

The City water system has hydrants for use in fighting fires. The flushing operation also opens every fire hydrant valve, checking their operability. Fire fighting manpower is provided by the KPB Fire Department. The City maintains the hydrants for use by the KPB fire department. Operating the hydrants twice yearly helps maintain the City's fire insurance rating level. Generally, several hydrants are found to require maintenance repairs during the flushing operation. These repairs are done when problems are found.

The transmission mains along Funny River and Kalifornsky Beach Road are long, large diameter pipes. To improve water quality to customers on these mains the City has installed bleeders at the end of each. These bleeders are operated year round and help to move water through the pipelines, thereby improving water quality and decreasing precipitation of iron and manganese. The bleeders also provide some freeze protection for these mains.

A concern for the City is pipe freezing during the winter. The City actively works to minimize this occurrence. The City is generally located on dry gravel material, which can freeze deeply during cold winters, especially where roads and parking areas are plowed. As most of the City's water pipes are located in plowed roads and parking areas, pipe freezing does happen. Freezing is especially problematic in dead end pipes. To address the issue the City installs and operates bleeder pipes on selected hydrants, requests residents to leave faucets running, and closes certain valves to force water flow through vulnerable pipes. These maintain flow through pipes, especially dead end ones, and can reduce pipe freezing issues.

Soldotna's pipe network is generally 40 years old and as pipes age breaks can increase. The most common industry standard to measure the structural performance of pipe is the annual number of breaks per 100 miles. The industry average is believed to be approximately 15-20 breaks per 100 miles. City staff has reported roughly six mainline breaks over the past ten years which equates to a break rate of roughly 1.6 breaks per 100 miles. Therefore, from a structural perspective, the City system is performing approximately ten times better than industry averages. Additionally, City staff has indicated that when pipes are exposed (e.g. service connection, roadway project, etc.), a visual inspection indicates the pipes are generally in good condition.

Currently, the City does not actively replace aging pipe. The City will consider replacing pipe if opportunities arise such as during street restoration. Based on the City's break rate performance and the lack of an inexpensive, effective, and industry standard condition assessment technique for water mains; HDR would not recommend replacing water mains at this time. However, these pipes will not last forever. At some point, breaks will become more frequent and the City will need to make investments to renew the infrastructure. Therefore, HDR recommends that the City keep good records of breaks, preferably in a GIS database for use in system analysis, and evaluate this data to determine if breaks are increasing and whether breaks are associated with particular variables. Such analysis can help in optimal programming pipe replacement.

The City operates two painted steel reservoirs. These reservoirs should be monitored for corrosion. In general modern steel reservoir coatings have a design life of 20 to 25 years, depending on many factors. Therefore, monitoring the coating performance, as the City has done at the Karen Street Reservoir, is a good practice to maintain the useful life of these assets.

3.2 Existing Water Use

3.2.1 Water Use Type

Water supplied by the City serves residential and commercial users. There is no large industrial water user connected to the system. Residential use includes all in-house demands, as well as other uses associated with homes (car washing for example), plus residential irrigation of lawns and gardens. Commercial uses include those at retail and wholesale outlets, motels, hotels, restaurants, offices, public institutions, schools, car washes, breweries, and other such buildings. In addition to residential and commercial demand, water must be available for fires and other emergencies. Emergency supplies are drawn from reservoir storage or wells.

3.2.2 Current Water Use

Soldotna presently serves areas within the eastern portion of the city limits and along Funny River Road and Kalifornsky Beach Road. The parcels served in 2014 with City water are illustrated in Figure 4. The parcels served include residential and commercial properties.

City water production records for the years 2005 to 2014 were used to evaluate usage. The data show that Soldotna water production has varied yearly depending on summer irrigation, twice yearly pipe flushing, and winter freeze protection needs. Yearly water production for the years 2005 to 2014 is shown in Table 9.

Also presented in Table 9 is an annual average daily water production. This value is calculated by dividing the yearly production by 365 days. Water production has varied but remained in the same general range through this period. While data does not exist to understand exact causes for yearly use changes, water use appears to vary in response to climate conditions and line flushing. Usage increases from population growth, appear generally small compared to the variation caused by other factors. This low increase in water use from population growth is consistent with data from Anchorage and cities in the continental United States. The low increase compared to population growth is attributed to the increased use of low flow fixtures and appliances now required by plumbing codes. This trend is expected to continue for up to a decade longer.

Table 9. Soldotna Water Production, 2005 to 2014

Year	Yearly (MG)	Annual Average Daily (MGD)	Maximum Month (MGD)
2005	252	0.69	0.91
2006	296	0.81	0.89
2007	321	0.88	1.05
2008	303	0.83	1.06
2009	367	1.01	1.11
2010	290	0.79	1.36
2011	304	0.83	1.38
2012	312	0.86	0.98
2013	302	0.83	0.92
2014	258	0.71	0.88

Soldotna billing records were evaluated by the *Water and Sewer Rate Study* (HDR, 2015) to estimate water usage by customer type. Data from this study for 2014 are presented in Table 10. Meter records by customer type were extrapolated to similar users and then totaled by customer type to estimate total water use. These data show that residential customers use about 60% of the yearly total and commercial users use about 40%.

Table 10. Soldotna Water Usage by Customer Type

Customer Type	Percentage of Total Yearly Water Use
Single Family	45.6%
Residential Multi-Family	11.7%
Duplex	1.7%
Commercial	40.5%
Irrigation	0.5%
Total	100.0%

The data presented in Table 10 does not include unaccounted for water uses like some freeze protection line bleeding, pipe flushing, pipe leak losses, and other non-metered uses. The extrapolated meter data was compared to water production which indicates that approximately 25% or more of the total water production may fall into the unaccounted for category. Unaccounted for water values greater than 10% of total water production are considered high and a reason to look for causes.

To evaluate the weather related component of water use HDR compared annual water use and sewage production with average Anchorage monthly temperature (see Appendix B). Anchorage weather data was used because it provides good information on general regional weather patterns. The temperature data is used to indicate whether a month was above or below normal temperature, which is the case for the entire region. Evaluating this data indicates that Soldotna water use values are associated more to winter bleeding for freeze protection than irrigation in warm summers.

Winter freeze protection bleeding is both a metered and non-metered use. Some metered customers bleed water for freeze protection. This water use does show up in metered use amounts, raising the per capita use of the city, as well as in the sewer system and accounted for as sewage influent flow, with an increase in the per capita sewage amount for the City. Unmetered line bleeding for freeze protection is done at hydrants by the City or before customer meters and is not accounted for as a metered use, or as a sewage flow, and is unaccounted for water.

Further analysis of the water production and sewage influent flow data was done to evaluate water system loss from leaks. Comparing Soldotna's water use against Anchorage's finds that Soldotna's per person use is consistently higher than Anchorage's, even accounting for greater freeze protection bleeding that may occur in Soldotna. Leaks in Soldotna's water system are reasonable to have considering its age and pipe material. Figure 5 shows when the system pipes were installed and what materials were used. The majority of the system was installed in the 1970s and is cast iron pipe. Line freezing is problematic now and it was likely worse in the system's early years when about a third of the current population was using it. Therefore it is a reasonable assumption that freezing occurred which cracked the brittle cast iron pipe. The system may have small leaks from these freeze induced cracks.

Because of the large amount of unaccounted for water and the relative small number of metered accounts, water use was combined into a single value and used to estimate a composite average per capita demand. Based on the 2005 through 2014 data analyzed the Soldotna uses an average of 258 gallons per capita per day (gpcd) and the ratio between peak month and average month is 1.3. These values are recommended for use in this plan to evaluate future water needs.

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4 Water System Development Criteria

This section presents the criteria used to identify and evaluate recommendations. The factors used in screening and analyzing specific capital improvement recommendations for water system improvements are developed. In addition, criteria for system hydraulics, fire flow storage, use of groundwater, and municipal planning for utilities are described.

4.1.1 Hydraulic Criteria

Soldotna operates a water system that consists of wells, storage reservoirs, and a distribution network. The following are recommended hydraulic objectives for Soldotna's water system.

- Operate sufficient well capacity to meet peak period day demands.
- Use water reservoirs to meet hourly variations in water demand.
- Design transmission mains to provide peak period day flow capacity for the design year.
- Install local distribution piping fed by mains and sized to ensure adequate fire flow during peak period day demand.

In the course of the 2015 WMP, other hydraulic operating criteria were confirmed. Table 11 presents the recommended criteria goals for acceptable pressures within the distribution system. Pressures are measured at the ground surface and with maximum pressures measured when the reservoirs are full and minimum pressure measured when reservoirs are one third full. Those customers served at greater than 80 psi are required by the Uniform Plumbing Code to install an in-residence pressure reducing valve.

Table 11. Hydraulic Criteria Recommendations

Parameter	Range (psig)
Operating Pressure Range	40 to 100
Minimum Pressure During Peak Hour	40
Minimum Pressure During Fire Flow	20

The distribution system should also have the ability to support fighting a fire within the areas covered with hydrants. For system planning it is assumed that the water system have sufficient production and storage capacity to provide water to fight a fire every day and recover the reservoirs to normal operating levels in 24 hours. The system should be configured to provide this level of fire flow during a peak period day demand event.

4.1.2 Annexation Impacts

The City could expand the city limits through annexation of adjacent areas and provide water service to annexed areas through the extension of transmission capacity and distribution pipes, depending on the location of the annexed area. The impacts to the water system from annexing specific areas were not evaluated in this master plan because the specific areas were not identified. When evaluating how to provide water service to potential annexation areas the City should consider the following items.

- The current water system currently has capacity in supply, transmission, and storage, to support moderate expansion. If a specific area is slated for annexation and water service will be provided, the City should evaluate the customer and distribution network increase on utility staff levels, water supply, and system maintenance. These analyses may indicate that the need for additional water supply is accelerated or utility staffing increased to maintain the current level of service over a larger network.
- Extension of the water system is best done in a systematic manner and avoids 'leap frog' extensions. Systematic expansion adjacent to the edge of the existing system can areas result in revenue being generated from the entire length of new pipe whereas 'leap frog' development results in long segments of pipe being installed to serve more distant areas and those connecting segments of pipe not providing revenue through customer connections.
- Service to new areas, especially east of the city core, will require a new pressure zone being established with requisite booster stations and pressure management equipment.
- Commercial areas added to the edge of the existing system may not have adequate fire flow service. System capacity for fire flows should be verified as the system is extended.

4.1.3 Storage

In general, the functions of reservoirs in a municipal water system are to:

- Provide storage to meet peak hour demands
- Supply storage for fire flow demands
- Provide operational flexibility
- Provide pressure equalization
- Provide system reliability

Recommended criteria for water storage for the 2015 WMP are based upon a combination of criteria industry standards, current system operation methods, and new data. Storage recommendations were determined by review of fire flow requirements, operational storage, and emergency storage needs.

1. Emergency Storage

There is a need for treated water storage to cover short-term emergencies, which may disrupt one or more of Soldotna's production wells. Soldotna has not adopted specific guidelines for emergency storage requirements. Adopting emergency storage criteria can give Soldotna another measure of the provided customer service level and a way to prioritize capital spending on the water system.

Emergency storage criteria are generally case and location specific. Soldotna could consider adopting the emergency storage requirements used by AWWU as these offer criteria used by a regional utility addressing the same emergency situations as Soldotna may encounter.

Through planning studies beginning in the 1980s AWWU determined that a total of three days average annual daily demand should be held in reserve be prepared for emergencies. Three days was projected to be the maximum amount of time AWWU planners estimated it would take to correct a situation where some of the source of water might be unavailable. Examples of such a condition include a temporary disruption of water production wells, a major break of transmission mains, or a natural disaster. Planning for an emergency of three days duration has been reasonable for AWWU in view of the system operated, geological conditions, and setting in which its service area is located.

Because of the similarities in climate and geological setting the 2015 WMP recommends Soldotna consider adopting similar emergency storage criteria. Emergency water storage requirements would be based on providing three days storage of water demand. Reviewing production records for Soldotna shows variation between peak period and non-peak water demands. During peak periods, May through August, the average demand is 310 gpcd, while during non-peak times, September to May, the average demand is 245 gpcd. The difference between the non-peak demand and peak demand is summer tourism and irrigation and other non-consumptive water use and represents approximately a 20% increase in water use.

While during emergency situations Soldotna could institute mandatory conservation and reduce some peak period demands, it is recommended that emergency storage be calculated based on peak period use, or 310 gpcd. The smaller non-peak period daily demand for Soldotna was not used in this calculation because it is assumed that an emergency situation can occur in the summer and the City should be prepared.

Emergency storage can be met by aboveground reservoirs and groundwater pumping, however, for planning purposes it is recommended that half the emergency storage be met by wells with aboveground reservoirs providing the other half. Limiting well storage provides leeway and allows for wells being under repair, loosing electrical power, or sustaining damage during an emergency. To ensure availability during many types of emergencies, wells should have redundant power supplies so that the well pumps can be operated during the duration of the emergency.

Emergency storage can be provided in reservoirs that are operated through either gravity supply or pumping. Ideally, reservoirs should be situated to provide gravity operation, which ensures that the supplies contained in the reservoirs will be available during power outages without the need for power at the reservoir site. Soldotna operates two gravity reservoirs in its system, however, Skyline reservoirs requires pumping to be filled.

2. Operational Storage

Operational storage is water held in storage to meet hourly fluctuations in demand. Industry standards generally define operational storage as a volume equal to 40 to 50% of the peak day demand to meet peak hourly demands. Operational storage volumes in practice are based on peak day use as this represents the largest amount of water normally supplied by the system. Basing operational storage on peak day demand is recommended as it maintains the maximum operational flexibility for the system.

3. Fire Flow Demand Requirements

To assess whether storage and well capacity is adequate, the 2015 WMP developed the following criteria for establishing the volume of aboveground storage to be reserved for fire flow demand:

- Storage and flow requirements are based upon a 4-hour, 4,000 gpm fire.
- Three production wells are in operation during the fire.
- One fire occurs within a 24-hour period.

This fire flow requirement is assumed to remain the same through the planning period.

4. Recommended Storage Requirements

To determine requirements, the 2015 WMP recommends that the Soldotna's water storage should be the greater of: a) the sum of fire flow storage plus operational storage or, b) emergency storage equivalent to three days of peak day demand. Table 12 presents recommended 2015 fire flow, operational and emergency storage requirements based on the previously set out criteria. It is assumed that half of the recommended emergency storage requirement be provided by groundwater accessed by the City's wells.

Table 12. Recommended Storage Requirements

Year	Fire Flow, MG	Operational, MG	Fire Flow plus Operational, MG	Emergency, MG
2015	0.76	0.56	1.32	1.68

Based on the proposed planning criteria, emergency storage is the greatest storage requirement. The City currently has two 1 MG reservoirs, which meet the proposed storage planning requirements.

4.1.4 Use of Groundwater Supply

Soldotna will continue to rely on wells as the only source of supply. In the planning period if projections of customers served are met, overall water demand will increase but no additional firm supply will be required. Demand will continue to be somewhat seasonal in nature with larger demands during the period of May through August.

However, because population growth or demands may increase more rapidly than expected, Soldotna should implement a program to identify future groundwater supplies early in the planning period. The program should begin by determining the safe yield of the aquifers used by the City. After that, a new well site should be identified and a test well drilled to determine yield and water quality. If the site can provide sufficient supply of adequate quality, site ownership should be secured and the site held in reserve for development when the City requires additional supplies.

4.1.5 Consistency with Related Planning Efforts

The 2015 WMP was developed to be consistent with comprehensive development plans for the study area. Maximum use of the findings in the current comprehensive plans for the City and KPB were made. In addition, specific strategies concerning extensions of public water service were considered, including:

- Extensions of public water systems are to be planned to adequate standards for fire flow demand, including volume and pressure.
- Extensions of the system should start with service to areas contiguous with the existing system and avoid ‘leap frogging’ through these areas.
- Extensions should not be planned to areas designated for rural low-density development, except to resolve public health needs or as requested by property owners.
- Utility improvements should be coordinated with other agency projects to achieve savings and prevent utility placement conflicts.

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5 Future Water Requirements

Predicting trends in water demand is difficult because of the number of variables that have the potential to influence demand characteristics. Such factors as voluntary conservation measures and metering of the water system, as well as more effective line freeze avoidance, leak detection, and repair tend to lower the overall water demand. A rapid expansion of the water system also tends to decrease the per capita water demands because the newly laid pipe generally exhibits less leakage than older piping within the system. Factors that tend to increase water demands are increased development of single family homes and aging and gradual deterioration of the existing water distribution pipes and services. Temperature extremes, both cold in winter and heat in summer, as well as periods of high or low precipitation are variables that can affect the water demand characteristics, but are difficult to predict.

5.1 Future Water Use

Future water use by the city will be a function of the projected population served during the planning period and the estimated water use by the served population. Served population estimates presented in Section 2 were used to estimate the total Soldotna population served by Soldotna in 2015. Of the total population of total City residents, it is estimated that approximately 77% are currently served by water, which will increase to 79% by 2035. The remaining people are served by other private water utilities, water systems, or wells.

Future water use was estimated based on served population estimates and the average peak month per capita demand and peak factor previously presented. The projected demands estimates are shown in Table 13.

Table 13. Future Water Use, 2015-2035

Year	Total Population Projected	Projected Population Served	Estimated Average Month Water Use, MGD	Estimated Maximum Month Water Use, MGD
2015	4,375	3,349	0.86	1.12
2016	4,419	3,389	0.87	1.14
2017	4,458	3,425	0.88	1.15
2018	4,496	3,461	0.89	1.16
2019	4,535	3,497	0.90	1.17
2020	4,575	3,534	0.91	1.19
2021	4,615	3,571	0.92	1.20
2022	4,647	3,602	0.93	1.21
2023	4,680	3,633	0.94	1.22
2024	4,712	3,665	0.95	1.23
2025	4,745	3,697	0.95	1.24
2026	4,779	3,729	0.96	1.25
2027	4,804	3,755	0.97	1.26
2028	4,829	3,781	0.98	1.27
2029	4,855	3,807	0.98	1.28
2030	4,881	3,833	0.99	1.29
2031	4,906	3,859	1.00	1.29
2032	4,926	3,880	1.00	1.30
2033	4,945	3,901	1.01	1.31
2034	4,964	3,922	1.01	1.32
2035	4,983	3,944	1.02	1.32

5.3 Water Storage Requirements

To determine future storage requirements, the 2015 WMP recommends that Soldotna's water storage should be the greater of: a) the sum of fire flow storage plus operational storage or, b) emergency storage equivalent to three days of peak day demand. Table 14 presents recommended 2035 fire flow, operational and emergency storage requirements based on the previously set out criteria. It is assumed that half of the recommended emergency storage requirement be provided by groundwater accessed by the City's wells.

Table 14. Recommended Future Storage Requirements

Year	Fire Flow, MG	Operational. MG	Fire Flow plus Operational. MG	Emergency. MG
2035	0.76	0.66	1.42	1.98

Based on the proposed planning criteria, emergency storage is the greater of the storage requirements. The City currently has two 1 MG reservoirs, which meet the storage planning requirements through the planning period.

It should be noted that the emergency and operational storage is based on the City's current water use projected into the future. The current amount of water use is high when compared to other cities in the region. If the source of the greater than expected water use is found and can be reduced or eliminated throughout the planning period, the amount of operational and emergency storage can be reduced. It is recommended that the City pursue determining the sources that may increase water use and eliminate those that are cost effective to do so.

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6 Water System Project Development

This section identifies system deficiencies and presents system extensions and improvements to resolve them. Identified recommended improvements form the basis for the CIP discussed in Section 7.

6.1 Water System Recommendations

In preparation of the 2015 WMP, it is acknowledged that most areas within the City of Soldotna's Certificated Water Service area are anticipated to remain on individual or small community wells through the 20-year planning horizon. These areas are the rural residential and commercial areas outside the Soldotna city limits, the rural residential areas in the eastern part of the City, and other areas within the city limits. However Soldotna water service may be extended into portions of these areas adjacent to the existing water system through private development.

Service to the other certificated water utility serving a small area within Soldotna's certificated area is assumed to not occur in the planning period.

6.1.1 Project Alternative Classes

In developing recommendations for the 2015 WMP, projects were divided into three broad project categories: Transmission and Supply (T&S), Operation and Redundancy (O&R), and Upgrade (UP) . These categories were selected as they represent the classes of capital projects Soldotna undertakes. T&S projects focus on well supply, treatment, and distribution of bulk water. Such projects provide the backbone infrastructure allowing Soldotna to have ample water supply capacity to serve water demands and the ability to store and deliver those supplies to Soldotna's customers. Examples of T&S projects are water treatment upgrades, well installation, reservoir construction, and large diameter water main installation.

Project development for the T&S category relied on future population estimates and developing recommendations to meet projected growth and water demands. Population growth scenarios were based on area comprehensive plans. These customer growth estimates were applied to the water system using the InfoWater water system model developed for this planning process and used to evaluate recommendations. The water system model was used to select the optimal pipe size, as well as identify projects that effectively met projected demands. Project locations were determined through maximizing use of existing right-of-way corridors, avoidance of expensive construction conditions, minimizing length, and coordination with other planned road or utility construction projects.

O&R projects were developed to minimize the cost to run the water system or maximize the system back-up capacity by creating multiple ways to serve customers. Examples of such projects include booster stations to serve new pressure zones, system interconnections to create looped pipe networks, or installing redundant power at wells to provide uninterrupted service during electrical system outages.

Projects selected for the O&R category relied on the system modeling and consultation with Soldotna staff. These projects were developed to provide fire flow to areas and to provide operational redundant (looped) mains. Fire flow coverage was often the prime motivation for these projects and many focused on creating system loops and multiple network routes to serve such demands. Finally O&R projects were also developed to optimize system operation in areas where customers are served at the low end of system pressures. These projects added connections to improve customer service.

The final class of recommendations is UP projects. These projects focus on pipe upgrades needed to renew or replace aging infrastructure and thereby decrease emergency repair or operating costs. Examples of such projects include identifying and addressing unaccounted for water loss.

6.2 Transmission and Supply Recommendations

As discussed in Section 3, Soldotna will serve additional customers in the coming 20-year period. T&S projects were developed to provide adequate supply to serve these demands, and move large volumes of water to where it is needed. The issues associated with these three T&S needs are discussed first and are followed by descriptions of projects developed to address T&S needs.

Analysis of the water system with the developed hydraulic model indicates that in general the system has adequate capacity to meet current and future water supply, storage, and distribution needs. However, fire flow delivery and system pressure maintenance at the eastern extent of the system along the Sterling Highway is at the limits of system operating criteria. To address these issues two transmission main projects are recommended. The Foothills Drive Water Main, a 12-inch diameter main along Foothills Drive connecting the Karen Street Reservoir and the Sterling Highway mains, will improve fire flows, provide capacity for future system expansion, and serve potential customers along Foothills Road. The Southeast Central Business District (CBD) Water Main, a 10-inch diameter water main connecting mains in 47th Street and East Redoubt Avenue, will improve fire flow service, provide redundant looping of this area, and serve development.

Should development warrant extending the water system east along the Sterling Highway corridor, the water system will require a booster station to pump water in to a higher pressure zone. The pressure zone serving Soldotna has reached its maximum limit on the eastern Sterling Highway. The Sterling Highway Booster Station project should happen in two phases. Phase 1 would acquire a location for the booster station and then in phase 2 construct a booster station to serve system expansion into this new pressure zone.

The Soldotna comprehensive plan notes the potential for growth around the college. This area is at the end of the existing distribution network and if customer growth becomes large enough, additional transmission capacity may be needed. One transmission main corridor is the East Poppy-West Redoubt Main. This water main would connect pipes in East Poppy Lane to West Redoubt Avenue would increase system looping and improve fire flow service at East Poppy Lane. While a direct route, the pipe must cross the Kenai River. Constructing the pipe under the river is likely cost prohibitive and does not meet Kenai River habitat management objectives. Therefore if this project is considered, it should only be done in conjunction with a project that constructs a bridge over the Kenai River at this location.

Soldotna should begin a program to identify future groundwater supplies early in the planning period. The program should begin by determining the safe yield of the aquifers used by the City. After that a new well site should be identified and a test well drilled to determine yield and water quality. If the site can provide sufficient supply of adequate quality, site ownership should be secured and the site held in reserve for development when the City requires additional supplies.

Constructing these recommended T&S projects will help Soldotna meet projected growth and water demands. The projects will provide for both adequate and strategically located water supplies and the ability to move those supplies efficiently to where they are needed. The water supply projects will allow Soldotna to meet the anticipated peak period day demand, operational storage, fire flow, and emergency supply requirements of existing customers and future development areas. Water transmission projects recommended by the plan will build the needed infrastructure to move supplies to serve customer needs through and beyond the planning period. The combination of the recommended T&S projects will maintain Soldotna's already high service level far into the future.

6.3 Operation and Redundancy Recommendations

Soldotna strives to serve its customers in a cost effective and efficient manner with the highest level of service possible. O&R projects were developed to improve the level of service provided to Soldotna's customers or to reduce system operation costs through capital improvements. The issues associated with these two O&R goals are discussed first and are followed by a list of the recommendations developed to address the O&R goals.

Soldotna relies on four water wells for supply. Wells C and C-2 are strategically located in the core of the service area can provide the bulk of needed supply. The generator at Well C is at the end of its service life and undersized to operate the well and the treatment chemical pumps at the same time. The Well C Generator Replacement project would replace this generator, located at Well C with a generator large enough to operate the Wells C and C-2 and water treatment systems at the well house. This will provide the redundant power supply for both wells and provide a high level of system resilience for daily and emergency water supplies.

The Soldotna water system has several long, small diameter water mains serving residential streets. Water system modeling analysis identified where the pipe length restricts fire flows at the farthest end of the system. Also, because of the dead end pipe length, water flow through the pipe is low and water quality can deteriorate. The Riverview-Trumpeter-Legacy Interconnection project would address the dead end water mains in Riverview and Trumpeter Avenues by interconnecting them with South Legacy Loop Main to improve fire flow capacity, water quality, and system redundancy.

Constructing these recommended O&R projects will help Soldotna maintain its high level of service throughout its system as population and associated demand increase. These projects will also reduce operation and maintenance costs through replacing aged equipment. Constructing the recommended interconnections will provide greater system redundancy allowing Soldotna to alternate pipe networks to serve its customers. These recommended O&R projects will improve Soldotna's service level to its customers while reducing operational costs in the future.

6.4 Upgrade Recommendations

Soldotna has a culture of placing a priority on system maintenance and UP projects have been developed to address maintenance issues in a systematic manner. The UP recommendations were developed to continue robust system maintenance.

Unaccounted for water use appears high compared to the number of customers and to larger regional utilities. Water loss can be real, like leaks, or virtual, through inaccurate metering. This plan recommends that Soldotna start a program to understand the potential sources of the large amount of unaccounted for water. This program should begin by the metering systems and the SCADA programming to report it for accuracy.

A second step would be to identify and measure all known unmetered City operated bleeders. Bleeder inventory could also include other known unmetered main or service line bleeders. This information is important in understanding the magnitude and timing of this use and how it compares to overall system demand.

The City flushes the water system twice yearly but does not record the amount of water used during this operation. Measuring the volume used through SCADA data or flow meters will identify whether this is a significant amount and how it impacts total use.

Once a through accounting of known unmetered uses is complete an analysis can be done to evaluate whether the remaining unaccounted for water is high. If it is, a Water Leak Study project would conduct a leak study of the system to identify if excessive leakage exists and if any identified leaks are severe enough to warrant repairs.

If significant and repairable leaks are found a Leak Repair Phases 1 to 4 projects will develop a phased program to repair the leaks or coordinate their repair with coincident projects. This work will be spread over the life of the plan and develop a systematic program to continually work to reduce leaks in the system. Reducing system leakage can reduce water use and delay water supply increase projects.

Water supply security is important for utility operators. The fencing around Well E is substandard and should be improved. The Well E Fencing project would address this issue and replace and improve the security fencing at the well.

The Soldotna Wastewater Treatment Plan (WWTP) effluent discharge permit may lead to work on the water system. The effluent discharge permit will likely have numeric limits for the concentration of copper and zinc in the effluent. To meet treated wastewater discharge limits, the concentration of copper and zinc in the sewage influent entering the WWTP may need to be reduced. This determination will be made during the WWTP discharge permit negotiations. If influent copper and zinc concentration reduction is warranted, the Water Treatment Upgrades project could be implemented to reduce the amount of copper and zinc arriving at the WWTP in the sewage influent stream through upgrades to the well water treatment process. This project would construct well water treatment systems at Well B and Wells C and C-2 and Well E. The project can be phased and will require a building at each location to house treatment equipment. The project can have the added benefit by removing iron and manganese from the well water also and improving water quality in the system, and reducing system line flushing.

During development of the system geographical information system database model it was discovered that two distribution mains serving Lorraine Court and Marydale Court are 1 ½ -inch pipes. While the pipe is adequate to met residential demands the pipes are undersized to support a fire flow should a hydrant be installed on the street. If the streets are reconstructed these pipes should be replaced with larger distribution piping and a fire hydrant to improve fire flow coverage on the streets.

Preventative maintenance to retain the integrity of a system is the hallmark of a well operated enterprise and will lower overall system operation costs by reducing emergency repairs. Implementing these projects will upgrade system components in a systematic manner, within Soldotna's budgeting structure. Also these projects represent an investment in bringing all components in the system to the same level of service. Constructing these UP projects is Soldotna's investment in operating its system at its current high level of service far into the future.

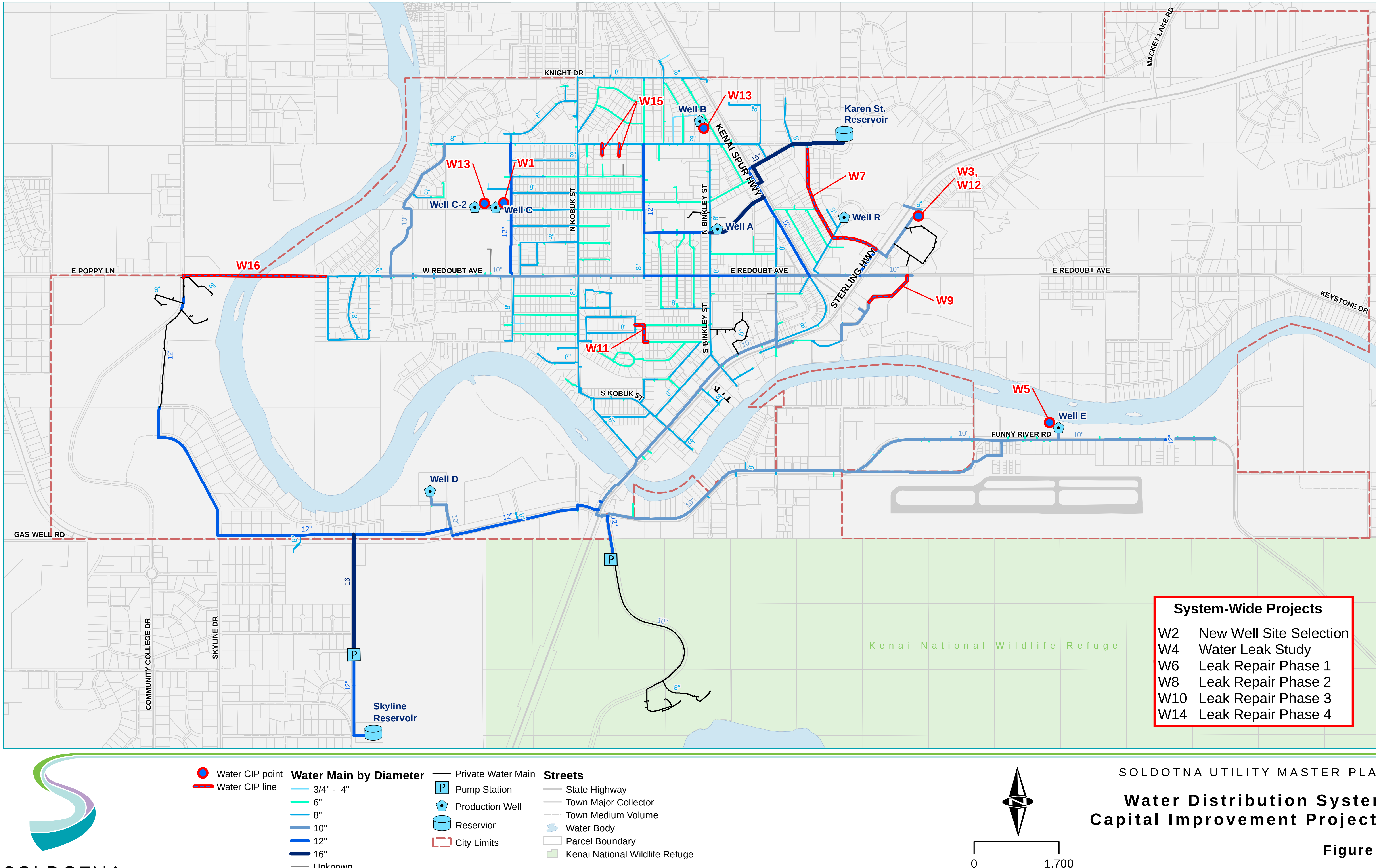
6.5 Project Development Recommendations

The previous sections identified T&S, O&R, and UP projects to address system needs and future service. The identified projects are compiled in Table 15 and their locations shown on Figure 8. The projects are developed to a planning level only; they are conceptual in nature and subject to refinement as they are implemented. Section 7presents the method used to establish project priorities and the final project list.

Table 15. Soldotna Recommended Projects

Project #	Project Name	Project Type	Description
W1	Well C Generator Replacement	O&R	The generator should be replaced with a generator large enough to operate the Wells C and C-2 and water treatment system at the well house.
W2	New Well Site Selection	T&S	This project will identify, prove up, and procure a site for a future water supply well.
W3	Sterling Highway Booster Station	T&S	This phased project will identify and purchase a booster station site to serve system expansion into a new pressure zone along the eastern Sterling Highway.
W4	Water Leak Study	UP	This project would conduct a leak study of the system to identify if excessive leakage exists and if any identified leaks are severe enough to warrant repairs. The study can be phased.
W5	Well E Fencing	UP	Well E security can be improved through adding fencing
W6	Leak Repair Phase 1	UP	This project will systematically repair leak sources identified through the Water Leak Study.
W7	Foothills Drive Water Main	T&S	This project will build a 12-inch diameter main along Foothills Drive connecting the Karen Street Reservoir and the Sterling Highway mains will improve fire flows, provide capacity for future system expansion, and serve potential customers along Foothills Road.
W8	Leak Repair Phase 2	UP	This project will systematically repair leak sources identified through the Water Leak Study.
W9	Southeast CBD Water Main	T&S	This project will build a 10-inch diameter water main connecting mains in 47th Street and East Redoubt Avenue will improve fire flow service, provide redundant looping of this area, and serve development

Project #	Project Name	Project Type	Description
W10	Leak Repair Phase 3	UP	This project will systematically repair leak sources identified through the Water Leak Study.
W11	Riverview-Trumpeter-Legacy Interconnection	O&R	This project would construct South Legacy Loop main to improve fire flow capacity, water quality, and system redundancy
W12	Sterling Highway Booster Station	T&S	This phased project will construct a booster station to serve system expansion into a new pressure zone along the eastern Sterling Highway.
W13	Water Treatment Upgrades	UP	This project would construct well water treatment systems at Well B and Wells C and C-2 and Well E. The project can be phased and will require a building at each location to house treatment equipment
W14	Leak Repair Phase 4	UP	This project will systematically repair leak sources identified through the Water Leak Study.
W15	Lorraine Court and Marydale Court Pipe Replacement	UP	The pipe serving Lorraine Court and Marydale Court are undersized can be replaced with larger pipes and a hydrant added to the streets when the streets are improved.
W16	East Poppy-West Redoubt Main	T&S	Connecting water mains in East Poppy Lane to West Redoubt Avenue would increase system looping and improve fire flow service at East Poppy Lane. This project should only be done in conjunction with a project that constructs a bridge over the Kenai River at this location



SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Water Distribution System Capital Improvement Projects

Figure 8

HDR

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7 Capital Improvement Program

7.1 Project Phasing and Priorities

The City of Soldotna uses a CIP as a basis for budgeting the planning, design, and construction of needed facilities. The projects recommended for the study areas were combined to create a 20-year list covering the period 2016 through2035. These projects form the Soldotna Water Utility CIP.

7.2 Project Priority Criteria

All projects identified through this planning process could eventually be constructed. Soldotna, however, does not have the capital resources to build them all immediately and therefore prioritizes its CIP.

Six generalized criteria are used in evaluating recommendations that are developed to meet the projected water demands of each study area. These include:

- Cost (capital and operating)
- Constructability
- Institutional and agency requirements
- Coordination with other agency projects
- Increasing system reliability and redundancy
- Public acceptance

Capital and operating costs are an important criteria used in evaluation. In most cases, the shortest route is preferable for water main extensions over a longer, more expensive route unless other factors are significant. Where new mains are recommended and multiple alignments are available, the alignment with the most potential customers is preferred because of the opportunity to increase the customer base. For purposes of the 2015 WMP, operational costs considered were energy costs to pump water, perform line flushing, and repair hydrants. Regular operation, maintenance, and replacement costs were assumed to be proportional to line lengths.

Constructability is considered in project selection because of its impact of cost. The location of distribution lines and booster stations can be influenced by subsurface soil conditions, particularly in swampy and wetland areas. These areas were avoided wherever possible in developing recommendations. Also, because of sensitive habitat in and adjacent to the Kenai River, recommending infrastructure in or adjacent to the river is avoided.

Coordination of Soldotna projects with other agency projects, Alaska Department of Transportation and Public Facilities road work for example, offers significant opportunities for Soldotna. Opportunities include reductions in overall project cost, reduction in public inconvenience during construction and others. Where possible and practical, Soldotna projects have been selected that coordinate with other agencies' work.

Increasing system reliability and redundancy is important in providing high levels of service. System reliability is enhanced by systematically performing preventative maintenance to reduce the occurrence of unforeseen system failures. System redundancy, or providing alternative means of service, gives Soldotna the ability to continue service in the event of unforeseen system failures. These criteria were used to evaluate and select projects.

Environmental impacts can be a significant factor in the siting of projects. Water distribution projects in developed areas seldom create insurmountable problems since most areas have already been disturbed. Booster stations can be the exception, since these projects are sometimes best located away from disturbed areas. Floodplains and wetlands are areas to be avoided whenever possible and practicable alternatives exist.

The last criterion recognizes that public acceptance is a necessity before a project can be constructed. Knowledge of local issues and conformance with the Soldotna and KPB comprehensive plans were applied in an attempt to reflect public acceptance of improvement recommendations.

7.3 Capital Improvement Schedules

7.3.1 2016-2035 Capital Improvement Program

Table 15and Figure 8detail the projects recommended in the 2015 WMP for the period 2016 through2035. Projects are organized chronologically starting with projects to be executed in 2016 and ending with those projects to be constructed in 2035. Estimated costs are also included. Feasibility studies and master plans represent the lowest level of effort in developing estimates of cost, and the American Association of Cost Engineers specifies that these types of planning level cost estimates have an anticipated accuracy of +50% to -30%.

Construction Costs

All cost estimates developed in this 2015 WMP are based on 2015 dollars, and they must be adjusted to account for inflation in the future. Sources of cost data used in development of the estimates include bid data from similar jobs, information from local contractors, budget quotations from equipment or material manufacturers, and standard cost estimating manuals.

Water main costs are based on cost per linear foot of pipe plus additional costs hydrants. All pipes are assumed to be constructed in roads requiring restoration of paved surfaces. The total length of main includes costs of in-roadway reconstruction. Lineal foot costs for pipe include contractor mobilization, overhead and profit, bond, appurtenances, earthwork, landscaping, roadway restoration, and traffic control. Cost estimates for major booster stations and appurtenances are based on engineering judgment of the probable costs.

Contingencies

Cost estimates presented in the 2015 WMP include a 25% contingency added to the construction cost estimates. This contingency is added to cover many construction unknowns, such as soil conditions, season of construction, bidding climate, unforeseen physical conflicts with other utilities, and various incidental costs for labor and materials not specifically included in the estimated construction quantities.

Engineering, Administration, and Right-of-Way Costs

Implementation of projects like this typically requires a variety of in-house and outside professional services including: engineering during design, construction administration, and project startup; in-house administrative costs during design and construction; legal fees; and costs associated with permit and right-of-way acquisition. The engineering and construction management portion of the project cost is estimated to be approximately 25% of the construction cost. In addition, Soldotna administration and legal fees are approximately 5% of construction cost. Land cost for booster stations and wells is based on KPB assessed values for property in Soldotna. These costs are added to the construction cost with the contingency described in 7.3.1 under Construction Cost to develop the total relative order of magnitude project cost.

7.4 Project Recommendations

Recommended projects to address identified system needs and future service are compiled in Table 16 and their locations shown on Figure 8. Table 16 presents the recommended project implementation schedule in the years 2016 to 2035. The schedule attempts to tie improvements to consistent funding of project and avoiding large rate increases. Revisions to the planned schedule will be necessary should growth patterns change.

The 2015 WMP's elements were developed on the basis of being flexible to accommodate changes in growth patterns. The projects are developed to a planning level only; they are conceptual in nature and subject to refinement as they are implemented.

Table 16. Soldotna Recommended Projects

Project #	Project Name	Implementation Year	Description	Estimated Cost (2015 Dollars)
W1	Well C Generator Replacement	2016	The generator should be replaced with a generator large enough to operate the Well B, C, C-2 and water treatment system at the well house.	$93,000
W2	New Well Site Selection	2016	This project will identify, prove up, and procure a site for a future water supply well.	$271,000
W3	Sterling Highway Booster Station Site Selection	2018	This phased project will identify and purchase a booster station site to serve system expansion into a new pressure zone along the eastern Sterling Highway.	$124,000
W4	Water Leak Study	2018	This project would conduct a leak study of the system to identify if excessive leakage exists and if any identified leaks are severe enough to warrant repairs. The study can be phased.	$39,000
W5	Well E Fencing	2018	Well E security can be improved through adding fencing	$14,000
W6	Leak Repair Phase 1	2019-2020	This project will systematically repair leak sources identified through the Water Leak Study.	$70,000
W7	Foothills Drive Water Main	2022	This project will build a 12-inch diameter main along Foothills Drive connecting the Karen Street Reservoir and the Sterling Highway mains will improve fire flows, provide capacity for future system expansion, and serve potential customers along Foothills Road.	$1,953,000
W8	Leak Repair Phase 2	2021-2025	This project will systematically repair leak sources identified through the Water Leak Study.	$116,000
W9	Southeast CBD Water Main	2026	This project will build a 10-inch diameter water main connecting mains in 47th Street and East Redoubt Avenue will improve fire flow service, provide redundant looping of this area, and serve development	$732,000
W10	Leak Repair Phase 3	20126-2030	This project will systematically repair leak sources identified through the Water Leak Study.	$116,000
W11	Riverview-Trumpeter-Legacy Interconnection	2028	This project would construct South Legacy Loop main can improve fire flow capacity, water quality, and system redundancy	$363,000
W12	Sterling Highway Booster Station	2035	This phased project will construct a booster station to serve system expansion into a new pressure zone along the eastern Sterling Highway.	$837,000
W13	Water Treatment Upgrades	2035	This project would construct well water treatment systems at Well B and Wells C and C-2 and Well E. The project can be phased and will require a building at each location to house treatment equipment	$2,558,000

Project #	Project Name	Implementation Year	Description	Estimated Cost (2015 Dollars)
W14	Leak Repair Phase 4	2031-2035	This project will systematically repair leak sources identified through the Water Leak Study.	$116,000
W15	Lorraine Court and Marydale Court Pipe Replacement	2035	The pipe serving Lorraine Court and Marydale Court are undersized can be replaced with larger pipes and a hydrant added to the streets when the streets are improved.	$278,000
W16	East Poppy-West Redoubt Main	2035	Connecting water mains in East Poppy Lane to West Redoubt Avenue would increase system looping and improve fire flow service at East Poppy Lane. This project should only be done in conjunction with a project that constructs a bridge over the Kenai River at this location. Bridge cost is not included.	$2,848,000

7.5 Staffing

7.5.1 Current Workload

The Soldotna utilities system, the combined water supply and distribution system, wastewater collection system, and wastewater treatment plant are operated and maintained by the same staff pool. Operators are cross trained between water and wastewater operations, and the staff works between each utility component. Therefore, staffing must be discussed in the context of the entire water and wastewater utility.

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

- Inspection of new water and sewer service connections installed by developers;
- Fulfillment of water and sewer pipe location requests;
- Operation and maintenance of the water supply and distribution systems, including cross-connection surveillance;
- Twice-annual water main flushing;
- Fire hydrant maintenance;
- Operation, cleaning, and maintenance of the sanitary sewer collection system;
- Operation and maintenance of the wastewater treatment plant;
- Sampling and monitoring to meet all regulatory requirements, including:
- Water supply sampling,
- Wastewater plant influent and effluent sampling, and
- Dewatered wastewater sludge sampling;
- Reporting as required by water and wastewater regulations and permits;

- Development and implementation of computerized maintenance management system for all utility equipment;
- Oversight of contractors hired to construct projects;
- Development and management of budgets and staff; and
- Maintenance of grounds, including snowplowing, at all water and wastewater utility sites.

The facility plan that addressed utilities operation was completed in 2001. Table 17 presents a comparison of general water, sewer, and wastewater treatment plant components operated by the utilities staff in 2001 and 2014. In general, systems and services have grown about 30% between 2001 and 2014. Several components decreased in size or complexity (e.g., the number of active wells), but the vast majority increased in operational requirements. Some system components, such as the number of water meters and lift stations, have increased quite significantly. Also, the system is now 13 years older, so some mechanical components of the treatment plant are now more than 30 years old. These increases in the utilities' system size, complexity, and age have resulted in additional work for staff.

Table 17. Soldotna Water and Sewer General System Changes, 2001 to 2014

Water System			Change	
Year	2001	2014	13	years
Customers	2700	3350	24%	increase
Average demand, MGD	0.6	0.71	18%	increase
Peak demand, MGD	0.9	0.88	-2%	decrease
Wells	5	4	-20%	decrease
Reservoir sites	1	2	100%	increase
Reservoirs	2	2	0%	change
Booster/PRV station	0	1		increase
Pipe length, miles	32	38	19%	increase
Hydrants	240	315	31%	increase
Service connections	1200	1810	51%	increase
Meters	30	377	1157%	increase
SCADA	limited	extensive		increase

Sewer System			Change	
Year	2001	2014	13	years
Customers	2700	3400	26%	increase
Pipe length, miles	24	29.5	23%	increase
Manholes	393	483	23%	increase
Lift stations	10	16	60%	increase
Vactor truck	1	1	0%	change
SCADA	none	In each LS		increase

WWTP			Change	
Year	2001	2014	13	years

Customers	2700	3400	26%	increase
Average flow, MGD	0.51	0.56	10%	increase
Maximum month, MGD	0.59	0.78	32%	increase
Aeration Basins	2	2	0%	change
Clarifiers	2	3	50%	increase
Disinfection	Cl	UV		
SCADA	limited	extensive		increase
Equipment age				
Clarifiers, years	19	32, 10		increase
Aeration Basins	19	32	79%	increase
Belt Press	19	32	79%	increase

7.5.2 Current Staffing

In 2014, the operations and maintenance staff for the water and wastewater utility consisted of one manager and four operators. Additional labor for utility-related tasks and special projects in 2014 was obtained from the following:

- Staff overtime (approximately 400 hours per year);
- Local contractors (about 80% of all electrical work and 90% of all mechanical work);
- City maintenance shop (approximately 80 hours per year); and
- Summer hire staff (approximately 475 hours annually).

The labor from the city maintenance shop, overtime, and temporary employees totals 960 hours annually. Using the EPA criteria of 1,500 hours per year of productive time (productive time is defined as normal full-time work year, 2,080 hours, excluding vacation, sick leave, and holidays) the borrowed labor, overtime, and temporary staff equals the equivalent of 0.65 full-time equivalent (FTE) employee.

Combining the current full-time staff of five with the borrowed, overtime, and temporary labor FTE of 0.65 results in a total equivalent staff of 5.65 people in the utility operation.

7.5.3 Staffing Analysis

The most recent utility staff analysis was completed in 2001 for the *City of Soldotna Wastewater Facilities Master Plan* (HDR Alaska, 2001). The 2001 *Wastewater Facility Plan* staffing analysis reported that the utilities' staff consisted of four full-time staff and one FTE consisting of 1,300 hours borrowed City maintenance shop staff and the remainder of utilities staff overtime. The 2001 report concluded that the utilities operations was understaffed by approximately one FTE based on the size of the systems operated, staff duties, and comparison with other similar utilities.

In 2003, Soldotna utilities operations added another operator, increasing the number of operators to four. Hiring the fourth operator allowed for reduced use of City maintenance shop staff, which was experiencing increased workloads as the city grew and had less time available to loan to the utilities maintenance.

With no staff additions since 2003, in 2014 the utilities had five full-time staff and used some summer hire staff. A comparison of the staffing between 2001 and 2014 is shown in Table 18.

Table 18. Soldotna Utilities Staff Levels

Year	FTEs	Employees	Staff OT FTE	Temporary or borrowed city staff FTE
2001	5	4	0.35	0.65
2014	5.43	5	0.18	0.25

WWTP Staff

HDR used the *Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants* (2008) developed by New England Interstate Water Pollution Control Commission (NEIWPCC). This guide was developed to build upon the U.S. Environmental Protection Agency reference guide titled *Estimated Staffing for Municipal Wastewater Treatment Facilities* (1973). Using this guidance, a 2015 analysis of plant staffing recommends 3.8 full-time staff at the WWTP. This is higher than the staff estimate developed in 2001 of 3.1 FTE and in line with the current plant's treatment processes and discharge requirements.

As a comparison, AWWU's Eagle River WWTP is a slightly larger plant with a design capacity of 2.5 MGD and an average daily flow of 1.5 MGD. They have a tertiary filter, but otherwise a fairly comparable process, size, age, and treatment requirements to the Soldotna WWTP. This plant is staffed with six people: one WWTP Superintendent, one Operations Foreman, and four Operators. The AWWU Eagle River WWTP staff is dedicated to the plant. They may occasionally address FOG issues (e.g., visit a FOG offender regarding pretreatment), but generally the Eagle River WWTP staff is dedicated to the job of operating and maintaining the plant. Eagle River WWTP staffing indicates that the estimated staffing for the Soldotna WWTP is reasonable.

Water and Sewer System Staff

Based on the water distribution and sewer collection system growth, operating staff have not increased proportionally. The general system has grown in complexity and extents since 2001. Factors that would increase staff requirements include more customers (about 25% increase); pipe in the ground, hydrants, and manholes (ranging from 20 and 30% increase); adding a remote reservoir, booster station, and PRV; adding six sewage pump stations (60% increase); system age increasing by 13 years, and other related factors increase operation and maintenance work load for the system. These indicate that additional staff may be required to operate these systems effectively and meet regulatory requirements.

Soldotna has mitigated the increased work load through labor saving changes instituted by the utilities operations. These include installing SCADA at all pump stations, wells, reservoirs, and booster stations; cross training all utility staff in operating water and sewer systems; WWTP upgrades of additional clarifier capacity, changing from chlorine to UV disinfection; advocating for pipe insulation to reduce freezing risk in water pipes;

and other measures. These measures have added labor efficiencies (e.g., not needing to inspect lift stations as often), and have allowed existing staff to keep pace with increasing workload from system expansion and aging. However, after 10 years of no staff increases while the system size and complexity increased, the workload to operate the utilities system should be considered.

The 2001 staffing analysis estimated that the maintenance of the water distribution and sewer collection system would require 2.9 FTEs. This was based on the miles of pipe in the ground, the number of lift stations, and the water supply and storage methods. In the past 13 years, the pipe length has increased by about 25%, lift stations increased by 60%, and a booster and PRV statin was added to the system. Because of these additions to the distribution and collection system, it is reasonable to assume that additional labor is required to operate the system. Maintenance of these systems generally increases with size, so a system increase of approximately 30% would represent a need of approximately 30% more labor to operate the system. This would equate to a labor need of 3.7 FTEs dedicated to the operation of the combined water supply and distribution system and the sewage collection system.

7.5.4 Total Staffing

The results of the individual staff analyses are presented in Table 19. Also shown is the current staffing level as evaluated in Section 7.5.2. The previous analysis indicates that the utility operation should have a staff of 7.5 people.

Table 19. Staff Analyses Results

Staff	Staffing Level
Water supply and distribution and sewage collection FTEs	3.7
Wastewater treatment plant FTEs	3.8
Total estimated FTE requirement	7.5
Current FTE total	5.4
Estimated staff deficit	2.0

Staffing Recommendations

The existing staff consists of one full-time supervisor and four operators plus borrowed, overtime, and temporary labor help for an equivalent full-time staff of 5.4 employees. The staffing analysis presented above recommends considering increasing utilities staff by one or two FTEs. As the system expands to serve additional customers and when the APDES permit is renewed, staff requirements should be reevaluated.

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Appendix A

Water Capacity Analysis

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City of Soldotna Utility Department

2015 City of Soldotna Water Master Plan

Water System Flow Analysis

Prepared for:

SOLDOTNA
City of Soldotna, Alaska

City of Soldotna
177 North Birch Street
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February 2016

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Table of Contents

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Water System Flow Analysis

INTRODUCTION

Understanding the design and evaluation of flows and system operation is an important part of operating an effective and efficient water supply system. As part of the 2015 City of Soldotna Water Master Plan several issues associated with flow and system operation were evaluated. The issues included:

- Fire hydrant flow capacity;
- Reservoir operating levels;
- Well operating guidelines; and
- Pressure zone boundaries.

These issues were analyzed in a technical memorandum which was reviewed with City of Soldotna Utility Department and Public Works staff. The completed memorandum is compiled in this document.

RECOMMENDATIONS

The preparation of the technical memorandum evaluating with fire flow and system flow resulted in several recommendations for the City to consider implementing with respect to the water system. These recommendations are summarized below.

1. Consider adjusting the reservoir operating levels to promote greater water turnover.
2. Consider adjusting the demand needed to start the wells to promote greater reservoir cycling.
3. Consider defining pressure zones and installing booster stations where needed.
4. Consider capital improvement projects to improve fire flows and increase water quality.

MEMORANDUM ORGANIZATION

This memorandum contains the following sections:

Section 1 covers the development of design and capacity criteria for the pipe network.

Section 2 covers recommended peak factors for the larger pipes.

Section 3 presents the results of the water system capacity evaluation

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Section 1 – Water System Model Development and Analysis

1.0 INTRODUCTION

In order to evaluate system pressures and fire flows, a full pipe model was developed and water demands distributed throughout the system. Once a model was developed, system pressures and fire flows could be analyzed and system deficiencies could be found. With this data, recommendations were made for improved operating procedures and for future projects in the Capital Improvement Program (CIP).

This section outlines the process used to develop and analyze a water system model, discusses the results, and proposes improvements to improve the system operation and network. The section is organized as follows. The first section describes the system modelling process. The next part discusses results from fire flows in several different scenarios. The final section proposes changes to operating procedures and several improvement projects to improve fire flows and improve system efficiency.

2.0 WATER MODEL

Analysis of the sewer pipe was done using the sewer system model developed by HDR modeling staff. The water distribution system was modeled using the InfoWater modeling software developed by Innovyze. InfoWater integrates advanced hydraulic and hydrologic modeling functionality in a GIS-based program used for planning, design, analysis, and expansion of water distribution and storage systems. InfoWater performs comprehensive hydraulic calculations of steady-state analysis of the pies network. Model development uses GIS data sets of the pipe network to pipe network models. Starting with a base GIS model from the City of Soldotna, HDR modelling staff used record drawings to correct and confirm pipe geometry and characteristics. Most pipe fittings, valves, and other elements were added to better model the system as installed. To simplify data entry, elevation data was not included from record drawings, but estimated from ground surface elevations.

Water demands in the model are parcel based. Each parcel with water service was assigned an estimated water demand based on the zoning, water use (derived for a previous Soldotna water system model), and use of the parcel. Corrections were made for properties with higher than average water usage (e.g. hospitals, high density trailer parks). Each parcel was then assigned to an adjacent pipe node.

The InfoWater model solves the pipe network model to balance all flows in the system. Model boundary conditions like PRV discharge pressures, reservoir levels, and well flow rates can be set to define different system operating conditions and model scenarios. Pump stations and wells were modeled in the pump discharge curves and main hydraulic considerations.

Operating InfoWater models can be exported for use in EPA Net water system analysis software.

The system model evaluated only a steady state flow condition. Pump stations and wells were assumed to be continuously operating creation the maximum downstream flow conditions allowd by system hydraulics. Steady state flow is a conservative assumption and is used to estimate maximum flows and minimum pressures in the pipe for the assigned flow condition.

An average day peak month base demand model was developed in order to model water usage for the City. Each parcel was assigned a per day water demand and assigned to the nearest pipe network junction. The total average day peak month demand was 600 gpm. Junction (tees, valves, caps) elevations were assumed to be 10 feet below the ground surface elevation. Elevations at critical points (tanks, wells, PRVs, and pumps) were adjusted from the system wide assumed elevation to reflect record drawing data. All valves were set to open with the exception of valves in the Westgate neighborhood that are generally closed in the winter to reducing freezing issues.

The flow model was calibrated using SCADA data of a 400 gpm average day average month demand. The PRV in the Skyline booster station was set to 50 psi so that the Skyline reservoir would provide the majority of the flow for the base scenario.

2.1 Fire Flow Model Development

In the steady state examination of average day and peak day demands, the system model showed all demands were met with sufficient pressure. No additional analysis of the system was done with respect to average and peak day demands.

2.2 Fire Flow Model Development

A fire flow model was set up with a base demand of 600 gpm distributed to the nodes as described above. Valves that are generally closed during the winter to help with freezing issues were closed in the model to simulate a "worst case scenario". The booster pump leading to the Skyline reservoir was turned off so it could only provide flow to a fire situation. The 3-inch PRV was closed and the 8-inch PRV was open to a setting of 50 psi, which is the default setting.

Each hydrant was chosen as a fire flow node and the critical pressure was set to 20 psi at the ground surface. This critical pressure was applied over the entire network of junctions and hydrants except the junctions near the Karen Street Reservoir and near the Skyline Reservoir. The model incrementally adds fire flow to each hydrant individually until one junction or hydrant dropped below 20 psi. This result is the total available flow at that hydrant under that particular scenario. Generally the critical node controlling flow was the hydrant itself, but in some conditions, junctions at the highest elevation of the pipe network at the north end of the system along the Sterling Highway served as the critical node.

3.0 FIRE FLOW RESULTS

This section presents the calculated maximum flows at hydrants flowing separately while maintaining a minimum system pressure of 20 psi measured at the ground surface. The modelling process estimated fire flows and pressure for all hydrants connected to pipes in the GIS based model. Model results are presented in figure 1. This section discusses several areas along the edges of the system where flow tests are needed to verify model results.

Hydrant flows were analyzed with both reservoir tanks at 35%, 50%, and 100% full and with all four wells running, with three wells running (B, C2, and E), and without any wells operating.

Maximum modelled flows for each scenario at every hydrant can be seen in the attached table. The lowest flowing hydrants all occur at the end of long 6-inch pipes with substantial head loss at higher flows or at higher elevations areas such as the east end of the system along the Sterling Highway. The lowest design flow is around 1,000 gpm - these hydrants mostly serve residential lots where 1,000 gpm would be sufficient fire flow.

3.1 North along Sterling Highway

Due to higher elevations and lower pressures, the fire flow at the northeastern edge of the system along the Sterling Highway is reduced. Model runs estimate that hydrants surrounding Fred Meyer and towards Skarkhatmi Road can provide only up to 1,500 gpm while maintaining a minimum system pressure of 20 psi, measured at the ground surface. Should additional flows be necessary or should any system expansion occur along the Sterling Highway, improvements should be made to the system to meet fire flow needs.

System expansion east along the Sterling Highway beyond Skarkhatmi Road would require a booster station at or near the current edge of the system at Sharkhatmi Rd. In order to serve the booster station and increase fire flows to the commercial district in that area, a new line is recommended from the Karen Street Reservoir to the booster station. This main could connect into the system at the current east end of the system and would add an additional 2,000 gpm of possible fire flow and allow for the installation of the booster station. A further discussion of this improvement project can be seen in section 4.1.1.

3.2 Airport

Available fire flow at the airport is very dependent on the state of Well E. With all the well pumps on and 50% full tanks, the modelled flow at the airport was around 2,500 gpm for most hydrants. The model estimates that with 50% full tanks, the hydrants along the airport could have up to a 1,000 gpm decrease in available fire flow when Well E was turned off, regardless of whether Wells B, C, and C-2 are operating. Should a full 2,500 gpm fire flow be necessary at the airport, or should increased commercial activity occur along Funny River Rd, the City should examine adding redundant power to Well E. With the current land use in that area, the system as modelled is likely sufficient.

3.3 Kenai Peninsula Community College

The model shows approximately 2,300 gpm flow to the hydrants at the college. Unlike the hydrants along the airport line, the hydrants at the college are not affected by the pump status of Well E.

3.4 Hydrant at Skyline Reservoir

The hydrant located near the Skyline reservoir is currently bagged and not in service. Initial investigations showed that the hydrant could possibly be used as a fire flow hydrant. With the Skyline reservoir at 50% full, three of the four wells running, the booster station on, and the PRV valve closed, the modelled hydrant flow is approximately 1,600 gpm at 20 psi. However, once Skyline Reservoir's level drops below 45%, the modelled static pressure in the hydrant drops below 20 psi at the ground surface. Should the City desire to run fire flows from this hydrant at less than 20 psi, the hydrant could be examined for potential fire flows, but it is currently recommended that the hydrant remain out of service.

3.5 Other Minimal Flow Hydrants

Most hydrants in the City with modeled flows less than 1,500 gpm are at the end of long 6-inch diameter pipes. The minimum estimated flow from a hydrant in the City is 1,000 gpm, this occurs that the west end of Trumpeter Avenue and the hydrants along Riverview Avenue just west of Hillcrest Avenue. The model predicts lower flow hydrants also at the end of Knoll Cir, the eastern ends of Arlington Court, Sunrise Court, and Redwood Court, the hydrants in Soldotna Creek Park and around Walgreens, and at the end of the 6-inch lines leading to the west side of Soldotna Middle School and the south side of the Hospital. Hydrants near the intersection of Sharkathmi Avenue and the Sterling Highway also have predicted lower flows; this situation has been addressed above.

Some of these lower flow scenarios could be remedied by adding lines to create loops. This would have the benefit of also allowing more water movement resulting in better water quality. For example, a connection could be made between the end of Trumpeter Avenue and the Riverview Avenue lines to create a loop. An eight-inch diameter pipe connection would add 1,000 gpm to the hydrants on both streets. Other hydrant flow issues are less simple to remedy, but should additional development happen in areas with lower flow hydrants, effort should be made to connect loops and allow more flow.

4.0 RECOMMENDATIONS

There exist several areas for improvement of both the water system infrastructure and system operating processes. The recommendations below are split into three areas: capital improvement projects, reservoir operating recommendations, well operating recommendations, and other water system operating recommendations.

4.1 Capital Improvement Projects

Fire flow modelling revealed several areas where additional pipe could vastly improve the flows to both residential and commercial areas.

4.1.1 Foothills Road Water Main

Since fire flow service may be lower than needed on the eastern Sterling Highway. A 12-inch diameter main along Foothills Drive connecting the Karen Street Reservoir and the Sterling Highway mains will improve fire flows, provide capacity for future system expansion, and serve potential new customers along Foothills Road

4.1.2 Southeast CBD Water Main

The southeastern central business district (Walgreen's area) many not have adequate system capacity for fire flow needs. A 10-inch diameter water main connecting mains in the 47th Street and East Redoubt Avenue will improve fire flow service, provide redundant looping of this area, and serve future development.

4.1.3 Riverview-Trumpeter-Legacy Interconnection

The Water Mains in Riverview and Trumpeter Avenues are dead-end 6-inch mains. Interconnecting them with the South Legacy Loop Main can improve fire flow capacity, water quality, and provide system redundancy.

4.2 Reservoir Operating Recommendations

In order to be prepared for a commercial fire, it is recommended that water system contain enough capacity to fight a 4,000 gpm fire for four hours while also providing 600 gpm for the average day, peak month demand. Therefore the system must be able to produce 4,600 gpm. With three of four wells operating and producing approximately 1,450 gpm. Each reservoir must produce 378,000 gallons over four hours, which amounts to a 13.1 foot drop in reservoir water level. With all four wells operating and producing approximately 1900 gpm, each reservoir must be able to produce 324,000 over four hours. This amount of water would deplete the reservoir levels 11.3 feet. It is recommended that the reservoirs be allowed to drop to a minimum level of 15 feet to allow for some reserve capacity before being refilled.

4.3 Well Operating Recommendations

The current set point configuration will turn the wells on at 2,500 gpm system demand. The model estimates that without the wells operating, the modelled fire flow at most hydrants do not change significantly compared to when wells are operating. At a minimum operating level of 15 feet of water in both reservoirs, there is 860,000 gallons in storage. A 2,500 gpm fire for two hours plus a peak demand of 600 gpm for a total of 3,100 gpm would require 372,000 gallons. Based on this information it is recommend to change the demand-based set point for the wells to be 3,500 gpm. This value would turn the wells on the wells for higher demand commercial fires, but allow the reservoirs to meet fire flow demands for smaller fire flows up to and including 2,,500 gpm.

4.4 Skyline Reservoir PRV Settings

During the winter, average daily demands drop to approximately 400 gpm. Based on an analysis of SCADA data and results from the model, in lower flow situations such as winter, the Karen Street reservoir supplies only a very small portion of the flow. This could result in longer residence times and poor water quality. The ratio of flow from Karen Street and Skyline reservoirs can be changed by adjusting the Skyline reservoir PRV valve. The model shows adjusting the PRV setting to 48 psi would result in approximately even flows from both reservoirs with city demands at 400 gpm. Future examination of PRV settings and the resultant flows from each reservoir could help balance flows and improve water quality.

Section 2 –City of Soldotna Pressure Zones

1.0 INTRODUCTION

Modeling of the City of Soldotna's water system showed areas at the higher elevations in the system with low pressures at the ground surface. These low pressures result in lower fire flows and lower operating water pressure for customers. The following is an examination of pressure zones in the Soldotna operating area.

2.0 KAREN STREET RESERVOIR PRESSURE ZONE

The City of Soldotna water system currently operates the gravity fed pressure zone from the Karen Street Reservoir at ground surface pressures of 40 psi to 100 psi. The hydraulic grade line of the system is determined by the water level in the Karen Street Reservoir. The lowest ground elevation able to be served at a maximum pressure of 100 psi with a full tank would be 30 feet. The highest elevation able to be served at a minimum pressure of 40 psi with 10 feet of water in the reservoir is 144 feet not accounting for head losses.

Currently, Fred Meyer's store is at the upper allowable elevation. Any additional build out above this level would be outside the current pressure zone and would have insufficient pressure for both daily use and for fire flows.

2.1 Booster Station

In order to provide sufficient pressure to any additional development above Fred Meyer's it is recommended to install a booster station at the intersection of Skarkhatmi Avenue and the Sterling Highway. This booster station would be supplied by a 12-inch water main as described in the recommendations section of Section 1 along Foothills Drive from the Karen Street Reservoir. This new water line and booster station would allow additional fire flows at this intersection and allow additional development along the Sterling Highway. This booster station would operate at approximately an HGL of 328 feet.

3.0 SKYLINE RESERVOIR GRAVITY PRESSURE ZONE

Currently all water supplied from the Skyline Reservoir flows through a pressure relief valve (PRV). An additional area could be served by a gravity supplied pressure zone from the Skyline Reservoir. The lowest elevation able to be served with a maximum pressure of 100 psi with a full take would be 80 feet. The highest elevation able to be served at a minimum pressure of 40 psi with 10 feet of water in the reservoir is 195 feet.

Even more homes could be supplied with water in the neighbor adjacent to the reservoir if in house booster stations were installed as long as the water main pressure remains above 20 psi..

3.1 Skyview Middle School

Skyview Middle School is located at an elevation of approximately 250 feet above sea level and is outside the operating level of a gravity supplied pressure zone from the Skyline Reservoir. A booster station would be needed to provide sufficient operating pressures.

4.0 RECOMMENDATIONS

Based on an analysis of the pressure zones and current set up of the Soldotna water system, the following recommendations are proposed

4.1 Booster Station at Skarkhatmi Avenue

Should additional water system served development occur farther east along the Sterling Highway a booster station at the intersection of Skarkhatmi Ave and the Highway would be required. This booster station would be served by a new 12-inch water main along Foothillls Drive as described in Section 1 and would operate a pressure zone with a hydraulic grade line of 328 feet.

4.2 Gravity Pressure Zone from Skyline Reservoir

Additional examination should be done to add service areas fed by gravity from the Skyline Reservoir. This pressure zone would also extend into the existing pressure zone set by the Karen Street reservoir providing system redundancies in areas such as the college and along Kalifornsky Beach Road. Figure 2 shows boundaries of the Karen Street and Skyline Reservoir pressure zones.

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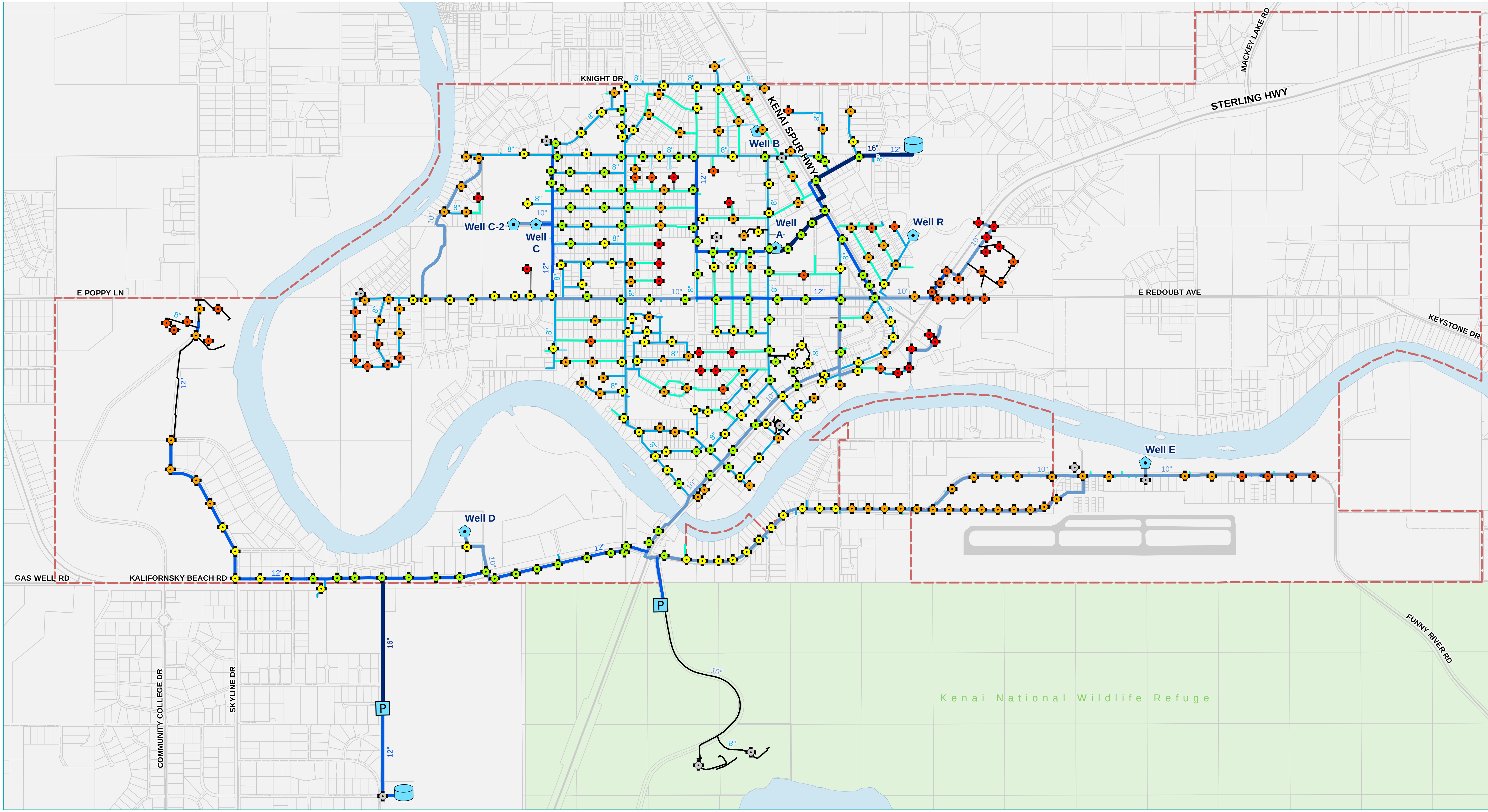


SOLDOTNA
City of Soldotna, Alaska

Modeled Water Hydrant Fire Flow

- Not in model
- 900 - 1500 GPM
- 1600 - 2000 GPM
- 2100 - 3000 GPM
- 3100 - 4000 GPM
- 4000 + GPM

Water Main by Diameter

- 3/4" - 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- Unknown

- Private Water Main
- Pump Station
- Production Well
- Reservior
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume
- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 1,700
FEET

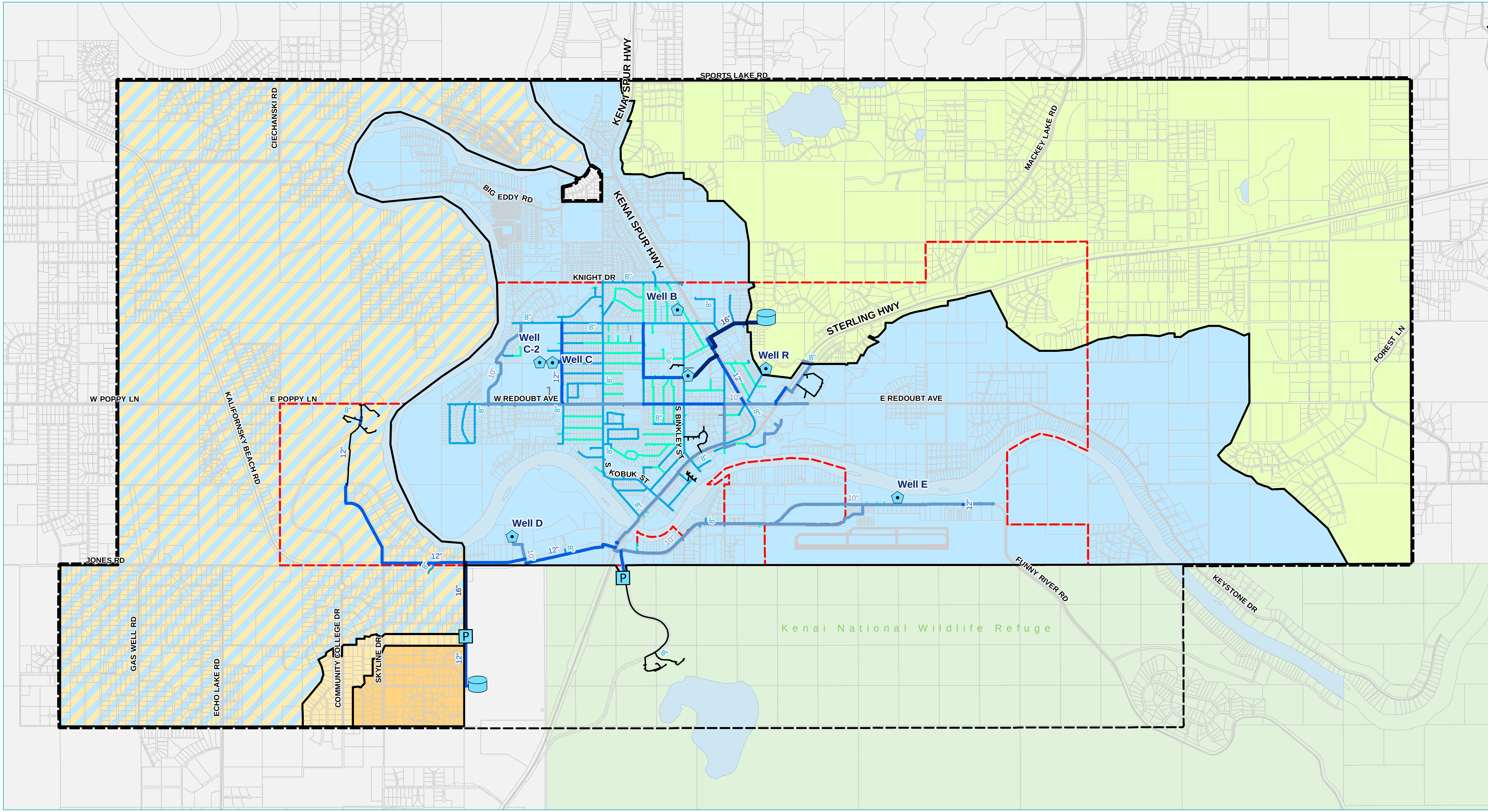
SOLDOTNA UTILITY MASTER PLAN

Water Distribution System

Modeled Hydrant Fire Flow

Figure 1

HDR



Proposed Pressure Zone Boundaires

- Karen Street Reservoir Gravity Pressure Zone
- Karen Steet or Skyline Reservoir Gravity Pressure Zone
- Skyline Reservoir Gravity Pressure Zone
- Skyling Reservoir With In-home Boosters Pressure Zone
- Future Pressure Zone

Water Main by Diameter

- 3/4" - 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- Unknown

- Private Water Main
- Pump Station
- Production Well
- Reservoir
- City Limits

Streets

- State Highway
- Town Major Collector
- Town Medium Volume
- Water Body
- Parcel Boundary
- Kenai National Wildlife Refuge

0 3,000
FEET

SOLDOTNA
City of Soldotna, Alaska

SOLDOTNA UTILITY MASTER PLAN

Water Distribution System

Proposed Pressure Zone Boundaries

Figure 2

HDR

Appendix B

Water and Sewer Flow Analysis

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SOLDOTNA
City of Soldotna, Alaska
Utility Master Plans

To: Kyle Kornelis, Rick Wood, Lee Frey City of Soldotna

From: Dan Billman, HDR

Date: December 9, 2015

Subject: City of Soldotna Water Use and Sewage Production

During the preparation of the Soldotna water and sewer rate study the analysis of water use found that upwards of 25% of the water produced is not accounted for when comparing water production against water delivered to customers. This amount of unaccounted for water is high when compared against industry standard of 10% or less for this value. This memorandum evaluates the City’s water use and sewage production in order to further define the unaccounted for water, what system factors might cause this, how sewage flows may be impacted, and how the City might want to approach managing the issue

HDR calculated the yearly water use in gallons per capita per day (gpcd) for the past 10 years. This value was derived by dividing the total reported water produced for the year by the served population estimate for that year and 365 days. The value ranged from 211 to 316 gpcd. For comparison, Anchorage water use averaged 155 gpcd between 2005 and 2010.

HDR did a similar calculation to estimate yearly the sewer per capita flow. For the same period calculated per capita sewer flows ranged between 160 to 189 gpcd. For comparison, Anchorage water use averaged 134 gpcd between 2005 and 2010.

HDR compared how much of the water production returns to the WWTF as sewage. The ratio varies between 59 and 76%. For comparison, Anchorage water use to sewage production ratio averaged 86% between 2005 and 2010. This value can vary in different jurisdictions depending on how much water is used for irrigation, leaves the system in bulk, like watering trucks or leakage, or enters through I&I.

Table 1 below compares the calculated yearly water use and sewage production values. The water use values have a larger range, up to 150%, compared to sewage production, up to123%.

Table 1 Yearly per Capita Water Use and Sewage Production

Year	Water, actual Yearly gpcd	Sewer, actual Yearly gpcd	Water above 155 gpcd gpcd	Water above 155 gpcd gpm	Sewer above 134 gpcd gpcd	Sewer above 134 gpcd gpm	Sewage to Water Ratio %, actual
2005	226		71	151			
2006	263		108	232			
2007	282	189	127	275	55	118	67%
2008	264	177	109	238	43	94	67%
2009	316	185	161	355	51	113	59%
2010	247	175	92	205	41	93	71%
2011	257	196	102	229	62	139	76%
2012	261	192	106	242	58	133	74%
2013	250		95	218			
2014	211	160	56	131	26	59	75%
Average			103	228	48	107	70%

Water use and sewage production from Anchorage were used as for comparison to Soldotna data because Anchorage is in the same climate, has similar age system, and similar surficial geology, except Anchorage generally has shallower groundwater in which many sewer pipes are buried. The Anchorage data allows comparison to a regional system versus national averages which include many locations in vastly different climates. Soldotna uses more water and has higher sewage production, measured by per capita values, than Anchorage.

Data about the water and sewer system are not available to pinpoint exact cause of the higher than Anchorage values for water use and sewage production and the difference between them. However, an evaluation for causes was done by HDR based on the available data.

The City has four large water uses outside domestic and commercial users: pipe leakage, summer irrigation, bleeding for freeze protection, and flushing. Two of these uses, irrigation and bleeding, are linked to weather. Of the four only a portion of bleeding for freeze protection returns to the sewage system the rest do not contribute to sewage flow.

To evaluate the weather related component of water use and sewage flow HDR compared annual water use and sewage production gpcd with average Anchorage monthly temperature. Anchorage weather data was used because it provides good information on regional weather patterns. The temperature data is used to indicate whether a month was above or below normal temperature, which is the case for the entire region. The data is shown in Table 2 below.

Table 2 Soldotna Water Use and Sewage Production Compared to Regional Temperature

	Water	Sewer	Average Temperature										
Year	Yearly gpcd	Yearly gpcd	January	February	March	April	May	June	July	August	September	October	November	December
2005	226		18.8	20.5	32.1	40.1	50.6	56.9	61.4	58.1	51.4	36.6	16.9	24.5
2006	263		10.6	21.9	23.7	35.8	48.6	54.4	58.2	54.9	49.5	39.0	11.5	21.6
2007	282	189	16.7	17.3	14.3	38.4	47.3	54.5	58.5	58.2	50.5	35.5	30.8	19.5
2008	264	177	13.4	16.6	30.3	33.4	45.8	51.6	55.8	55.6	48.5	29.3	21.2	14.2
2009	316	185	13.0	17.5	21.8	35.3	48.5	54.2	59.4	56.2	49.0	40.7	20.6	20.2
2010	247	175	18.4	25.6	27.1	36.9	48.4	54.3	56.6	56.7	49.7	38.2	26.0	11.2
2011	257	196	18.8	17.5	25.1	37.6	48.1	54.2	58.0	55.5	49.7	37.7	14.9	23.7
2012	261	192	2.8	25.5	21.4	38.7	45.5	54.3	55.5	55.8	47.9	33.2	17.7	14.0
2013	250		22.4	24.6	24.5	29.7	45.0	58.8	61.5	58.4	49.2	44.0	23.2	16.1
2014	211	160	30.2	19.3	27.6	38.5	52.4	54.7	60.6	58.5	50.5	34.7	31.4	27.9
2015			20.5	25.1	29.8	40.7	50.2	59.5	62.1	58.9	46.6	39.2		
61 Year Average			17.0	20.0	27.0	37.0	48.0	55.0	59.0	57.0	49.0	35.0	22.0	19.0

Data in Table 2 is color coded in the following ways. All values, except certain months, are scaled from red to green with the extreme values being red or green and the rest scaling between in orange and yellow. Red was assigned to the extreme temperature value which might have the most impact on water use. In winter this was thought to be the coldest value because colder values can prompt more line bleeding. In summer red was associated with the highest temperature because it can prompt more irrigation. Highlighted the extremes and averages are described as follows:

- Water use and sewage production are scaled with the highest value as red and the lowest green.
- The summer months of May through August are coded with the highest value in each series as red and the smallest as green. The long term average is included in the scaling.
- The winter months of January through March and November and December are coded with the coldest value for the series for each month as red and the highest as green. The long term average is included in the scaling.
- The months of April, September, and August were not coded because they are neither winter or summer and weather in them may not impact water use or sewage production except that line flushing happens in these months.

Inspection of Table 2 shows that water use gpcd values are associated more with winter bleeding for freeze protection in cold winters than irrigation in warm summers. The blue colored years have winters with many months below normal temperatures, generally starting in November of the previous year. In 2007 and 2009, the years with the highest water gpcd, the cold lasted through March, likely extending the bleeding period. This practice as confirmed by utility staff.

Note the summer can be either hot or cold, which change irrigation use, and have less impact on the yearly water use gpcd value. The lower water use years have above average winter temperatures or have a late start of cold temperatures and fewer months of them. The winter periods of in 2014 are good examples.

These observations are linked to how freeze protection and irrigation uses differ. Winter freeze protection is an every day, all day low use over a long time, sometimes 5 months. The daily peak may not be extreme but the use is constant. Summer hot weather irrigation is shorter duration, both in the number of days and time during a given day, and creates larger peaks but of not long duration. While summer may be more dramatic use rates, the overall amount in a year may not be a large.

Another piece of evidence that the high water use years are related to freeze protection line bleeding can be seen in the sewage production data. Generally the higher sewage production values correspond to the higher water uses values and the colder winters. Line bleeding is done two ways, one by attaching bleeders to the water system and discharging them to the ditch or storm drain and the second by encouraging individuals to leave faucets running. The former is water lost from the sewage collection system, the latter increases to sewage plant flows. While the correlation between colder winters and increased sewage production is notable, it is not entirely consistent.

If it is accepted that a large proportion of the higher water use gpcd is related to freeze protection bleeding of lines, this practice does not account for all the apparent difference between the City's water use gpcd and Anchorage's.

Using the water use gpcd values a gross estimate of water leakage and bleeding for freeze protection and sewer inflow and infiltration was calculated. The 2014 water use value, 211 gpcd, was assumed to have minimal bleeding of pipes because of the warm winters during that year. Table 1 shows that Soldotna used about 56 gpcd more water than Anchorage that year. In a simplified approach, this value could be considered to represent pipe leakage, flushing, and pipe bleeders that are not turned off during the summer. The 56 gpcd value can also be expressed as 131 gpm. Utility staff report that the bleeders connected hydrants at the college and airport are operated all year and account for upwards of 20 gpm constant flow from the system.

The 2014 sewage production rate of 160 gpcd was also compared to Anchorage sewage production in Table 1and is 26 gpcd higher, or 59 gpm. This value represents either higher I&I than found in the Anchorage system or other sources, one of which could be customer freeze protection bleeders operated all year. To evaluate the potential source of the higher sewage production, two weekday periods' in 2015, August 4 and 5 and October 25 and 26, water use and sewage flow were compared.

The August period was selected because it was at the end summer, during a warm weather period, and after a long period of little rain. It represents a time when the city has a large tourist population and should have low shallow groundwater levels because of the dry conditions. The October period was selected because it was after the tourist season and after two months of rain. No rain fell within two days during either period so inflow into the system should not be present.

Figures 3 and 4 present SCADA screen shots of water use and sewer flow for August 3 and 4 and October 25 and 26, 2015 respectively. This data set shows approximately 120 gpm of flow during the lowest sewage flow period of the two days. The two periods have very different water usages with about double the peak demands in August compared to October. This observation can indicate that:

- the amount of I&I in the Soldotna system could similar to the Anchorage system, measured on a per capita basis, if the difference observed in 2014 is attributed to other sources;

- the Soldotna sewage collection system does not appear to have increased infiltration into it after extended periods of rain when shallow groundwater tables become elevated; and
- approximately half of the sewage low flow could be attributed to winter freeze protection operated all year, 59 gpm, of the observed 120 to 130 gpm sewage low flow.

The two figures also show the likely impact of summer irrigation. Comparing the water graphs shows that in August 100 gpm more water was in use during the low flow period. The selected August time frame was at the end of a 15 day period with 12 days over 70 F. The increase low flow amount could be entirely attributable to irrigation use. Soldotna utility staff do report that lawn watering at night is seen in the city during extended dry summer periods.

Figure 3 August 2015 Water Production and WWTF Influent

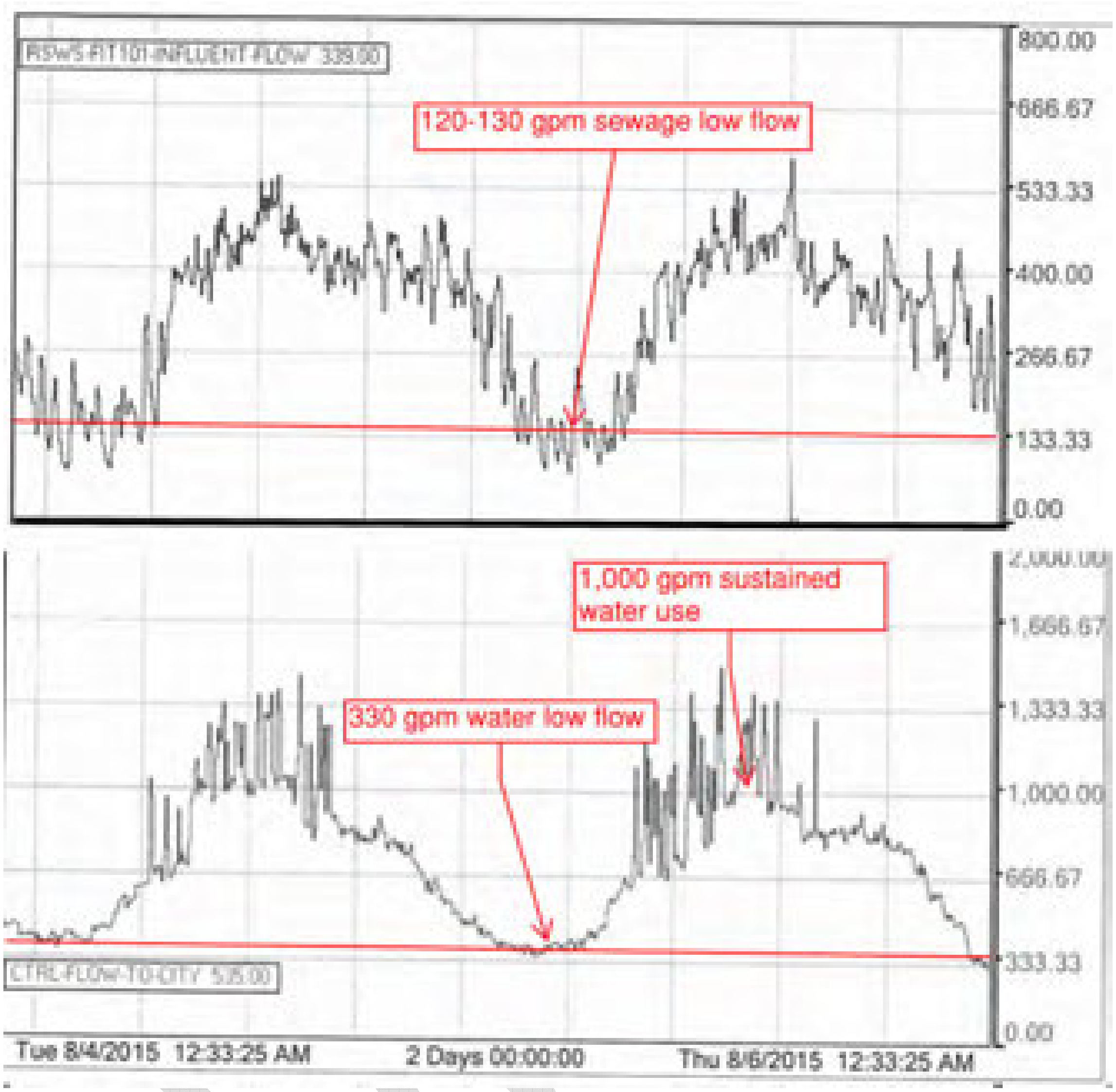
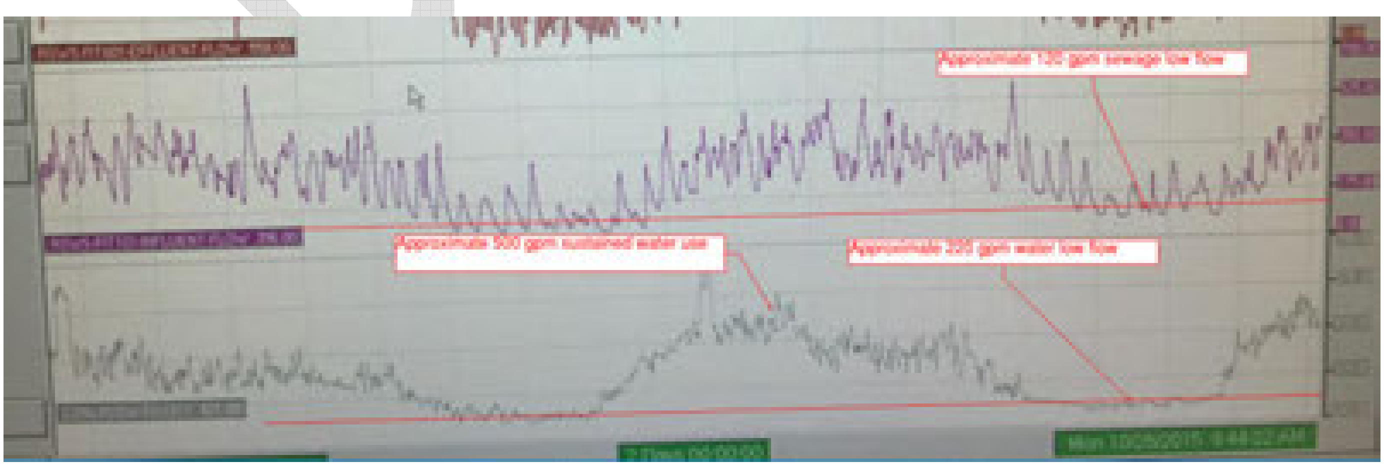


Figure 4 October 2015 Water Production and WWTF Influent

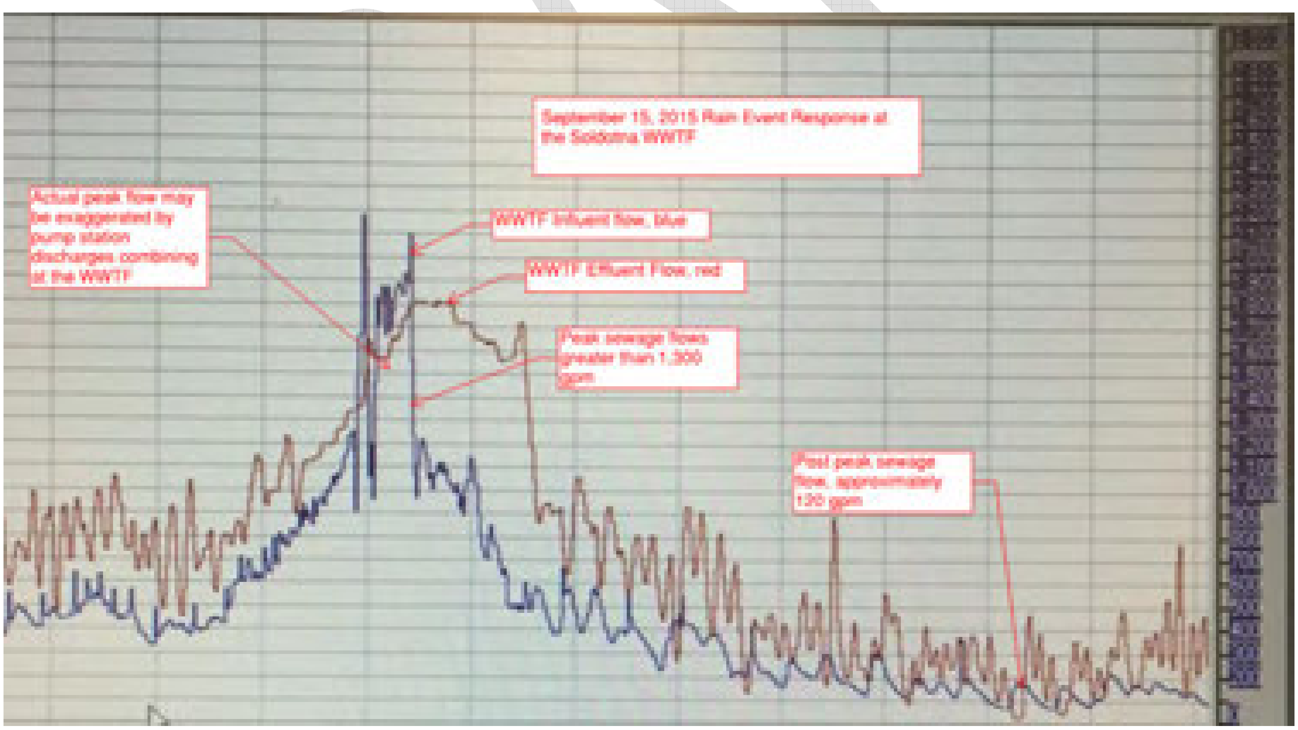


Comparing the August and October non-rainy period flows to a rain fall event flow at the WWTF can point to potential I&I sources. I&I in sewer systems has two components: inflow - event related direct flow of water into the pipe or manhole and infiltration - chronic and continuous leakage into a pipe or manhole. Comparing the sewage low flow between August and October 2015 indicates that infiltration into pipes does not appear to increase in response to rainfall.

A large rain event on September 15, 2015 produced the largest flow seen at the WWTF. The influent hydrograph at the WWTF is shown in Figure 5. The night after this rain event sewage low flow returned to approximately the same level as is seen in the August and October records. The peak flow indicates that system inflow is high.

Examples of common inflow locations in sewer systems are frost damaged manholes located in road ditches, manholes located in stream floodplains, manholes in roads that flood, drainage flowing onto pump station access covers, roof drains connected to the sanitary sewer system, sump pumps connected to the sanitary sewer system, or other sources. Soldotna could visually inspect some of these sources in their system to estimate the magnitude of the inflow from each. Also the City does not allow roof drain connection to the sanitary sewer systems. Suspected installations should be verified, perhaps through smoke testing, and disconnected. If I&I sources can be identified and repaired or eliminated, they will reduce peak plant flows, increase plant operating efficiency, and perhaps delay future plant capacity upgrades.

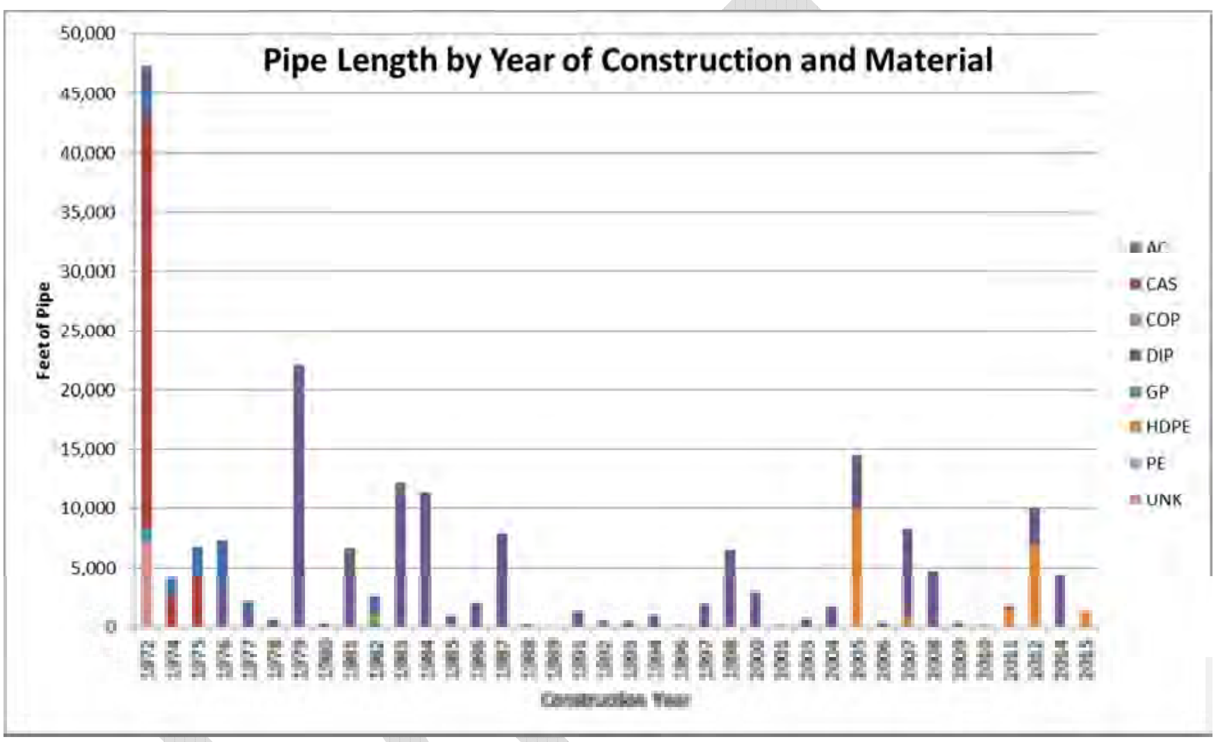
Figure 5 September 2015 WWTF Influent Hydrograph



Water use in the Soldotna system is high compared to Anchorage per capita water use. Previous analysis of Soldotna sewage flow indicates that some of the higher use could be attributed to freeze protection bleeding left operating all year, as is done by the utility staff. Also, the relationship between cold winters and increased water use indicates that the amount of water used for bleeding increases during cold winters. However freeze protection bleeding does not account for al the high water use.

Leaks in this water system are reasonable to have considering its age and pipe material. Figure 6 shows the when the system pipes were installed and what materials were used. The majority of the system was installed in the 1970s and is cast iron pipe. If line freezing is problematic now, it was likely worse in the system's early years when about a third of the current population was using it. Therefore it is a reasonable assumption that freezing occurred which cracked the brittle cast iron pipe. The system may have small leaks from these freeze induced cracks.

Figure 6 Water System Materials and Year Installed



While this estimated leakage rate cannot be determined, the analysis does indicate that the Soldotna water distribution system could have leaks. It is possible that the system leaks could account to upwards of 5 to 20% of normal water production.

The cost of the leaks is, however, relatively small at this time. The leak cost is equal to the cost of chemicals and electricity to operate pumps and equipment. The cost is proportional to the leak rate, grossly estimated to be 5 to 20% of total water production costs.

This annual cost should be compared to the cost of eliminating the leaks. Pipe replacement is expensive and may need to be widespread. Without data of where leaks are located or how large they are, pipe replacement is not recommended.

In the same way, bleeding water for freeze protection also has a cost, similar to leakage. The freeze protection bleeding cost is equal to the cost of chemicals and electricity to operate pumps and equipment, with an additional utility labor cost to install and remove selected bleeders. The cost is proportional to the bled amount, grossly estimated to range up to 50% of total pumping and chemical costs for the 2014 water production year, but generally less.

Again, this annual cost should be compared to the cost of freezing mains and services. Pipe thawing and replacement is expensive and may need to be widespread without bleeding water. The cost effectiveness of eliminating freeze protection bleeding may be very high compared with the incremental water cost.

Installing insulating over shallow or freeze prone pipes and services can help, however this will also have its limitations. When this can be done in with new construction or during reconstruction of roads, it should be considered. However, if the work is only being done in the City owned street right of way, the service line beyond the right of way may not be insulated. Without insulating the entire service to the building, winter bleeding may still be required.

Recommendations

Because data does not exist to quantify the system water main leakage, or where it occurs, it is recommended that Soldotna consider starting leak detection analysis of the system. This program could focus on the older system pipe and those pipes where freezing has occurred. Leak detection programs are non invasive and can identify location and magnitude of the problems. The program does not need to be completed in a single year but can be broken in to cost efficient phases over several years to reduce budget impacts. The collected data can be used to plan pipe repairs, pipe replacement, or coordinate such work with road upgrades or other projects. The collected leak data should be linked to the water system data in GIS so it can be managed spatially and for future project planning.

Because data does not exist to quantify the sewer system I&I, or where it occurs, it is recommended that Soldotna consider starting I&I evaluation of the system. I&I evaluation programs are non invasive and can identify location and magnitude of the problems. A simple way to start would be to evaluate pump station operation to see if certain pump stations pump during low flow periods at greater than anticipated frequency. This might identify candidate system sub basins for in-pipe flow monitoring. Also suspected roof drain connections to the system could be smoke tested and, if verified, disconnected. The I&I evaluation does not need to be completed in a single year but can be broken in to cost efficient phases over several years to reduce budget impacts. The collected data can be used to plan pipe repairs, pipe replacement, or coordinate such work with road upgrades or other projects. The collected I&I data should be linked to the sewer system data in GIS so it can be managed spatially and for future project planning.

To address pipe freezing the City should evaluate whether to require insulation with new or reconstructed water pipes and water services (and sewer pipes with known freezing problems). This will be a long term investment in addressing pipe freezing issues and related freeze protection bleeding. However, over a long period the frequency of pipe freezing may decrease and bleeding may be reduced.

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Appendix C

Water Treatment Analysis

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White Paper

Date:	Wednesday, February 10, 2016
Project:	City of Soldotna Utilities Master Plans – Water System Master Plan
To:	Rick Wood, Utilities Manager, City of Soldotna
From:	Pierre Kwan
Subject:	**Review of AquaMAG use and applicability for City water treatment needs**

The City of Soldotna, AK (City) owns and operates several groundwater wells to meet the drinking water needs of the City. This supply is currently treated with a combination of a chemical sequesterant and sodium hypochlorite at each wellhead prior to the groundwater entering the distribution system. The chemical sequesterant used is AQUA MAG, a blended phosphate compound for iron/manganese sequesteration. The sodium hypochlorite is to maintain a disinfection residual throughout the distribution system. The purpose of this white paper is to review the AQUA MAG properties, discuss its current use at the City, and identify the benefits and constraints with using the product. Specific emphasis is placed on discussions related to copper and zinc control to provide input on metal-related discharge issues at the City's wastewater treatment plant.

Description of City System and Water Supply

The City operates four wells. Table 1 lists select water quality data applicable to corrosion control. Wells C and C-2 are the primary supplies to the City whereas Well B is less used and Well E is rarely turned on.

In general, the water is considered moderately hard, well-buffered and highly discolored from iron and manganese. The wells have little copper content in the groundwater. There is a discrepancy with regards to zinc concentrations. The historical water quality reports indicate that the groundwater produced from the wells is low to non-detectable, whereas the grab samples from Feb. 18, 2015 detected significant concentrations. The differences have not yet been resolved at the time of this white paper.

While not part of this study, the laboratory analysis does indicate that Well E has arsenic concentrations at the State and Federal limit of 10 ug/L. Additional treatment is required for this well if the well is to be used more frequently. Finally, one sample for Well C indicates that the water contains significant amounts of organic material. HDR's experience with groundwaters in this area leads us to estimate that the water from the other wells are similarly organic-laden.

The City controls the iron- and manganese-induced discoloration by adding AQUA MAG at 2.99 mg/L to each of the wells. An additional benefit of AQUA MAG is that it helps control copper and lead corrosion in the distribution system. The choice of chemical and dosage was established in the past and there is no available documentation to highlight how the chemical type and dose was selected.

Table 1. Select City Water Quality Data

Parameter	Source	Data[a] for Well:			
		B	C	C-2	E
2014 annual supply (%)	City records	23	38	35	4
pH (s.u.)	See note B	8.10	7.62	7.93	8.00
	Grab samples on Mar. 9. 2015	7.89	7.89	7.88	7.81
Hardness (mg/L as $CaCO_3$)	See note B	86	103	116	137
Alkalinity (mg/L as $CaCO_3$)	See note B	130	149	146	131
Dissolved inorganic carbon (mg/L)	Calculated based on well reports.	32	37	36	32
Total organic carbon (mg/L)	See note B	Not tested	5.99	Not tested	Not tested
Arsenic, total (µg/L)	See note B	7.57	4	4.85	**10.0**
Copper, total (µg/L)	See note B	5.32	<5	0.3	37.8
	Grab samples on Feb. 18, 2015	1.6	2.7	9.6	1.4
Zinc, total (µg/L)	See note B	16.8	<8	<5	<5
	Grab samples on Feb. 18, 2015	32.9	793.0	1,850	63.9
Color (PCU)	See note B	5	**15**	10	10
Iron, total (mg/L)	See note B	<0.25 for pre- and post-chlorine	**0.45**	**0.54**	**0.41 pre-chlorine, 0.84 post chlorine**
Manganese, total (µg/L)	See note B	**150 pre-chlorine, 163 post chlorine**	**188**	**195**	**250 pre-chlorine, 389 post chlorine**
Iron+manganese, total (mg/L)	Calculated based on well reports, post-chlorine addition.	≤0.41	0.64	0.74	1.23

Note:

A. Parameters in **BOLD** are at or exceed primary and secondary maximum contaminant levels.

B. Data are laboratory analyses of grab samples from the following dates:

1. Well B: February 2010 grab sample for pre-chlorination, December 2010 grab sample for post-chlorination,
2. Well C: January 1998 grab sample, no information provided if sample was before or after chlorination
3. Well C-2: March 2008 grab sample no information provided if sample was before or after chlorination
4. Well E: February 2010 grab sample for pre-chlorination, December 2010 grab sample for post-chlorination,

The City monitors for pH and chlorine residuals throughout the distribution system every weekday at four locations around the system. Those measurements have typically shown a pH range of 7.0 to 7.9. There is no pH control at the wells. The target chlorine residual applied at each wellhead is 0.3 mg/L, which is empirically established by the City to control the growth of iron bacteria in homes. Field chlorine measurements range from 0.03 to 0.09 mg/L.

A final part of their City's distribution system operations is the implementation of an annual flushing program throughout the entire piping system. Crews start at the north end of the system and proceed southward to purge each pipe of accumulated debris. The process takes seven to eight days and is conducted twice a year.

Chemical Description

AQUA MAG is a proprietary compound manufactured by Carus Chemical and purchased by the City from Univar, a local chemical distributor. A cut sheet of the compound is included at the end of this white paper. AQUA MAG is classified as a sequestrant. AQUA MAG is a blended phosphate chemical whose phosphate composition consists of 30 percent orthophosphate and 70 percent polyphosphate. These two types of phosphate have different effects in water:

- Orthophosphate – interacts with pipe surfaces to form a microscopic protective film that limits water-to-bare metal contact. This film reduces the corrosion of copper, brasses, galvanized iron, and steel surfaces.
- Polyphosphate – binds with dissolved iron and manganese to interfere with metal precipitation that could result in discolored water.

The strength of the supplied chemical is variable. The manufacturer claims that the neat solution is shelf-stable for up to two years at constant room temperatures. However, over months, the polyphosphate portion of the chemical degrades into orthophosphate. The result is that the chemical's ability to bind iron and manganese reduces with long storage times. The Revised Guidance Manual for Selecting Lead and Copper Control Strategies (USEPA, 2003) states that:

> *Over time, polyphosphates change to become orthophosphates so long term storage of the blended product, particularly if it is a liquid, is not recommended.*

This long storage is an issue with the City as current practice is to order the chemicals needed for one year's worth of use all at the same time for best pricing. In addition, prior attempts to place orders during winter resulted in the chemical deliveries freezing, which degrades all of the polyphosphates and immediately renders the AQUA MAG to be less useful.

In addition, the polyphosphate portion of AQUA MAG rapidly becomes unstable once introduced into water. HDR (2001) indicates that polyphosphates are typically effective for only 48 to 72 hours, after which point the polyphosphate chemical breaks up and the previously sequestered iron and manganese can again interact with chlorine to precipitate and generate colored water. These conditions typically occur in large, underused water mains, dead-end mains, and the furthest reaches of the distribution system. The break-down of this chemical and loss of all treatment benefits explains why the City has found debris removal is greatest when flushing dead-end mains.

AQUA MAG Regulatory and Literature Review for Copper and Zinc Control

The use of orthophosphates alone or blended with polyphosphates has been recommended by the United States Environmental Protection Agency (USEPA) for reducing lead and copper corrosion in plumbing systems for compliance with the federal Lead and Copper Rule. Figure 1 is the treatment decision worksheet from the Revised Guidance Manual for Selecting Lead and Copper Control Strategies that is directly applicable for the City. Blended phosphates, such as AQUA MAG, are recommended when dissolved inorganic carbon (DIC) is greater than 5 mg/L. As noted in Table 1, the City's groundwater DIC is approximately 32 to 37 mg/L.

Multiple research papers published before, during, and after the release of the USEPA manual all conclusively indicate that orthophosphate, the smaller active fraction of AQUA MAG, is beneficial to reducing copper and zinc corrosion. In comparison, most published articles indicate the polyphosphate have little to no impact on copper and zinc. However, there are some incidences that indicate that polyphosphates might have had a negative effect on copper release from plumbing. Edwards, et. al (2002) found that polyphosphate in combination with pH 7.2 water and 300 mg/L alkalinity caused plumbing to release more copper than at higher pHs in controlled lab tests. In addition, Cantor et al, (2000) documented how a community in Wisconsin saw copper concentrations to triple and to violate copper levels in drinking water once polyphosphate was added to control iron, and that copper concentrations reduced once polyphosphate addition stopped. No conclusive papers could be located to determine the impact of AQUA MAG or other blended phosphates on copper. However, the published literature appears to indicate that polyphosphate might increase copper corrosion while orthophosphate fraction of the blended chemical is very protective and more than counteracts whatever negative impacts polyphosphate generates.

As with copper, zinc release has been found to be greatly reduced with the orthophosphate addition. However, zinc release has also been found to be controlled by polyphosphates in some instances but this benefit is highly variable and dependent on many other variables.

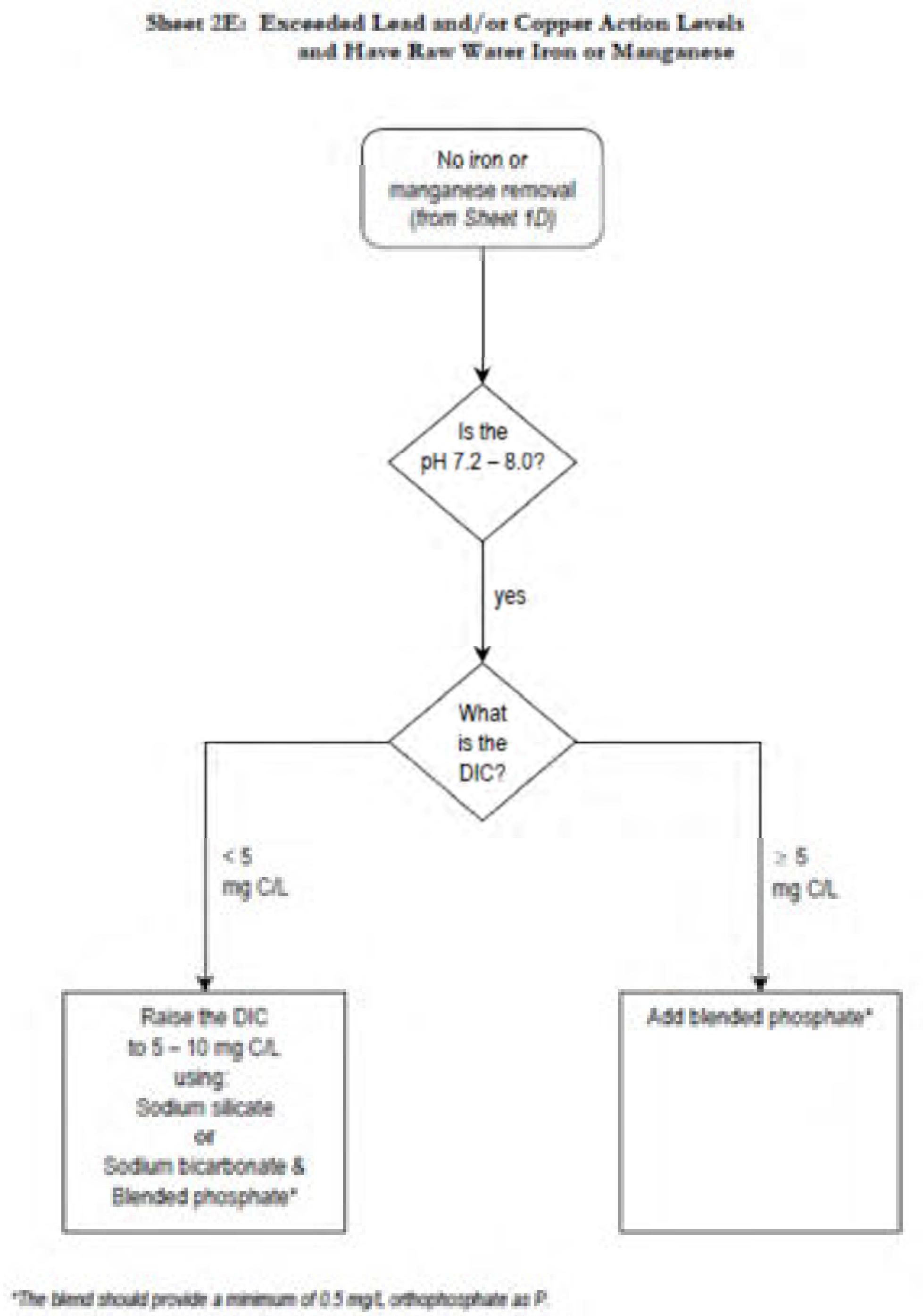

Figure 1. Worksheet from Revised Guidance Manual for Selecting Lead and Copper Control Strategies (USEPA, 2003).

Other Issues with AQUA MAG

As noted earlier, AQUA MAG is unstable in water and rapidly degenerates. Once gone, the contained iron and manganese interacts with the chlorine present to form deposits in dead-end and oversized water mains. Historically, these deposits readily develop into persistent color episodes once disturbed, resulting in staining of fixtures and laundry. These deposits also prematurely wear out water heaters, heat exchangers, boilers, and any other equipment generating hot water.

Recent research by Friedman et al. (2010) found that besides color issues, these deposits also accumulate heavy metals, such as arsenic and barium, over time and can result in metal concentrations higher than allowable drinking water standards. In several case studies, utilities found that stirring up these deposits resulted in arsenic, copper, and lead concentrations to be hundreds of times higher than allowable drinking water limits and that concentrations exceeding drinking water levels still persisted once the water appeared clear (Reiber, et al., 1997, Leonard and Dabrero, 2010). These issues developed despite that arsenic, copper, and lead were non-detect at the each of their wells. The role of iron/manganese deposits accumulating heavy metals and becoming potential health issues is a very active research topic by the USEPA and the American Water Works Association, with the emphasis on preventing these deposits from forming and/or limiting their health impacts by improved water quality monitoring during flushing. Because of these issues, the 2012 edition of the Ten States Standards revised the design criteria in Section 4.8.6 – Sequestration by polyphosphates:

> *This process is not recommended when iron, manganese or combination thereof exceeds 0.5 mg/L and shall not be used when it exceeds 1.0 mg/L. The total phosphate applied shall not exceed 10 mg/L as PO4. Where phosphate treatment is used, satisfactory chlorine residuals shall be maintained in the distribution system. Possible adverse affects on corrosion must be addressed when phosphate addition is proposed for iron sequestering. Polyphosphate treatment may be less effective for sequestering manganese than for iron.*

As noted in Table 1, the combination of iron and manganese in Wells C and C-2 groundwaters are 0.64 and 0.74 mg/L, respectively, and exceed the recommendation limits. The rarely used Well E exceeds both the recommended and mandatory limit with a iron+manganese concentration of 1.23. Only the Well B groundwater would meet the Ten States Standard recommendations. HDR notes that the recommended maximum limit of 0.5 mg/L was only recently added in the 2012 edition, which was released in June 2012, as the 2007 edition of the Ten States Standards only prohibited the use when combined iron and manganese concentrations exceeded 1.0 mg/L.

Copper Concentrations Detected at the City

Reported copper concentrations in the distribution system come from the City's triennial lead and copper sampling. This data is the best available information but there are several issues with using this data. The issues are summarized in Table 2. These issues limit the ability to develop strong correlations between detected copper concentrations leaving the distribution system and the copper concentrations entering the wastewater. However, corrosion of drinking water systems and plumbing has been established as one of the major contributors of metals to wastewater (Isaac et. al, 1997). In the instance of the City, corrosion of copper, brass, bronze, and galvanized metals is likely to be the single largest contributor of metals as the City lacks smelting, semiconductor, electroplating, paint manufacturing, large volume color printing, or wood preservative operations, industries that typically release large quantities of heavy metals into municipal sewer systems.

Table 2. Issues in Using Distribution System Lead and Copper Compliance Data

Issues that Result in Under-reporting Copper or Zinc Release	Issues that Result in Over-reporting Copper or Zinc Release
Sampling is from cold water lines whereas copper release is significantly higher from hot water lines.	Sampling is from a six-hour stagnation period, when water use is lowest. Water use is highest during the day, when stagnation periods are much lower. (Metal release increases with longer stagnation periods).
Sampling is from kitchen faucets of single-family residential homes. Sampling omits schools and businesses, whose stagnation periods can be as high as 16 hours during weekdays and two days during weekends.	Sampling is from kitchen faucets of single-family residential homes. Cold water in toilets, washers, and showers cause have less metal contact and thus less metal release.
Sampling is from decades-old plumbing, whereas copper and zinc release is highest in new plumbing.	Water in contact with plastic pipes does not cause metal release.

Despite these issues, the City's distribution system still provides useful information for indicating how much copper is being released. Figure 2 shows copper concentrations at select locations in the City's drinking water and wastewater systems. The flow-averaged groundwater is calculated to be 4.8 μg/L. The drinking water sampling in 2009 and 2012 indicates that copper concentrations increased to 132 μg/L. This concentration is only 10 percent of the USEPA and state's drinking water action level of 1,300 μg/L and HDR's experience is that this copper concentration is among the lowest found for drinking water. These results show that the AQUA MAG blended phosphate is exhibiting good performance for controlling copper corrosion from copper plumbing, brasses, and bronzes.

The copper then entering the wastewater treatment plant (WWTP) was determined to have decreased to 38 μg/L in one grab sample. The decrease between the drinking water sampling results from regular stagnation samples at kitchen faucets and the WWTP can the result of the reasons listed in Table 2. In addition, some of the copper could have been adsorbed onto solids that are not analyzed by the laboratory and some dilution could have occurred due to inflow/infiltration in the sewer collection and conveyance system. Copper is reduced to 14 μg/L in one grab sample as much of the influent copper is further bound to solids and removed as waste activated sludge.

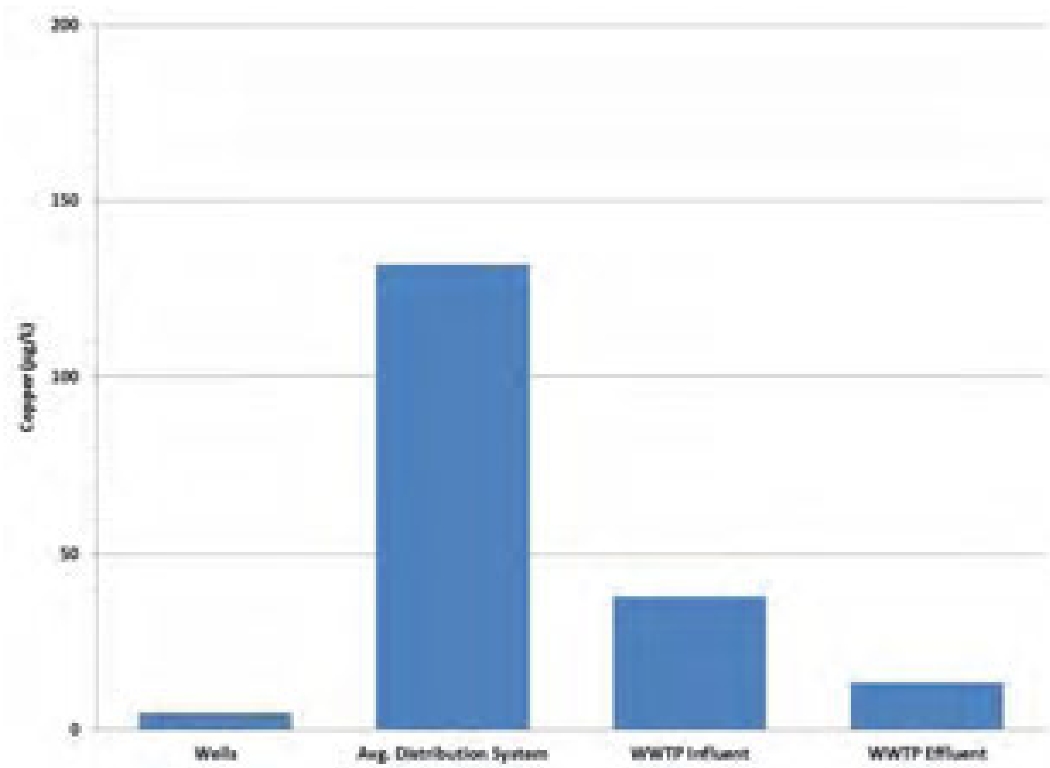

Figure 2. Copper Concentrations At Select Points in City's Water/Wastewater Systems

A further examination of the copper sampling results is shown in Figure 3. This figure is a distribution of the copper results by occurrence for 2009 and 2012. In general, the median (50th percentile) is about 100 µg/L, which is just about the lowest expected copper concentration in drinking water systems. The difference between the average value of 132 µg/L shown in Figure 2 and the median value of 100 µg/L in Figure 3 is because of the very large outliers shown in Figure 3. These very large values of >500 µg/L skew the average upwards. However, HDR notes that these large outliers would still be considered below the drinking water action level.

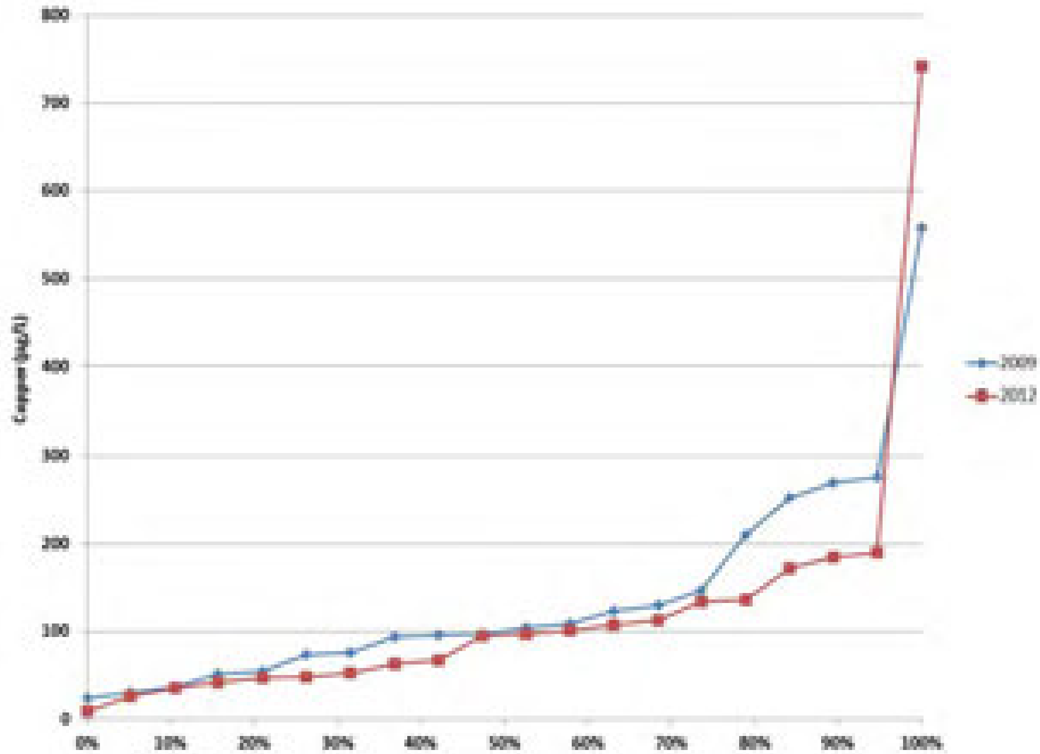

Figure 3. Distribution of Copper Results in Water Distribution Sampling

Zinc Concentrations Detected at the City

Unlike copper, zinc is not normally analyzed for drinking water and there are no regulatory limits for the element. The available zinc results are summarized in Table 3. As listed in Table 1, the influent zinc concentrations appear especially high, which then results in flow-averaged groundwater concentrations of 959 µg/L. HDR recommends further sampling to determine the accuracy of the February 18, 2015 results. If accurate, the much of the soluble zinc in the groundwater is adsorbed by solids, with a 15-fold reduction in concentrations in the WWTP influent. The sampling shows that zinc is barely removed by the wastewater treatment processes.

Table 3. Detected Zinc Concentrations in Groundwater and WWTP

Sampling Location	Concentration (µg/L)	Comment
Groundwater (flow-averaged)	959	Feb. 18 grab samples.
WWTP Influent	64	Grab sample
WWTP Effluent	58	Grab sample

Considerations Related To AQUA MAG for Copper/Zinc Control at the Wastewater Treatment Plant

HDR recognizes that the AQUA MAG blended orthophosphate compound is clearly beneficial for controlling copper corrosion for drinking water compliance. There is no apparent need to change the City's current water treatment practices.

However, given that the proposed WWTP discharge limit is 3.1 µg/L, decreasing copper contributions from the drinking water system into the wastewater system could be part of a comprehensive approach to meeting the WWTP discharge permit requirements. In addition, the breakdown of AQUA MAG to generate potentially hazardous heavy metal-laden deposits in water mains is an emergent issue that federal health officials are currently considering regulating, with the likely result that the current AQUA MAG use will not be allowed.

Based on these the City could consider changing from a blended phosphate solution to a 100 percent orthophosphate solution, such as phosphoric acid. More orthophosphate should further reduce copper corrosion. However, to counteract the acid's pH depression, caustic soda (sodium hydroxide) might need to be added to maintain the current water pH. The orthophosphate has approximately the same hold times as blended phosphate so careful consideration for winter time deliveries will still need to occur.

Since polyphosphate addition would be terminated, iron/manganese removal would need to occur through using greensand filters. Greensand filtration will greatly reduce the potential for deposits to form in the distribution system, thereby resulting in clearer-looking water, improved chlorine residuals, and longer hot water equipment lifespans for customers. An additional benefit is the manganese greensand filters have some capacity to remove arsenic, which would be an additional benefit to Well E. Pending pilot testing results, use of greensand filters should reduce arsenic concentrations enough to allow continued well operation at below the MCL.

Implementing these changes could hypothetically result in copper reductions between approximately 25 to 30 µg/L to the average distribution system contribution, which could translate to a 20 percent reduction to the WWTP input.

HDR suggests that further sampling and analysis for zinc be conducted to ascertain the accuracy of the Feb. 18, 2015 results. If accurate, then the proposed changes for copper would result in some zinc reduction, though HDR is unable to quantify the reduction at this time using the currently available data.

The process of changing from AQUA MAG to another orthophosate solution needs to be slowly implemented if the City proceeds with changing from AQUA MAG use. Rather than making the change on the full-scale system, HDR strongly recommends that a series of pilot tests be implemented using short sticks of copper plumbing in a pipe loop to monitor and quantify the exact change in copper reduction.

Before the City moves ahead with any of the considerations put forth in this memorandum, HDR suggests a comprehensive financial evaluation of water treatment methods; coupled with a determination of how to attain the proposed WWTP effluent permit requirements can be met, to determine whether the City should change its current practices.

References

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