Central Kitsap County Wastewater Facility Plan

March 2011

KITSAP COUNTY PUBLIC WORKS
WASTE WATER DIVISION

Brown AND Caldwell

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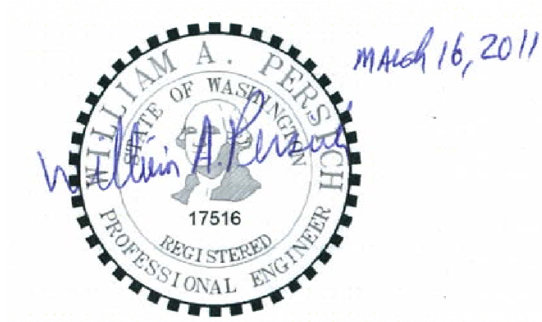
Central Kitsap County Wastewater Facility Plan

Prepared for

Kitsap County Department of Public Works

March 2011



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LIST OF ABBREVIATIONS

µg/L: microgram(s) per liter

10-Year Update: *Kitsap County Comprehensive Land Use Plan 10-Year Update* (2006)

401 Certification: Section 401 Water Quality Certification

AAF: average annual flow

AB: aeration basin

ACEC: acute critical effluent concentration

ADF: average design flow

ADWF: average dry weather flow

AS: aeration station

ASCE: American Society of Civil Engineers

ASL: above sea level

ATAD: autothermal thermophilic aerobic digestion

AWWF: average wet weather flow

BABE: bioaugmentation batch enhanced (process)

BAF: biological aerated filter

BAR: bioaugmentation re-aeration (process)

BOD_5: biochemical oxygen demand

BSL: below sea level

CAHTS: Class A heat treatment system

CAS: conventional activated sludge

CBOD: carbonaceous biochemical oxygen demand

Cd: cadmium

CEC: compound of emerging concern

Centennial: Centennial Clean Water Fund Program

CEPT: chemically enhanced primary clarification

CIP: Capital Improvement Program

CKWWTP: Central Kitsap Wastewater Treatment Plant

CNG: compressed natural gas

COD: chemical oxygen demand

Compliance Plan: *Central Kitsap GMA Compliance Plan*

Corps: U.S. Army Corps of Engineers

COSA: cost of service analysis

Cr: chromium

Cu: copper

cu ft: cubic foot/feet

CWA: Clean Water Act

CWA SRF: Clean Water Act-State Revolving Fund

d: day

DAFT: dissolved air flotation thickener

DAHP: Washington Department of Archaeology and Historic Preservation

DCD: Kitsap County Department of Community Development

DH+: Data Highway Plus

DHI: Danish Hydraulic Institute

DNR: Washington Department of Natural Resources

DNS: determination of nonsignificance

DO: dissolved oxygen

DSC: debt service coverage

DSVI: dilute sludge volume index

EA: environmental assessment

Ecology: Washington State Department of Ecology

ECS: Engineered Compost Systems

EIS: environmental impact statement

ENR-CCI: *Engineering News-Record* Construction Cost Index

EPA: U.S. Environmental Protection Agency

EQ: equalization (basin)

ERU: equivalent residential unit

ESA: Endangered Species Act

Facility Plan: *Central Kitsap County Wastewater Facility Plan* (2011) (this document)

FM: force main

FONSI: Finding of No Significant Impact

FPC: firm pumping capacity

fps: foot/feet per second

ft: foot/feet

gal: gallon(s)

GBT: gravity belt thickener

GHG: greenhouse gas

GMA: Washington State Growth Management Act

gpcd: gallon(s) per capita per day

gpd: gallon(s) per day

gpd/acre: gallon(s) per day per acre

gpm: gallon(s) per minute

GWMP: Groundwater Management Plan

HDD: horizontal directional drilling

Health District: Kitsap County Health District

Hg: mercury

HGL: hydraulic grade line

HMI: human-machine interface

hp: horsepower

HPA: Hydraulic Project Approval

HPO: high-purity oxygen

HRT: hydraulic retention time

HVAC: heating, ventilation, and air conditioning

I/I: infiltration and inflow

IFAS: integrated fixed-film activated sludge

IMLR: internal mixed liquor recycle

IO: input/output

ISS: inert suspended solids

J&B: jack-and-bore

JARPA: Joint Aquatic Resources Permit Application

KCC: Kitsap County Code

kPa: kilopascal

kV: kilovolt

kVA: kilovolt-ampere

kW: kilowatt

LAMIRD: limited area of more intense development

lb: pound(s)

lf: linear foot/feet

LS: lift station

MBBR: moving bed biofilm reactor

MBR: membrane bioreactor

MCC: motor control center

MDF: maximum day flow

MG: million gallon(s)

mgd: million gallon(s) per day

mg/L: milligram(s) per liter

MH: manhole

MHHW: mean higher high water

MHI: median household income

mL/g: milliliter(s) per gram

MLLW: mean lower low water

MLSS: mixed liquor suspended solids

MSL: mean sea level

MTL: mean tide level

MT: membrane tank

NBOD: nitrogenous biological oxygen demand

NEPA: National Environmental Policy Act

NH_3-N: ammonia nitrogen

Ni: nickel

NOAA: National Oceanic and Atmospheric Administration

NPDES: National Pollutant Discharge Elimination System

NPV: net present value

NTU: nephelometric turbidity unit

O&M: operation and maintenance

Operations: Kitsap County Public Works Operations

Orange Book: *Criteria for Sewage Works Design* (Ecology, 2008)

PAC: powdered activated carbon

Pb: lead

PDF: peak design flow

PDWF: peak dry weather flow

PHS: Priority Habitats and Species

PIC: Pollution Identification and Correction

PLC: programmable logic controller

PMF: peak month flow

POP: point-of-presence

Poulsbo Sewer Plan: *City of Poulsbo Draft Comprehensive Sanitary Sewer Plan 2007 Update*

ppd: pound(s) per day

ppm: part(s) per million

PSCAA: Puget Sound Clean Air Agency

psi: pound(s) per square inch

psig: pound(s) per square inch gauge

PSRP: process that significantly reduces pathogens

PUD: Kitsap County Public Utility District

PWWF: peak wet weather flow

R&R: repair and replacement

RAS: return activated sludge

RBC: rotating biological contactors

RCW: Revised Code of Washington

RDT: rotary drum thickener

remote input/output (RIO)

Reuse Standards: *Washington State Water Reclamation and Reuse Standards* (2007)

RO: reverse osmosis

SBR: sequencing batch reactor

SCADA: supervisory control and data acquisition

scfm: standard cubic feet per minute

SDAP: Site Development Activity Permit

SEPA: Washington State Environmental Policy Act

SERP: State Environmental Review Process

SLR: solids loading rate

SMA: Shoreline Management Act

SOC: Species of Concern

SOR: surface overflow rate

SOTE: standard oxygen transfer efficiency

sq ft: square foot/feet

SR: State Route

SRF: Washington State Water Pollution Control Revolving Fund Program

SRT: sludge retention time

SSV30: settled sludge volume at 30 minutes

SVI: sludge volume index

SWBD: switchboard

SWD: State Waste Discharge

SWGR: switchgear

TDH: total dynamic head

TDS: total dissolved solids

TF/SC: trickling filter/solids contact

TKN: total Kjeldahl nitrogen

TN: total nitrogen

TP: total phosphorus

TPAD: temperature-phased anaerobic digestion

tpd: ton(s) per day

TMDL: total maximum daily load

TSS: total suspended solids

UGA: Urban Growth Area

ULCA: *Updated Land Capacity Analysis* (2006)

USCS: U.S. Soil Conservation Service

USFW: U.S. Fish and Wildlife Service

USGS: U.S. Geological Survey

UV: ultraviolet

VFD: variable-frequency drive

VS: volatile solids

VSS: volatile suspended solids

WAC: Washington Administrative Code

WAS: waste activated sludge

Water Quality Memo: *Central Kitsap County Wastewater Facilities Development Strategy Plan Preliminary Water Quality Issues* (BHC, June 2006)

WDFW: Washington Department of Fish and Wildlife

WML: waste mixed liquor

WRIA: water resource inventory area

WWTP: wastewater treatment plant

Zn: zinc

EXECUTIVE SUMMARY

ES-1 Introduction

Planning the 20-year wastewater infrastructure needs of a fast-growing region presents enormous challenges. Expanding populations must be served and increasing flows must be handled. Infrastructure must be used wisely to maximize limited resources; regulations must be followed. Planning on this level involves weighing a complicated array of interconnected—and often conflicting—factors and variables.

But challenges also reveal opportunities. Exciting technologies are now available that promote water reclamation, energy efficiency, biosolids and biogas utilization, and overall environmental sustainability as never before. A window is open to extraordinary possibilities. This *Central Kitsap County Wastewater Facility Plan* (Facility Plan) provides a road map for the Central Kitsap area's long-term wastewater infrastructure needs. It also explores system improvements that will start moving Kitsap County toward a greener future.

The overall goal of providing sewerage service is to protect public health and the quality of water resources. This Facility Plan identifies the facilities required to meet these goals and provides guidance for the development of wastewater facilities for a growing service area. Beyond that, it highlights opportunities for Kitsap County to chart a more sustainable, energy-efficient course. It also must comply with Washington Department of Ecology (Ecology) regulations for facility plans (Washington Administrative Code [WAC] 173-240-060). This Facility Plan will allow the County to manage growth within the context of a countywide wastewater service network.

Another key driver was Kitsap County's "Water as a Resource" Policy. The County has enacted a far-reaching resolution (Resolution 109-2009, dated June 22, 2009) to conserve and protect the county environment by enlightened stewardship of local county water resources. These aquatic resources and assets include wetlands, stormwater, groundwater, streams, lakes, and Puget Sound. The County has declared its policy to reuse wastewater effluent and minimize flow and nutrient loading to Puget Sound while preserving and conserving precious groundwater resources. This resolution articulates the County's environmental leadership to preserve and protect its resources. A copy of this resolution is included in Appendix 5B.

To develop a 20-year wastewater facility plan, a comprehensive, defensible decision-making methodology first must be established. The recommendations provided in this Facility Plan were arrived at by determining a set of key criteria. These criteria are based on the following factors:

- planning area characteristics and population projections
- estimated wastewater flows and loadings
- condition of existing infrastructure
- current regulations
- water conservation and reuse.

After determining the key criteria based on the factors listed above, they were applied to all potential wastewater infrastructure project alternatives to identify, evaluate, and rank them. Only capital projects that can be easily supplemented or modified for future wastewater reclamation and reuse were identified for consideration. (Note: The term "reuse" is used broadly in this Facility Plan to express any efforts to increase the wastewater system's beneficial use of biosolids and biogas, energy efficiency, water reclamation, and overall environmental sustainability.) Figure ES-1 provides a general graphical depiction of the methodology that was employed to reach the final recommendations.

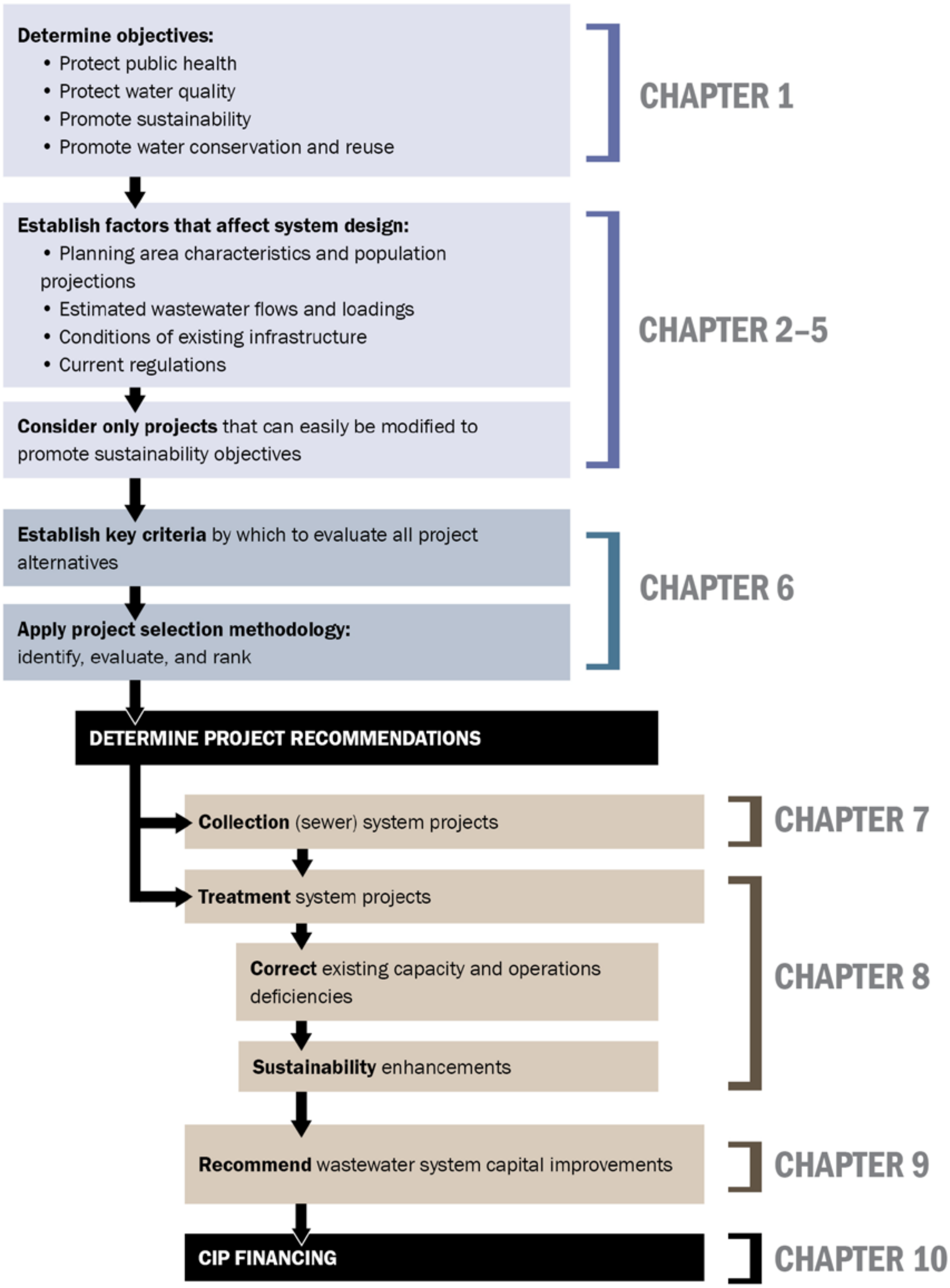


Figure ES-1. Facility planning methodology

The criteria that most heavily influence the selection of potential projects for further consideration are shown in Table ES-1. This table also indicates which of the two main wastewater infrastructure categories these criteria apply to.

Table ES-1. Key Criteria Used to Select Projects

Key criterion number	Key criterion	Key criterion attributes	Applicable to collection system projects	Applicable to treatment system projects	Facility Plan chapters where discussed
1	Correct known wastewater system deficiencies	Facilities are intended to rectify known existing significant wastewater infrastructure deficiencies.	✓	✓	4, 7
2	Repair and replace aged assets	Facilities are intended to repair and replace wastewater system components that are near or beyond asset service life.	✓	✓	4
3	Provide wastewater service capacity for planning period growth (serving wastewater flow and load projections)	Facilities provide capacity expansion to meet wastewater service requirements for anticipated growth in the planning period (to year 2030), consistent with Growth Management Act (GMA) requirements.	✓	✓	3
4	Regulatory compliance	Facilities must comply with all applicable regulations and permits.	✓	✓	4, 5
5	Land use	Facilities are intended to provide service for applicable designated land use categories, and to avoid sensitive areas unsuitable for service or for wastewater facilities. Use and upgrade of existing infrastructure is encouraged.	✓	✓	2, 7, 8
6	Accepted engineering design criteria	Facilities must comply with Ecology and other accepted industry standards for design and operations.	✓	✓	6, 7, 8
7	Best available technologies	Facilities utilize the currently available best technology to meet existing and anticipated wastewater system needs economically, efficiently, and reliably.		✓	8
8	System operational considerations	Capital improvements facilitate maintenance and operations of facilities.		✓	8
9	Flexibility for future expansion	Facilities can be modified or expanded to provide new roles or services without creating stranded investments or precluding future opportunities.	✓	✓	7, 8
10	Reclaimed water utilization	Facilities enable the beneficial use of highly treated wastewater effluent for irrigation, groundwater recharge, and stream flow augmentation. All wastewater effluent is currently discharged to Puget Sound.		✓	8
11	Energy usage	Treatment processes or facilities are capable of reducing energy consumption or of producing "green power."		✓	8

Table ES-1. Key Criteria Used to Select Projects					
Key criterion number	Key criterion	Key criterion attributes	Applicable to collection system projects	Applicable to treatment system projects	Facility Plan chapters where discussed
12	Biosolids utilization	Facilities continue or enhance the use of biosolids and nutrient recycling. Currently, biosolids from the CKWWTP are conveyed to a private enterprise for a beneficial reuse of this product.		✓	8
13	Environmental and sensitive area concerns	Facilities minimize environmental impacts for water quality, biosolids quality, noise, odor, and wildlife habitat in the surrounding community and in sensitive areas in particular.	✓	✓	2, 7, 8
14	Community considerations	Facilities are consistent with Kitsap County policies and are least disruptive to community values, aesthetics, and safety.	✓	✓	7, 8
15	Planning-level costs	Facilities provide the maximum value for the least cost. In the case of collection system improvements, total project cost (capital cost) is used as the key cost criterion. For treatment system improvements, net present value (NPV) is used as the key cost criterion for alternatives evaluation. Planning-level cost accuracy typically ranges from +50 to -30 percent.	✓	✓	6, 7, 8, 9

This Facility Plan constitutes a portion of the Kitsap County Comprehensive Plan capital facilities element. At the time of adoption this Facility Plan is consistent with the other elements of the Comprehensive Plan. However, if subsequent changes to other elements of the Comprehensive Plan render it inconsistent with this Facility Plan, revisions may be required. Further, in accordance with Revised Code of Washington (RCW) 36.70A.070(3)(e), if probable funding for the proposals set forth in this Facility Plan fall short of meeting needs, the land use element of the Kitsap County Comprehensive Plan will be reassessed.

According to RCW 90.48, all engineering reports, facility plans, construction plans, and specifications for new construction, improvements, or extensions of existing sewerage systems, sewage treatment, or disposal plants or systems shall be submitted to and approved by Ecology before construction may begin. In general, this review is intended to ensure that facilities proposed to be designed, constructed, operated, and maintained will meet the applicable state requirements to prevent and/or control pollution of state waters.

This Facility Plan will first be approved by Kitsap County as part of the capital facilities element of its Comprehensive Plan. The final Facility Plan must comply with Ecology regulations for facility plans (WAC 173-240-060). Ecology is expected to review the final Facility Plan in 2011. The requirements for an engineering report are specifically structured for projects that are funded only through local funds or by state funding programs. If a project is to be considered eligible for funding by the U.S. Environmental Protection Agency (EPA), then additional requirements are imposed in this document to conform to a Facility Plan. A facility plan must also follow the guidelines contained in the EPA publication, "Guidance for Preparing a Facility Plan" (MCD-46), and shall indicate how the special requirements contained in Code of Federal Regulations (CFR) Title 40 Part 35.719-1 will be met. One fundamental additional requirement of a facility plan is that a discussion of treatment alternatives must be included to document that the most cost-effective solution has been recommended. This document meets the requirements for both a facility plan and an engineering report.

Approval of the Facility Plan by Ecology and the standard design criteria submitted to support development of the Facility Plan will enable Kitsap County to proceed with sewer line extensions, including pump station projects. The submittal to Ecology for approval of engineering reports and plans and specifications for these conveyance systems projects is not required (WAC 173-240-030[5]).

Adoption of this Facility Plan also requires State Environmental Policy Act (SEPA) review by Kitsap County. A non-project SEPA checklist was prepared and included in Appendix 9. Project-specific SEPA review will be prepared for each of the recommended capital improvement projects at the time they are designed and permitted.

ES-2 Factors that Influence Wastewater Facility Design

This section summarizes the factors that determine which design alternatives are considered for a wastewater system. These factors are all discussed in greater detail in the main body of this Facility Plan.

ES-2.1 Planning Area Characteristics and Population Projections

Central Kitsap County's physical characteristics, population projections, and subsequent land use priorities play a critical role in selecting wastewater infrastructure project alternatives. This Facility Plan discusses population estimates for the future planning period. Equivalent residential unit (ERU) population projections for the Central Kitsap planning areas are presented in Table ES-2. A vicinity map showing the general planning area for Central Kitsap is provided in Figure ES-2.

Table ES-2. Equivalent Sewered Population for CKWWTP Service Area and Poulsbo

Year	Central Kitsap UGA	Silverdale UGA	Southern Service Area total[a]	Poulsbo	Bangor	Keyport (base)	Northern Service Area total	Total system
2005	14,069	16,912	30,981	7,295	4,800	1,400	13,495	44,476
2025	26,275	27,765	54,040	15,263	4,800	1,400	21,463	75,503
2030	28,641	30,601	59,242	17,632	4,800	1,400	23,832	83,074

ES-2.2 Wastewater Characteristics

Wastewater flows and loadings also heavily influence facility design. Consequently, data related to wastewater characteristics and projected flows and loadings affect the selection of key criteria used to select project alternatives for further consideration. Flows affect the hydraulic capacity of the treatment plant, and loadings, characterized by biochemical oxygen demand (BOD) and total suspended solids (TSS) relating to sewage strength, impact the sewage treatment capacity at the Central Kitsap Wastewater Treatment Plant (CKWWTP). Existing wastewater flows and loadings are characterized and projected in proportion to the estimated population expected to be served. This information is used to develop the future target capacity requirements for new wastewater systems. Projected flows and loadings for the CKWWTP are presented in Table ES-3.

Table ES-3. Projected Flows and Loadings at CKWWTP

Raw influent parameter	Current design [a]	2030
Average annual flow (AAF), mgd	4.6	6.6
Average design flow (ADF), mgd	6.0	8.2
Peak design flow (PDF), mgd	15.0	22.7
Average peak month BOD5, ppd	14,100	16,500
Average peak month TSS, ppd	11,400	15,800

a. Corresponds to Contract I design flows and loads, except for average peak month TSS and 5-day biochemical oxygen demand (BOD_5) loadings, which correspond to the design loadings shown in the current National Pollutant Discharge Elimination System (NPDES) permit. The ADF for the secondary treatment system has been re-rated from 6 to 7 mgd per letter from Department of Ecology, July 28, 2008.

ES-2.3 Existing Wastewater System Condition

One of the basic objectives of facility planning is to evaluate the feasibility and cost-effectiveness of incorporating existing systems into a comprehensive wastewater management program. Accordingly, information regarding the characteristics and conditions of the existing system is analyzed to define each component's potential role in the long-term program. Maximum utilization of existing facilities is considered as the baseline condition for planning improvements.

This Facility Plan provides a description of the nature and general condition of the current wastewater system. This analysis provides an understanding of how the existing system functions. Major problem areas and existing, known deficiencies are identified; these deficiencies form the basis for recommended system upgrade and expansion programs.

ES-2.4 NPDES Permit and Other Regulations

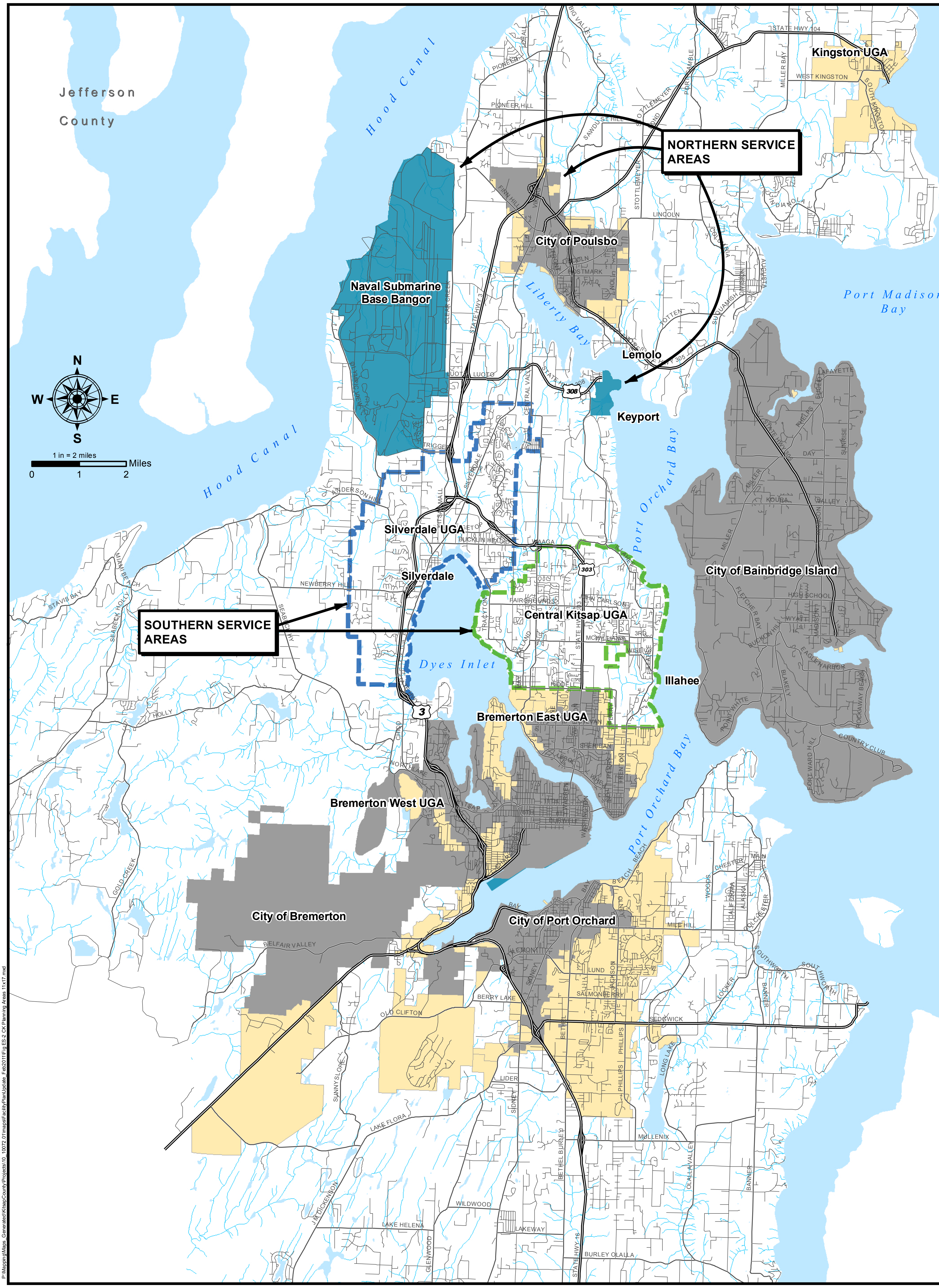
Federal, state, regional, and local regulations also play an important role in the process by which project alternatives are selected for consideration. Numerous regulations, laws, and policies affect the design, construction, and operation of wastewater facilities. This Facility Plan describes the various regulations—particularly the National Pollutant Discharge Elimination System (NPDES) permit and legislation that regulates the treatment and use of biosolids, energy conservation, effluent nitrogen concentrations, and greenhouse gas (GHG) emissions—that relate to wastewater planning for the Central Kitsap planning area.

ES-3 Wastewater System Project Recommendations

After a thorough analysis of all the factors that influence project alternatives has been completed, a carefully crafted methodology is applied to narrow the field of viable alternatives. Through this evaluation process, the optimal combination of technologies emerges. In developing project alternatives designed to perform a given function, each project must be evaluated in sufficient detail to reveal project similarities and differences. Only then can reliable comparisons be made and alternatives ranked accordingly.

This Facility Plan presents a thorough discussion of the key criteria used to evaluate specific projects for collection and treatment systems. These criteria and subsequent applied methodologies for collection system projects necessarily vary in scope and composition for alternatives used for treatment system projects.

The first several chapters of this Facility Plan establish the foundation for a sound, systematic decision-making process. After key criteria have been established, the task of applying them to wastewater infrastructure project alternatives to develop recommendations begins.



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- Central Kitsap UGA
- Silverdale UGA
- Urban Growth Areas
- Incorporated City Limits
- Military Locations
- Water Bodies
- Water Courses
- State HWY/Route
- Principal Arterial

KITSAP COUNTY 18 57 WASHINGTON

CENTRAL KITSAP PLANNING AREAS

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure

ES-2

ES-3.1 Collection System Improvements

This Facility Plan provides the identification, evaluation, and ranking of projects required for the existing sewer system and for new sewer infrastructure. These projects are separated into two main categories: lift stations and piping. A detailed review of collection projects for the 2010–30 planning period is provided, along with cost estimates for all projects.

The total project cost to the County for all recommended existing and future piping and lift station improvement projects for existing and future flows is $147.2 million: $39.9 million for the 6-year CIP and $107.3 million for the 20-year CIP. The costs of these projects are about equally split between lift stations and conveyance piping. The breakdown of this cost is shown in Table ES-4.

Table ES-4. Summary of Total Collection System Improvements, Construction, and Project Costs

Project category	6-year CIP project costs: design year 2030 (2010$)	20-year CIP project costs: design year 2030 (2010$)
Existing piping improvements for existing flows	$15,890,000	$21,870,000
Existing piping improvements for future flows	-	$13,930,000
Existing lift stations	$23,970,000	$34,532,000
Future lift stations	-	$13,065,000
Future piping	-	$23,900,000
Subtotal	$39,860,000	$107,297,000
Grand total		$147,157,000

ES-3.2 Treatment System Improvements

After collection system recommendations are made, this Facility Plan carries the project evaluation process forward to the wastewater treatment system. The key criteria described above are applied to all feasible treatment alternatives, resulting in a final set of recommendations.

A two-step process is used to assess possible treatment alternatives. An initial pass/fail evaluation is performed to determine which unit processes merit further consideration. A final evaluation of some of the treatment alternatives is then conducted. This final evaluation concludes with a ranking of alternatives and a description of the recommended improvements encompassing the best overall treatment strategies and technologies.

These recommendations for wastewater treatment, reuse, and solids treatment are summarized in Table ES-5. The total project cost for these recommendations, including all of the features necessary to comprise a complete project at the CKWWTP, is approximately $181.3 million: $50.2 million for the 6-year CIP and $131.1 million for the 20-year CIP. This estimate does not include the cost of the headworks improvement project currently under implementation.

Table ES-5. Summary of Recommended Facilities for CKWWTP

Process train	Recommendations
Liquid-stream treatment	• Construct new headworks with Mahr screens, aerated grit tanks, and a septage receiving station (under implementation). • Replace existing primary clarifiers with new conventional primary clarifiers. • Modify existing aeration basins and channels (new diffuser membranes, baffles, mixers, pumps and piping). • Add two new aeration basins • Replace existing aeration blower with new high efficiency blowers and add one blower. • Add one new secondary clarifier.
Water reuse	• Provide reclaimed water at the CKWWTP instead of construction of satellite plants. • Construct effluent filtration facility
Solids treatment/biosolids disposal	• Add gravity belt thickener (GBT) for waste activated sludge (WAS) thickening and keep gravity thickeners for primary sludge thickening only. • Stay with conventional mesophilic anaerobic digestion until regulations and/or market for biosolids disposal drive the need for Class A biosolids. Add additional digester. • Provide existing digester improvements to upgrade sludge withdrawal, heating and mixing systems. • The existing system will be modified to provide the flexibility to produce Class A biosolids in the future. • Continue to send Class B biosolids to Fire Mountain Farm or similar facility for disposal.
Biogas utilization/energy usage	• Provide combined heat and power generation (cogeneration) to eliminate flaring of the biogas. • Upgrade the biogas management system to convert from the existing fuel-oil-based digester heating to biogas based heating (via cogeneration).

It is important to note that options to further improve reuse can still be added, if funding or other current market conditions make such upgrades more economical. The current baseline set of recommendations provides a foundation upon which potential future add-on projects can be built when timing, conditions, and policy decisions dictate.

ES-3.3 Total Recommended Project Costs

The total costs for recommended existing and future wastewater infrastructure projects for the Central Kitsap planning area for the 2010–30 planning period are shown in Table ES-6.

Table ES-6. Summary of Total Infrastructure Improvement Project Costs (2010$)			
Project category	6-year CIP project costs: design year 2030	20-year CIP subsequent project costs: design year 2030	Overall total
Collection system:			
Existing conveyance flows	$39,860,000	$70,332,000	$110,192,000
Future conveyance flows	$0	$36,965,000	$36,965,000
Collection system subtotal	$39,860,000	$107,297,000	$147,157,000
Treatment system:			
Additional treatment capacity	$18,512,000	$65,352,000	$83,864,000
Resource reclamation and reuse	$31,662,000[a]	$65,728,000	$97,390,000
Treatment subtotal	$50,174,000	$131,080,000	$181,254,000
Grand total	$90,034,000	$238,377,000	$328,411,000

a. Includes $500,000 project for reclamation at the Kingston WWTP and is not part of the Central Kitsap CIP.

Information on capital expenditures is shown in Figure ES-3. The data shown in this figure are factored into the financial and rate assessments in Chapter 10.

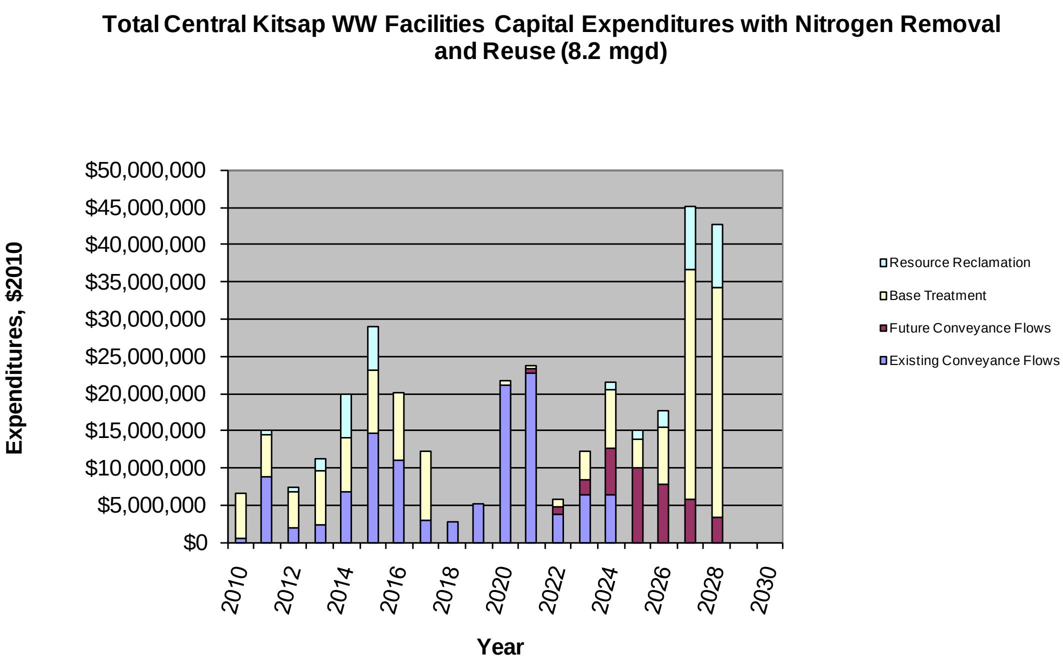


Figure ES-3. Total CKWWTP capital expenditures
(including costs for Suquamish projects)

ES-4 Financing Evaluation

The impact that the Central Kitsap County wastewater Capital Improvement Program (CIP) will have on wastewater utility customers is an important factor in determining an appropriate level of service to the community. Consequently, an evaluation of the CIP financing plan and subsequent customer rate impacts is necessary to support the selection of the recommended project alternatives for this Facility Plan.

Annual revenues required to fund the 6-year CIP and ongoing operations are projected to increase from $14.4 million in 2011 to $20.1 million in 2016. The projected wastewater system revenues would need to be increased over current rates by 224 percent, or approximately 6 percent per year, by 2030.

A CIP financing plan for the wastewater collection and treatment recommendations was developed. The recommended capital improvements would require a $55 million bond issue in 2014, in addition to the $41 million bond issued in December 2010. In an effort to avoid dramatic rate increases, the County evaluated a level annual increase required to fund the CIP and ongoing operations, which balances the use of cash and debt financing. Wastewater system revenues would need to be increased over current rates by 6–7 percent per year between 2011 and 2016 and 6 percent per year between 2016 and 2030 to achieve this goal.

In assessing the implications of these projected rate increases, it is important to note that several of the underlying assumptions are conservative and that deviations from these assumed conditions will likely lessen future rate increases. These assumptions relate to potential reclaimed water revenue, population projections, grant funding opportunities, possible private/public or interlocal partnerships, and the proportion of future improvements to be funded by private developers.

A summary of rate impacts required to fund the capital improvements discussed in this Facility Plan is shown in Figure ES-4. Future collection systems required to serve growth have a higher impact on rates, whereas the comparative rate impact of wastewater treatment improvements is much less. Based on the evaluation provided in Chapter 10, the County's CIP presented in this Facility Plan could be affordably implemented.

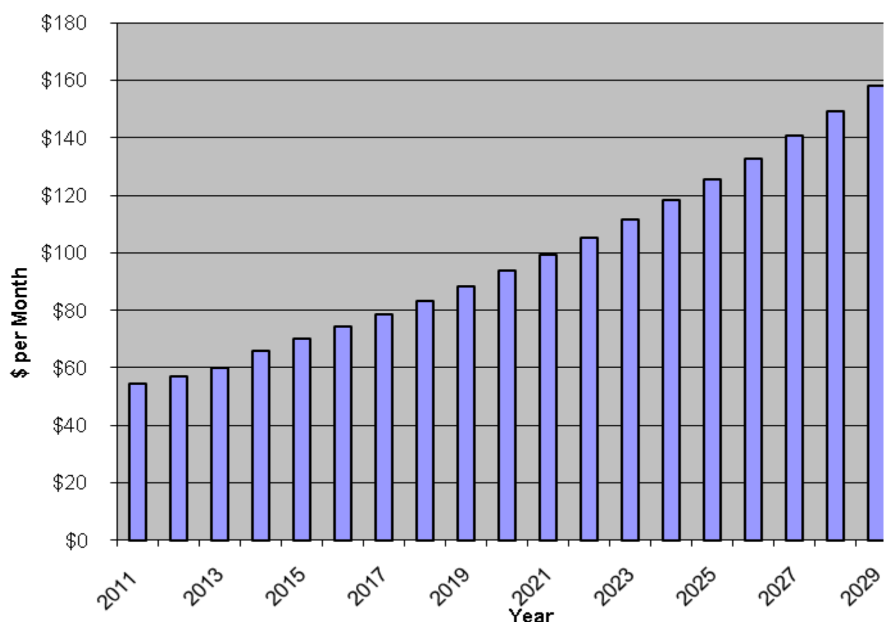


Figure ES-4. Adopted and projected monthly residential sewer rate

Complementing the 2009 "Water as a Resource" policy, this Facility Plan takes Kitsap County another step toward a greener future. Exciting new wastewater treatment technologies promote sustainability, energy efficiency, and water reclamation and reuse, further "closing the loop." These upgrades are not only good for the environment, but they are also cost-effective and economically viable.

CHAPTER 1

INTRODUCTION

Kitsap County Public Works is responsible for providing sewerage service to unincorporated central Kitsap County. Its overall goal is to protect public health and the quality of water resources. The purpose of this 2011 Facility Plan is to provide guidance for the systematic and cost-effective development of wastewater facilities required to meet these goals under projected growth levels for the 2010–30 planning period. Recommendations found in this Facility Plan are influenced by land use priorities, recent technological innovations in wastewater treatment and reuse, changing regulations, and Kitsap County's commitment to move in a more environmentally sustainable direction.

This Facility Plan will allow the County to manage growth within the context of a countywide wastewater service network. It also must comply with Ecology regulations for facilities plans (WAC 173-240-060), and it highlights opportunities for Kitsap County to promote reuse.

This Facility Plan constitutes a portion of the Kitsap County Comprehensive Plan capital facilities element. At the time of adoption this Facility Plan is consistent with the other elements of the Comprehensive Plan. However, if subsequent changes to other elements of the Comprehensive Plan render it inconsistent with this Facility Plan, revisions may be required. Further, in accordance with RCW 36.70A.070(3)(e), if probable funding for the proposals set forth in this Facility Plan fall short of meeting needs, the land use element of the Kitsap County Comprehensive Plan will be reassessed.

1.1 Background and Purpose

Kitsap County has prepared several sewerage planning documents since the 1960s. As development occurred in the late 1960s, dry-line sewers were constructed in anticipation of the addition of County sewerage facilities in the Central Kitsap planning area. The CKWWTP was constructed and first put into service in 1979. With the installation of the Navy base at Bangor, and significant growth in the Silverdale and Meadowdale areas, this wastewater service area has become the largest sewered area within unincorporated Kitsap County.

The last wastewater facility plan for the Central Kitsap planning area was prepared in 1994 and updated in 1999. Since then the Central Kitsap planning area, and the County as a whole, has grown substantially. With this growth, the need for a renewed evaluation of sewerage service to the entire County became increasingly apparent. This Facility Plan presents the findings and recommendations for the Central Kitsap wastewater facilities.

All project alternatives are identified to serve the 20-year planning period (2010–30). The 2030 populations established by the Kitsap County Department of Community Development (DCD) serve as the basis for the future densities modeled for tributary areas. Depending on the actual growth rate, the anticipated 2030 population may occur sooner or later than projected. Within the study area, some tributary areas may develop to DCD-estimated densities much sooner than others. This study deals with the average overall density without respect to time.

Also, within the last 15 years a shift in emphasis has occurred within the environmental, regulatory, and business communities toward wastewater reuse and increased energy efficiency. This Facility Plan explores technologies and strategies that would maximize the efficiency and sustainability of the Central Kitsap wastewater system.

1.2 General Planning Area Definition

A vicinity map showing the general Central Kitsap planning area is provided in Figure 1-1, provided at the end of the chapter. The planning area is narrowed in scope as physical, regulatory, and jurisdictional considerations are taken into account; this is described in Chapter 2. This modified area becomes the study area for which specific recommendations are made.

1.3 Description of Scope of Work

This Facility Plan presents a through analysis of the factors that affect the selection of project alternatives over a 20-year period (2010–30):

- planning area characteristics and population projections
- estimated wastewater flows and loadings
- condition of existing wastewater infrastructure
- current regulations
- water conservation and reuse.

Another key driver was Kitsap County's "Water as a Resource Policy." The County has enacted a far-reaching resolution (Resolution 109-2009, dated June 22, 2009) to conserve and protect the county environment by enlightened stewardship of local county water resources. These aquatic resources and assets include wetlands, stormwater, groundwater, streams, lakes, and Puget Sound. The County has declared its policy to reuse wastewater effluent and minimize flow and nutrient loading to Puget Sound while preserving and conserving precious groundwater resources. This resolution articulates the County's environmental leadership to preserve and protect its resources. A copy of this resolution is included in Appendix 5B.

Based on these factors, a methodology is established by which capital projects for wastewater collection, treatment, and reuse are identified, evaluated against relevant criteria, and ranked. The key criteria that most heavily influence the selection of future projects for further consideration are shown in Table 1-1. By systematically screening all project alternatives against these criteria, the field of alternatives is narrowed and the optimal combination of technologies emerges. Resultant project recommendations are provided—both with and without reuse alternatives—and cost estimates are provided.

Table 1-1. Key Criteria Affecting Wastewater Capital Projects

Key criterion	Facility Plan chapters where discussed
1. Correct known wastewater system deficiencies	4, 7
2. Repair and replace aged assets	4
3. Provide wastewater service capacity for planning period growth (serving wastewater flow and load projections)	3
4. Regulatory compliance (present and future)	4, 5
5. Land use	2, 7, 8
6. Accepted engineering design criteria	6, 7, 8
7. Best available technologies	8
8. System operational considerations	8
9. Flexibility for future expansion	7, 8
10. Reclaimed water utilization	8
11. Energy conservation and generation	8

Table 1-1. Key Criteria Affecting Wastewater Capital Projects	
Key criterion	Facility Plan chapters where discussed
12. Biosolids utilization	8
13. Environmental and sensitive area concerns	2, 7, 8
14. Community considerations	7, 8
15. Planning-level costs	6, 7, 8, 9,10

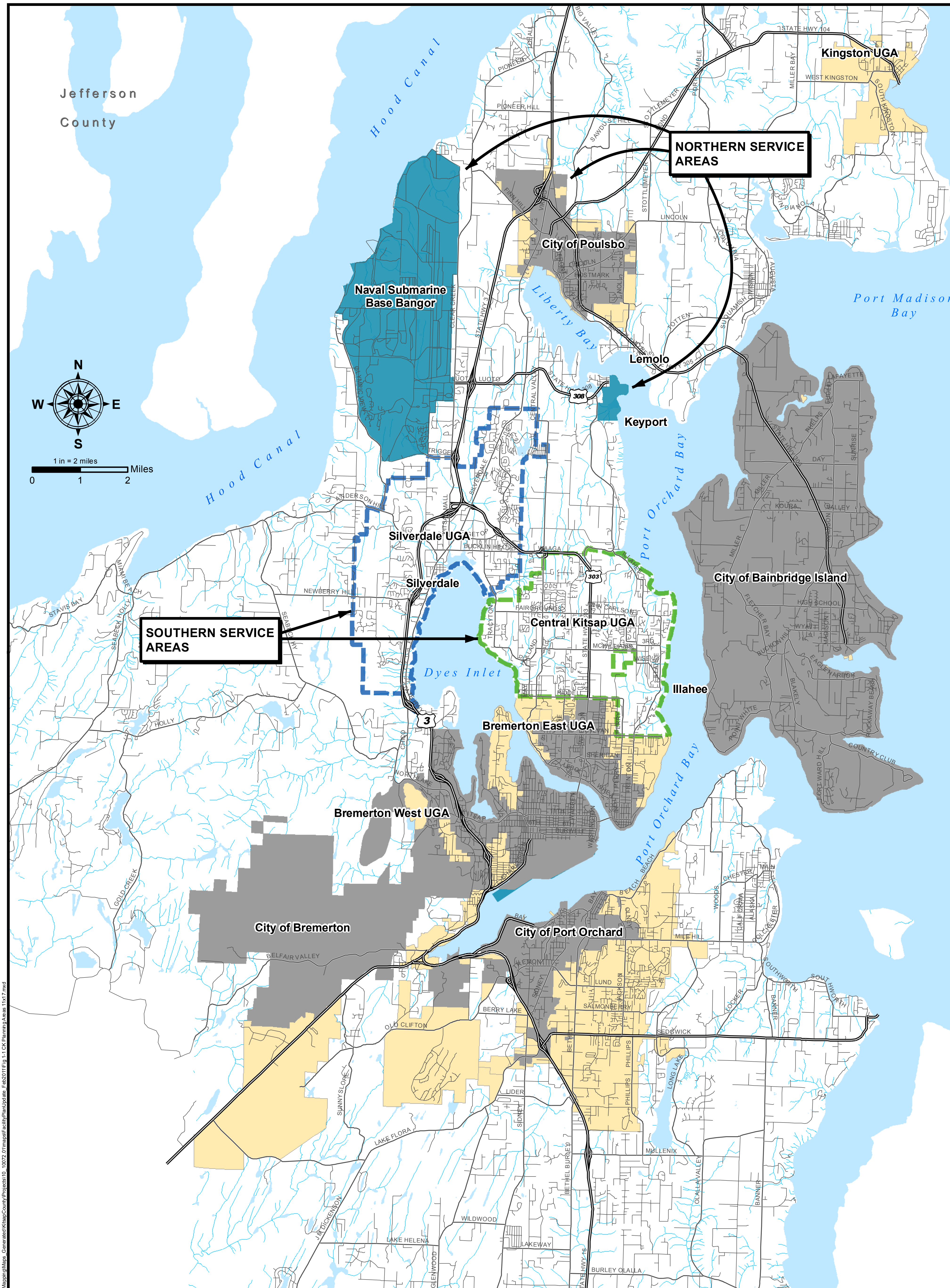
This Facility Plan also addresses the County's efforts to provide far-reaching leadership and stewardship for the preservation and enhancement of all local aquatic, land, and air environmental resources. Protection of these valuable resources is supported by the County's desire to promote water reclamation, nutrient (e.g., nitrogen) reduction in effluent discharged to Puget Sound, full beneficial utilization of biosolids, energy conservation, GHG reduction, and energy generation from biogas resources. As is common to most municipal wastewater systems, resources inherent in wastewater (e.g., water, nutrients, and energy) were previously either wasted in treated effluent or not put to full beneficial use. The result often was detrimental to the environment. The County's new vision is to utilize all these inherent wastewater resources to the fullest extent practical, enhancing the environment while providing affordable wastewater service to its customers. This approach is a cornerstone of this Facility Plan.

1.4 Overview of the Facility Plan

This Facility Plan is divided into several chapters to provide an understanding of the current nature of the service area, and to examine the key criteria and their impacts on the wastewater system. Chapters 2–5 provide descriptions of the planning area, wastewater flows and loadings, the condition of the existing infrastructure, and regulations that guide system design. Chapter 6 explains the key criteria and evaluation methodologies applied to select project alternatives for further consideration. Chapters 7 and 8 identify potential projects for the collection and treatment systems, respectively; they then explain the evaluation and subsequent ranking of project alternatives. A final set of recommended capital improvements to the CKWWTP wastewater collection and treatment infrastructure for the 6- and 20-year planning periods are then presented in Chapter 9. Chapter 10 presents an evaluation of how these capital improvements will be financed. The organization of the Facility Plan is shown in Table 1-2. To facilitate an understanding of terminology used in this document, a glossary of commonly used technical terms and abbreviations used in this Facility Plan is provided in Appendix 1.

Table 1-2. Organization of the Central Kitsap County Wastewater Facility Plan	
Chapter	Content
1. Introduction	1.1 Background and Purpose 1.2 General Planning Area Definition 1.3 Description of Scope of Work 1.4 Overview of the Facility Plan

Table 1-2. Organization of the Central Kitsap County Wastewater Facility Plan	
Chapter	**Content**
2. Planning Area Characteristics	2.1 Overview of Chapter Contents 2.2 Urban Growth Areas 2.3 Planning and Service Areas 2.4 Natural Systems Affecting Wastewater Collection and Treatment Systems and Reclaimed Water Opportunities 2.5 Population Estimates and Projections 2.6 Land Use and Zoning 2.7 Equivalent Residential Unit Criteria 2.8 Sewered Equivalent Population Projections
3. Wastewater Characteristics	3.1 Overview of Chapter Contents 3.2 Wastewater Flows 3.3 Wastewater Composition and Loadings
4. Description and Condition of Existing Wastewater System	4.1 Overview of Chapter Contents 4.2 Existing Collection Facilities 4.3 Existing Wastewater Treatment Plant 4.4 Outfall and Diffuser
5. Regulatory Requirements and Other Drivers Impacting the Facility Plan	5.1 Overview of Chapter Contents 5.2 Federal Requirements 5.3 State Requirements 5.4 Local Regulations, Policies, and Guidance
6. Facilities Design and Evaluation Criteria and Methodologies	6.1 Overview of Chapter Contents 6.2 Key Criteria and Methodologies Used to Identify, Evaluate, and Rank Projects 6.3 Collection System Projects 6.4 Treatment System Projects
7: Collection System Improvements	7.1 Overview of Chapter Contents 7.2 Project Identification 7.3 Project Evaluation 7.4 Project Ranking and Prioritization
8. Wastewater Treatment Improvements, Reuse Options, and Energy Conservation and Generation Opportunities	8.1 Overview of Chapter Contents 8.2 Summary of Initial Process Screening and Evaluation 8.3 Evaluation of Combined Wastewater and Reuse Alternatives 8.4 Project Recommendations
9. Recommended Wastewater System Capital Improvements	9.1 Overview of Chapter Contents 9.2 Collection System Improvements 9.3 CKWWTP Improvements and Kingston WWTP Wastewater Reclamation and Reuse 9.4 Project Cost Summary
10: Financing Evaluation	10.1 Overview of Chapter Contents 10.2 Capital Costs 10.3 Projected 6-Year Revenue Requirement 10.4 Cost of Service Analysis and Rate Increases Required 10.5 Affordability 10.6 Alternative Funding Resources Available 10.7 Conclusions 10.8 Major Funding Assumptions



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- Central Kitsap UGA
- Silverdale UGA
- Urban Growth Areas
- Incorporated City Limits
- Military Locations
- Water Bodies
- Water Courses
- State HWY/Route
- Principal Arterial

Data sources supplied by Kitsap County and may not reflect current or actual conditions. This map is a geographic representation based on information available. It does not represent survey data. No warranty is made concerning the accuracy, currency, or completeness of data depicted on this map.

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CENTRAL KITSAP PLANNING AREAS

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure

1-1

CHAPTER 2

PLANNING AREA CHARACTERISTICS

Growth Management Act (GMA) requirements, planning area physical characteristics, population estimates and projections, and related land use priorities all play a critical role in determining the key criteria used to select project alternatives for the central Kitsap County sewer system and the CKWWTP facility design in the planning period through 2030. This chapter presents the physical and demographic characteristics of the planning area, with a focus on features that are considered during the facility planning process. This information is provided to show how wastewater infrastructure relates to its community and environs.

The Central Kitsap service areas generally range from Bremerton to Poulsbo and from Port Orchard Bay to Hood Canal. Specifically, these service areas include the following:

- Central Kitsap Urban Growth Area (UGA)
- Silverdale UGA
- city of Poulsbo and surrounding UGA
- Keyport community
- Bangor and Keyport naval bases.

Additionally, septage collected countywide and biosolids generated at other County WWTPs (Manchester, Suquamish, and Kingston) are trucked to the CKWWTP for processing and disposal. The locations of these service areas and treatment plants are shown in Figure 2-1 (all Chapter 2 figures are provided at the end of the chapter). These areas and their characteristics are discussed in this chapter.

2.1 Overview of Chapter Contents

This chapter describes the Central Kitsap UGAs established by the GMA and discusses the GMA's role in establishing wastewater service requirements. Subsequent sections describe the physical characteristics of the planning area and its sub-basins including natural systems (e.g., topography, land use, zoning, sensitive habitats, drinking water aquifers, and geological impediments) that limit construction of wastewater system improvements and reclaimed water opportunities. Finally, this chapter discusses service population estimates for the future planning period covered in this Facility Plan.

2.2 Urban Growth Areas

This document differs from the previous Facility Plan (published in 1994 and amended in 1999) by using UGAs to define the service areas. A UGA is defined by the State of Washington as a mostly contiguous area around an urbanized area, often a commercial core, within which growth and services can be concentrated over time, resulting in a more efficient use of public infrastructure.

The State of Washington adopted the GMA in 1990 with the intent of concentrating most new development within urban areas of the more populous and rapidly growing counties. These counties are required to define an urban growth boundary within which urban services, like sewers, are provided. New parcels that develop outside the UGA boundary must be low-density with sufficient acreage to support onsite sewage disposal systems conforming to county and state health regulations. Once the UGA boundaries have been established, counties can adjust or expand them only within a prescribed planning and legal framework. The Central Kitsap planning area includes three UGAs as well as several special areas occupied by naval facilities.

For Kitsap County, the UGA boundaries are identified in the *Kitsap County Comprehensive Land Use Plan 10-Year Update*, December 2006 (10-Year Update). The 10-Year Update included modifications in the extent of the Central Kitsap planning and service area as currently defined by the Silverdale and Central Kitsap UGA boundaries illustrated on Figure 2-2.

Under the GMA, only the three following potential exceptions to the prohibitions of sewers outside of an urban growth boundary are recognized under state law and case law:

1. Where it is a necessary response to a documented public health or environmental hazard and the County has determined that providing sewer service is financially supportable and will not permit urban growth.
2. Where the County has entered into a preexisting contractually binding agreement to provide sewer service to a property outside of the UGA.
3. Where sewer service is required to service areas of more intensive rural development allowed by the Kitsap County Comprehensive Plan Land Use Map.

Sewers provided in these cases may be satellite systems limited to serving only the qualified and defined parcels. Alternatively, a sewer extension may be "tight-lined" to convey wastewater from the qualified and defined parcels into the UGA for connection to the existing sewer system.

2.3 Planning and Service Areas

The central Kitsap County planning area is divided into the Countywide, Northern, and Southern Service Areas. The various areas and services provided by the County are identified in Table 2-1 below and described in more detail in the following paragraphs.

Table 2-1. Wastewater Service Responsibilities by Service Area

	Collection system owner	Owner's responsibility	Kitsap County role
Countywide Service Area			
Septage haulers	Private	Private systems	Wastewater treatment and biosolids processing and disposal
Other treatment plants	Kitsap County	Wastewater treatment and biosolids processing and disposal	
Future facilities by others	Port Gamble, state parks MBRs, other	To be determined	To be determined
Northern Service Area			
Bangor	U.S. Navy	Collection system capital costs Treatment costs Flow metering	Wastewater treatment Biosolids Operation and maintenance (O&M) of collection facilities (outside of Owner's service area in the County)
Keyport Navy	U.S. Navy		
Poulsbo city and UGA	Poulsbo city		
Keyport community	Kitsap County	Infrastructure and O&M for collection and treatment	
Southern Service Area			
Silverdale UGA	Kitsap County	Infrastructure and O&M for collection and treatment	
Central Kitsap UGA			
Special connections			

2.3.1 Countywide Service Area

The CKWWTP provides biosolids processing and disposal for additional non-contiguous "service areas." Biosolids from ancillary treatment plants for Suquamish, Kingston, and Manchester are trucked to the CKWWTP for processing. Port Gamble may, in the future, expand its wastewater treatment facilities to accommodate growth. At such time, the County could own and operate the plant or the community could contract to utilize the CKWWTP facility for biosolids management. Biosolids may also be received from other smaller WWTPs in the future, such as the membrane bioreactor (MBR) plants being constructed for state parks on Bainbridge Island and Hood Canal.

2.3.2 Northern Service Area

Flows generated in the Northern Service Area come predominantly from areas that have contracted for or been allocated portions of the CKWWTP capacity. The contracted areas are Poulsbo and the Keyport naval base. The Bangor naval base is allocated capacity and served at straight commercial rates. Each of these service areas is responsible for collection, flow measurement, and collection to the County facilities.

The Navy flows are not expected to increase over the next 20 years; however, a portion of plant capacity is set aside for the Bangor and Keyport bases. The Keyport community, with a small served population, is the only residentially permitted flow generator in the Northern Service Area. Keyport is designated as a limited area of more intense development (LAMIRD) and although it is assumed to currently be near maximum density, some future connections are permitted for this area. The source of future flow quantities from Poulsbo is the *City of Poulsbo Comprehensive Sanitary Sewer Plan 2008 Update* (Poulsbo Sewer Plan) (Parametrix, 2008).

2.3.3 Southern Service Area

The Southern Service Area includes the Silverdale UGA, the Central Kitsap UGA, and special connections. Population allocations and future estimated flows from the Southern Service Area are based on population data from the DCD. Future growth in the Southern Service Area will drive the majority of the future infrastructure needs for wastewater that is generated in the CKWWTP service area.

2.3.3.1 Silverdale UGA

The Silverdale UGA, which has an area of approximately 7,400 gross acres, includes the unincorporated area of Silverdale and is located to the north and west of Dyes Inlet. Outside of the Silverdale downtown area, which primarily comprises commercial uses, the surrounding community is suburban in character and has predominantly single family residential development. The Silverdale UGA boundary is shown on Figures 2-1 and 2-2.

2.3.3.2 Central Kitsap UGA

The Central Kitsap UGA, which has an area of approximately 6,400 gross acres, is located just north of the city of Bremerton between Dyes Inlet to the west and Port Orchard Bay to the east and includes the community of Illahee. It has a predominantly suburban character with commercial uses concentrated along State Route (SR) 303 which bisects the area from south to north. The Central Kitsap UGA boundary is shown on Figures 2-1 and 2-2.

2.3.3.3 Special Connections

Special connections are those facilities and areas meeting the allowed exceptions listed in Section 2.2.

2.4 Natural Systems Affecting Wastewater Collection and Treatment Systems and Reclaimed Water Opportunities

This section presents an overview of the natural systems that comprise the central Kitsap County service areas. The characteristics of these systems have a significant impact on the design of wastewater facilities and the disposal of treated wastewater and biosolids.

Table 2-2 lists the various characteristics and how each affects elements of wastewater management infrastructure.

Table 2-2. Natural System Characteristics and Their Effects on Wastewater Management Infrastructure

Natural system characteristic	Effects on wastewater infrastructure
Steep terrain	Unsuitable for construction of wastewater facilities.
Impermeable soils	Unsuitable for reclaimed water recharge areas.
Aquifer recharge areas	Provides focus for sewers to serve tributary septic tanks and potential for indirect reclaimed water recharge.
Drinking water wells	Setback limits for septic tanks and reclaimed water recharge areas.
Impaired water bodies	Setback limits for septic tanks and wastewater facilities. Provides focus for sewers to serve tributary septic tanks and potential for indirect reclaimed water recharge and flow augmentation areas.
Geohazards	Unsuitable for construction of certain wastewater facilities. Increases cost of wastewater facilities.
Flood zones	Unsuitable for construction of certain wastewater facilities. Increases cost of aboveground wastewater facilities.
Wetlands and streams	Setback limits for septic tanks and wastewater facilities.
Wildlife conservation areas	Setback limits for septic tanks and wastewater facilities.

This section briefly describes the outcome of this overall natural systems assessment and provides numerous graphical representations and maps of the environmental factors affecting future wastewater infrastructure. These maps are useful for identifying areas that can be targeted for placement of wastewater facilities and those which should be avoided. These representations are located in Appendix 2A as follows:

- Appendix Figure 2A-1. Topography and drainage
- Appendix Figure 2A-2. Potential reuse investigation sites
- Appendix Figure 2A-3. Drinking water wells
- Appendix Figure 2A-4. Preliminary water quality issues
- Appendix Figure 2A-5. Geohazards
- Appendix Figure 2A-6. Sensitive habitat

Appendices 2A and 2B include a more detailed discussion of specific natural systems characteristic of the service area. Moreover, specific details on regions with specific local water quality issues for various streams and receiving waters are discussed in Appendix 2C. This information is particularly useful in identifying streams with water quality impacts (caused either by low flows or pollution sources) that could benefit either by providing future sewage collection in tributary areas served by septic tanks or from flow augmentation by indirect reclaimed water applications. Appendix 2D presents a preliminary discussion of the general location of local permeable soils and the locations of potential significant reclaimed water irrigation or other non-potable users on potential water reuse opportunities.

2.5 Population Estimates and Projections

Kitsap County DCD prepared the data used as the basis for population estimates for this report in accordance with GMA requirements. Existing 2006 populations were estimated based on the 2000 Census. Population projections within UGA boundaries are based on the GMA allocations as developed by DCD for a planning period through 2025 and extended through 2030 using growth rates calculated from the DCD-generated 2005–25 population growth. Population allocations for the period 2005 through 2025 have been well-documented and adopted by the County in the 10-Year Update. Details of the methodology used to develop the 2030 populations are in Appendix 7B.

Population values cited in this report for the Poulsbo area are based on population projections through 2025 developed for the City of Poulsbo in the Poulsbo Sewer Plan. Two growth rates were presented: one for the City at 1.8 percent per year and a second rate of 2.7 percent that includes the future population allocations for the Poulsbo UGA. The latter rate was used for this report to extrapolate the Poulsbo population projection to 2030 (Appendix 7B).

The population data used to estimate future flows are provided in Table 2-3. In summary, the service area population is projected to increase by more than 25,000 people during the 20-year planning period, which represents an increase of about 50 percent. It is important to recognize, however, that some of the existing population is served by individual, onsite wastewater systems, so the existing population served by the CKWWTP is less than the total 2005 population shown in Table 2-3.

Table 2-3. Population Projections for CKWWTP Service Area and Poulsbo [a]

Year	Central Kitsap UGA	Silverdale UGA	City of Poulsbo & UGA	Total
2005	23,262	16,627	7,450	47,339
2025	30,478	23,340	12,693	66,511
2030	32,608	25,405	14,700	72,713

a. No population data are available for Bangor and Keyport bases. Minimal growth is projected for the Keyport community.

2.6 Land Use and Zoning

The County prepares land use and zoning mapping, which are used for a broad range of purposes. With respect to wastewater infrastructure planning, both are important tools used to understand existing and future opportunities, limitations, and requirements. Land use mapping (see Figure 2-2) identifies the locations and types of existing development within the area of interest. Zoning mapping (see Figure 2-3) identifies allowable potential future land uses and may be supplemented with sensitive area mapping as a means to identify undevelopable lands.

As part of the development of the 10-Year Update, DCD prepared a buildable lands analysis. This study relied upon the sensitive areas, land use, and zoning mapping for the preparation of the *Updated Land Capacity Analysis* (ULCA), finalized in 2006.

The County used the ULCA to identify developable and re-developable parcels within the UGAs and thus determine the distribution of future populations. Once the developable and re-developable lands were identified, zoning was used as the basis to determine future population densities of the parcels. The population distributions were estimated on a parcel-level basis, allowing for a high level of detail. The parcel-level data were extracted from the County database and used for modeling and mapping existing and future population distributions. The ULCA data were also used for the hydraulic modeling of the sewer system, as described in Chapter 7.

Land use, zoning, and population distributions for the Northern Service Area are not necessary for this analysis because each of those customers (except the Keyport community) develop their own forecasts.

2.7 Equivalent Residential Unit Criteria

In order to determine future wastewater infrastructure needs within a particular service area, a per capita flow rate must be developed. Kitsap County keeps information on the number of properties permitted for sewerage but not on the number of individuals residing at a particular property. There are also records of wastewater flows entering the CKWWTP and at various other points throughout the system. In order to estimate flows accurately, a system of ERUs is used.

Flow sources include single family and multifamily residences, commercial, industrial, and institutional (public facility) flows. For the purposes of this Facility Plan, "commercial" flows include all nonresidential flows.

Flows originating from a variety of sources, including commercial sources, schools, residences, businesses, and other large contributors, are converted to ERUs. ERUs are derived as follows:

- each multifamily ERU = 1.8 users
- each single family residential unit (ERU) = 2.5 users
- commercial (based on water usage) ERU= 2.5 users.

By this means, each parcel that is permitted for sewerage service is converted to an estimated number of ERUs. ERU populations are higher than actual populations because they also account for commercial users.

For the Southern Service Area, sewered parcel data and wastewater flow data were combined with ERU estimates to develop an estimate of 76 gallons per capita per day (gpcd).

For the Northern Service Area, different estimating techniques were used. Because there is no ERU population data for the naval bases, but there are records of total wastewater flow, a standard literature value of 100 gpcd was adopted. The average annual flows (AAF) for Keyport and Bangor are 140,000 and 480,000 gallons per day (gpd), respectively. Therefore, ERU population values of 1,400 and 4,800, respectively, were incorporated into future estimates. As noted, Poulsbo population estimates are based on the Poulsbo Sewer Plan.

2.8 Sewered Equivalent Population Projections

Future population estimates are a necessary component for projecting wastewater flows. For the Northern Service Area, future sewered populations for the Navy bases are unknown so set-aside flows are based on the assumption that the existing flows will remain the same in the future. The City of Poulsbo reports that 100 percent of the population is sewered and that future customers will be generated by growth in Poulsbo and the UGA.

Future sewered ERU populations in the Southern Service Area include existing populations on septic tanks that will become sewered as well as new incoming populations and growing commercial sources. Existing unsewered populations that will be connected to the County sewer system in the future are limited to all parcels located in four areas of concern due to potential failures of septic systems identified by the Kitsap County Health District (Health District) plus a small allowance (5 percent) of the existing onsite systems in the UGAs. The projected population of these four areas of concern at full buildout and the 5 percent allowance is approximately 5,000 people (Appendices 7B and 7E). The future incoming populations within the service areas are assumed to eventually become connected to the system as well. Existing sewered and unsewered developed properties are identified on Figure 2-4.

As of December 2006, approximately 62 percent of the existing population within the Southern Service Area was connected to the wastewater system. In summary, the four following components are assumed to estimate wastewater flows:

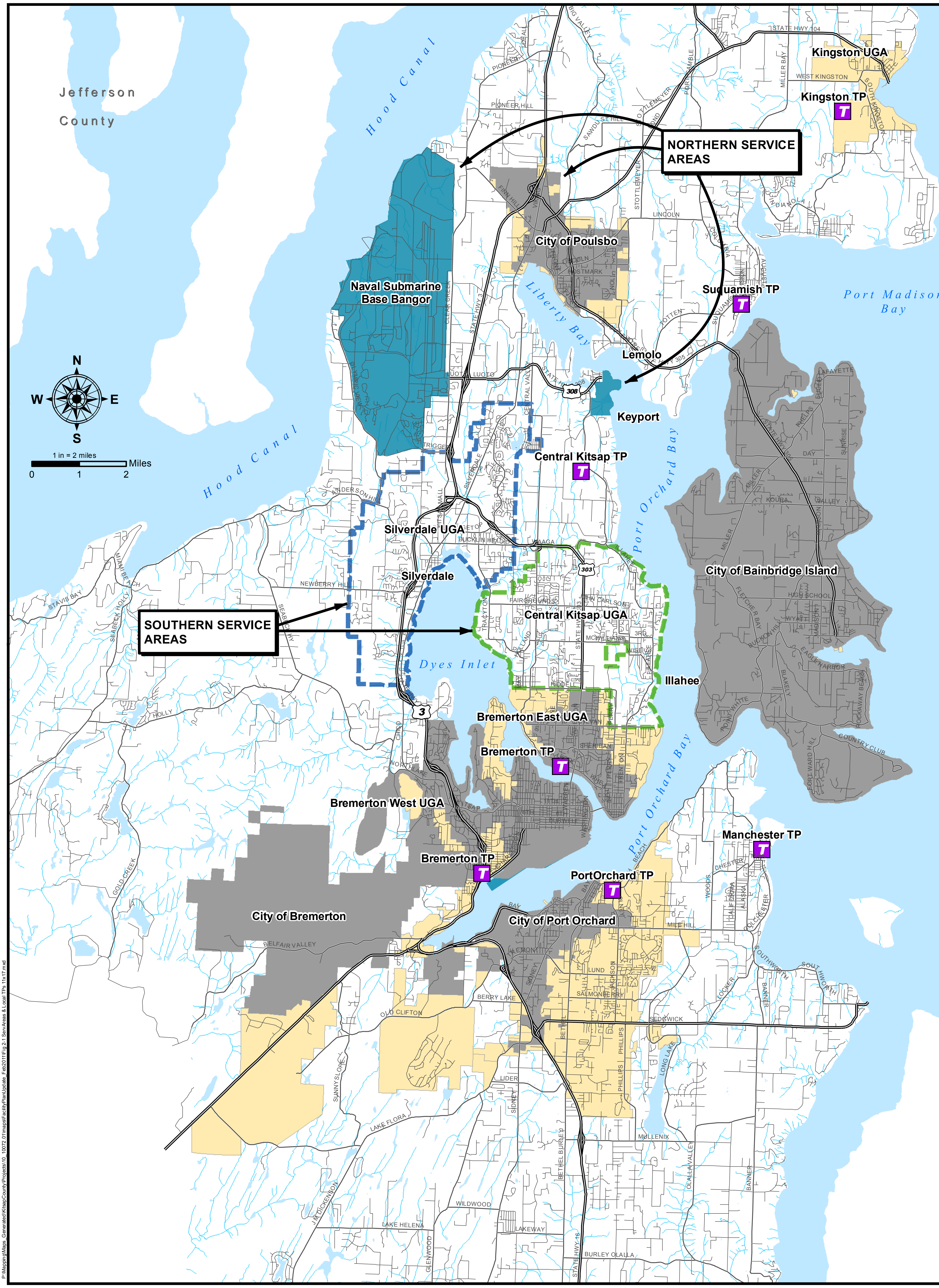
- The unsewered portions of the existing and future population in the four areas of concern and 5 percent of the existing onsite systems are assumed to convert from septic systems to sewer service by 2030. Three of the four areas of concern are located in the Central Kitsap UGA: Illahee and west of Illahee State Park, Tracyton, and University Point. The fourth area of concern is located east of Island Lake in the Silverdale UGA. The methodology for computing the increases in sewer connections is provided in Appendix 7B.
- Of the future incoming population that is attributed to growth, 100 percent is assumed to become sewered. The sum of converted and incoming users provides the additional sewered ERU population for each of 2015 and 2025.
- A future commercial growth component is also added. This value is approximated based on the existing commercial-to-residential ratio of 11 percent for the Central Kitsap UGA and 34 percent for Silverdale. Without specific information to indicate otherwise, the use of existing commercial-to-industrial ratios is considered appropriate for facilities planning purposes. On this basis, the Silverdale commercial projections may appear to be high; however, the net effective commercial portion for the combined areas would be 22 percent, which is considered a reasonable collective value.
- The city of Poulsbo equivalent population estimates are based on projected flows and estimated per capita flow rates. Projected AAF is estimated to increase from 0.66 million gallons per day (mgd) to 1.34 mgd in 2030 while average per capita flows are predicted to decrease from 90 gpcd to 76 gpcd in the same period (Poulsbo Sewer Plan and Appendix 7B). As a result, the equivalent sewered population is calculated to increase from about 7,300 in 2005 to 17,600 in 2030.

These four components are added to provide estimates for the 2025 and 2030 total Equivalent Populations that will be sewered. The equivalent sewered population for the entire service area is projected to increase from about 44,500 in 2005 to 83,100 in 2030, which represents an 87 percent increase. (Table 2-4).

Table 2-4. Equivalent Sewered Populations for CKWWTP Service Area and Poulsbo

Year	Central Kitsap UGA	Silverdale UGA	Southern Service Area total [a]	Poulsbo	Bangor	Keyport (base)	Northern Service Area total	Total system
2005	14,069	16,912	30,981	7,295	4,800	1,400	13,495	44,476
2025	26,275	27,765	54,040	15,263	4,800	1,400	21,463	75,503
2030	28,641	30,601	59,242	17,632	4,800	1,400	23,832	83,074

a. *Includes special connections that are permitted outside of UGA boundaries such as schools.*



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- Treatment Plant
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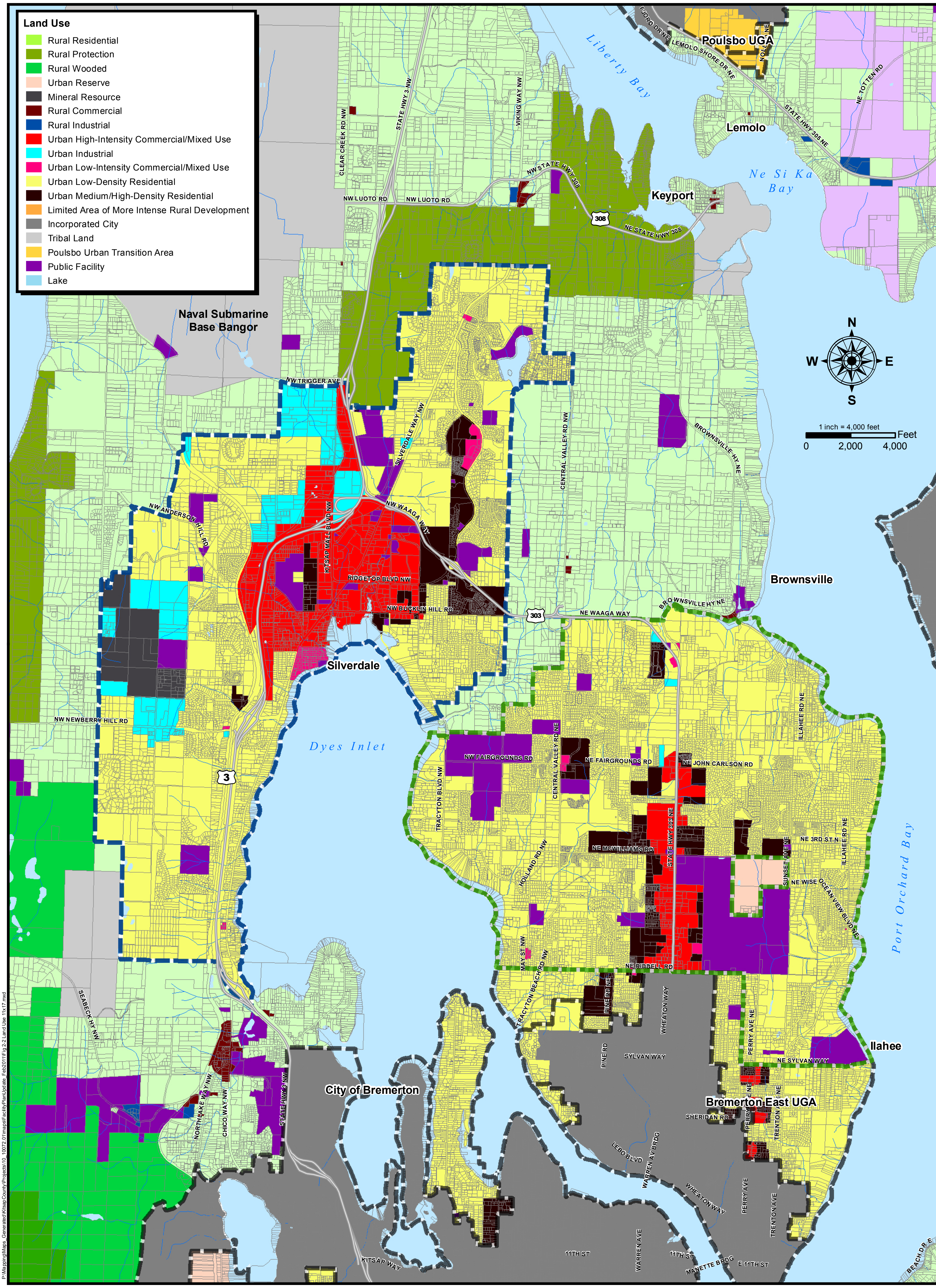
SERVICE AREAS & LOCAL TREATMENT PLANTS

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure

2-1



Central Kitsap UGA	Water Bodies		
Silverdale UGA	Water Courses		
Other UGAs	State HWY/Route		

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Land Use: Kitsap County 2006
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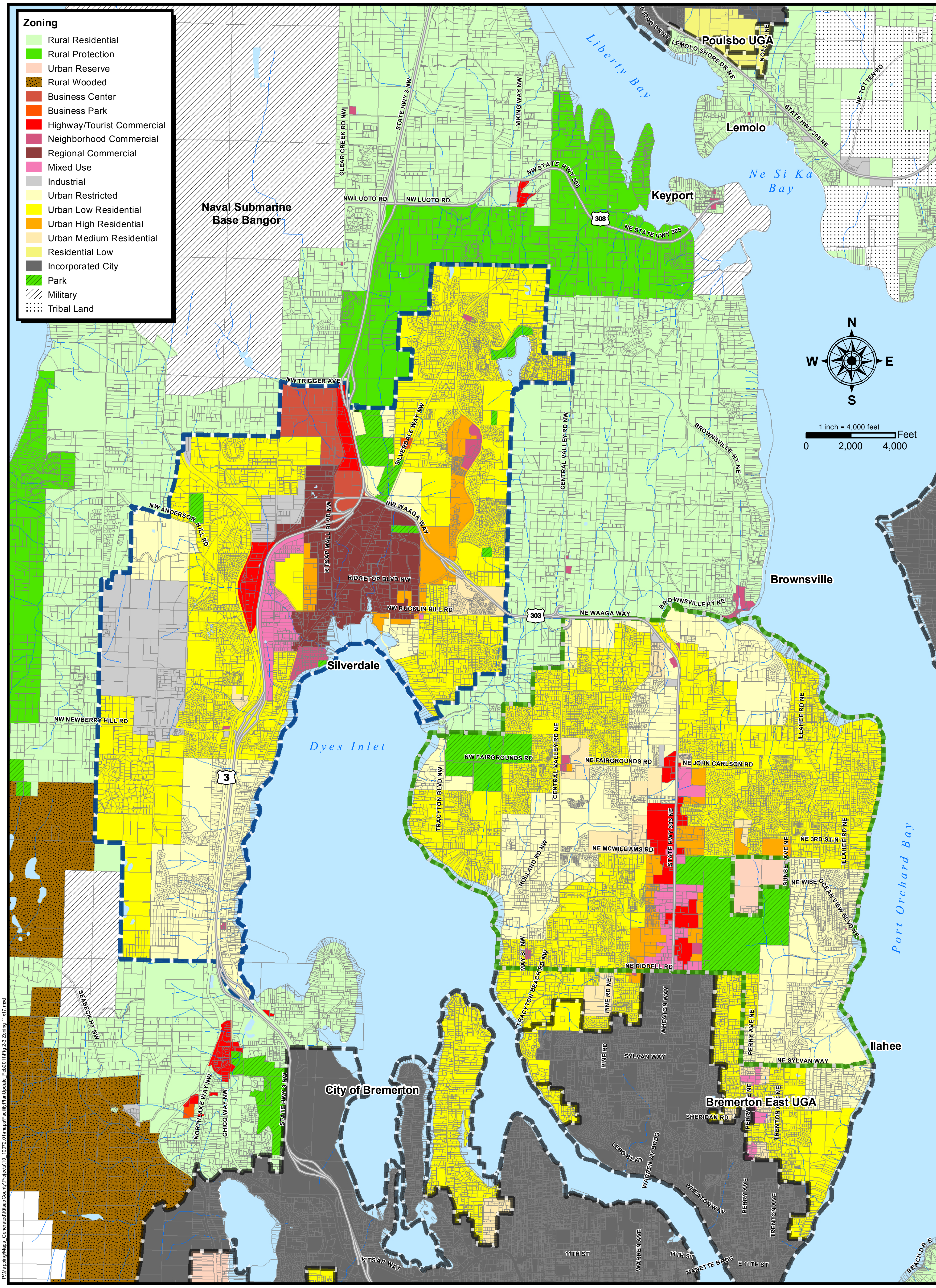
2006 LAND USE

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure

2-2



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Central Kitsap UGA
Silverdale UGA
Other UGAs
Water Bodies
Water Courses
State HWY/Route

Zoning Designations: Kitsap County, January 2007
Data sources supplied by Kitsap County and may not reflect current or actual conditions. This map is a geographic representation based on information available. It does not represent survey data. No warranty is made concerning the accuracy, currency, or completeness of data depicted on this map.

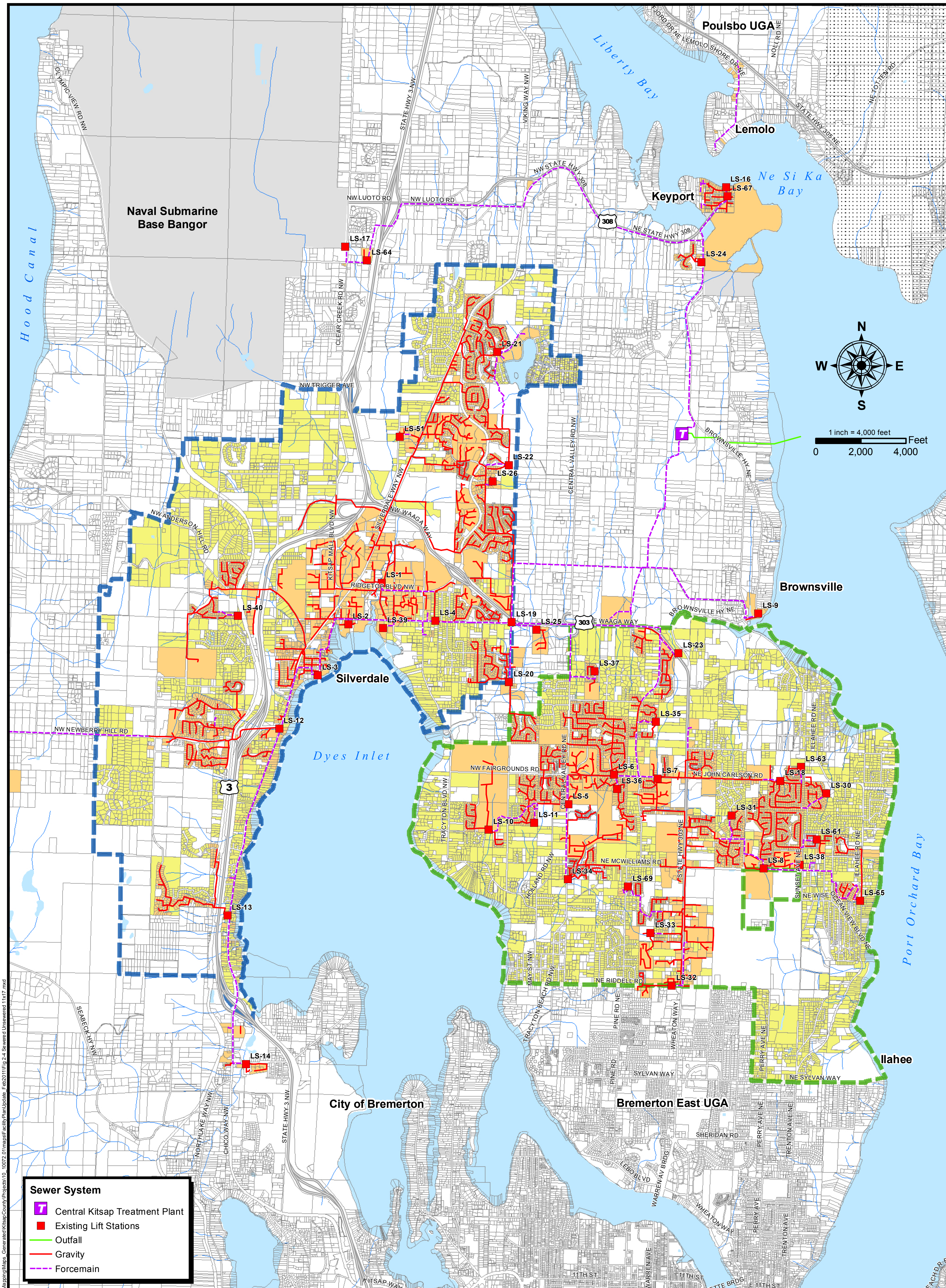
KITSAP COUNTY 18 57 WASHINGTON

ZONING DESIGNATIONS MAP

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure

2-3



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Permitted Properties (Sewer Service)
Developed Properties (No Sewer Service)
Central Kitsap UGA
Silverdale UGA
Water Bodies
Water Courses
State HWY/Route

Sewer System: Kitsap County, March 2010
Data sources supplied by Kitsap County and may not reflect current or actual conditions. This map is a geographic representation based on information available. It does not represent survey data. No warranty is made concerning the accuracy, currency, or completeness of data depicted on this map.

KITSAP COUNTY 18 57 WASHINGTON

SEWERED & UNSEWERED DEVELOPED PROPERTIES

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure

2-4

CHAPTER 3

WASTEWATER CHARACTERISTICS

Wastewater flow projections fundamentally influence the design of wastewater facilities. Consequently, wastewater characteristics and flow projections strongly affect the selection of the key criteria used to identify, evaluate, and rank project alternatives for this Facility Plan. In this chapter, existing wastewater flows to the CKWWTP are characterized, and they are then projected in proportion to the estimated population expected to be served throughout the study period. Information for both flows and loadings is used as a basis to develop the future target capacity requirements for new infrastructure described in subsequent chapters.

3.1 Overview of Chapter Contents

The purpose of this chapter is to summarize the characteristics of existing and projected wastewater streams generated in the Central Kitsap service area. The first part of this chapter focuses on the following:

- flow characteristics and their importance
- how flows are measured in the system
- how flow projections are made for each sub-basin and the system as a whole.

The second part of this chapter describes actual and projected wastewater chemical and physical characteristics, and mass loadings for the raw sewage stream conveyed to the CKWWTP.

3.2 Wastewater Flows

To evaluate the current operating capacity of the CKWWTP and estimate future capacity requirements, it is necessary to understand the historical and existing wastewater flows and their relationship to population and rainfall events. This section discusses the following aspects related to flows; further details related to wastewater flow measurements and projections are shown in Appendix 7B.

- wastewater flow parameters
- historical and existing flows:
  - flow measurement
  - hydraulic peaking factor overview
  - historical wastewater flows
  - infiltration and inflow (I/I) analyses: groundwater-related
- wastewater flow projections:
  - per capita flows
  - peak design (hour) flows
  - hydraulic peaking factor summary
  - overall projected flows at the CKWWTP.

3.2.1 Wastewater Flow Parameters

This section defines common flow parameters and how they apply to facilities design. Definitions and engineering uses of flow parameters often used in wastewater studies and designs are summarized in Table 3-1. Perhaps the most widely used of these flow parameters in planning and designing wastewater facilities are average design flow (ADF) and peak design flow (PDF).

ADF, defined as the average daily flow occurring in a maximum-flow month, has a significant bearing on the size and selection of wastewater treatment process units. Ecology recognizes this flow parameter as the primary design parameter used to rate WWTPs.

PDF is defined as the maximum flow rate likely to be sustained over a 60-minute period. PDF is used to properly size collection and treatment units where hydraulic capacity is of primary concern, such as treatment plant headworks structures, sewers, and pumping stations. PDF is equivalent to peak wet weather flow (PWWF), another common measure used to characterize peak flows.

Table 3-1. Applications of Wastewater Flow Parameters

Parameter	Definition	Application
Average annual flow (AAF)	The average daily flow computed from year-long flow records.	Detention times, energy usage, chemical usage and storage, and sludge quantities produced.
Average dry weather flow (ADWF)	Average daily flow occurring in dry weather seasons (May–Sept.).	Useful in determining I/I. Used in this study as the basis for projecting flows.
Average wet weather flow (AWWF)	Average daily flow occurring in wet weather seasons (Oct.–April).	Useful in I/I studies.
Peak dry weather flow (PDWF)	Peak hourly flow rate occurring in a dry weather season.	Useful in I/I studies.
Peak design flow (PDF)	Peak hourly flow rate occurring in a wet weather season; often called peak wet weather flow (PWWF).	Sizing of unit operations such as pipelines, channels, flow measuring structures, inlet and outlet structures, and peak power demands.
Average design flow (ADF)	Peak month average daily flow rate.	Basis of treatment process design and of contractual agreements for wastewater treatment.
Maximum day flow (MDF)	Maximum daily flow experienced in the year.	Basis of sizing maximum capacities of unit processes to treat sewage.
Minimum daily flow	Minimum daily flow rate.	Sizing of conduits to avoid solids deposition. Usually most important during early stages of planning period when flows are still well below future ADWF.

Other flow parameters, such as average dry weather flow (ADWF) and peak dry weather flow (PDWF), are useful in determining the amount of I/I entering a collection system. They are also used for determining an effective peaking factor (such as the ratio of PDF to ADWF) for sanitary flows entering the collection system.

3.2.2 Historical and Existing Flows

This section discusses flow measurement, historical wastewater flow rates, and the development of hydraulic peaking factors and I/I flows.

3.2.2.1 Flow Measurement

Accurate wastewater flow measurement and recording is a critical factor in the effective planning, design, and operation of wastewater facilities. Ecology requires that flow measurement be provided at all treatment plants with capacities greater than 50,000 gpd, and at lift stations with capacities greater than 1 mgd or 700 gallons per minute (gpm).

Permanent flow metering with instantaneous data recording provides information needed to most accurately assess system performance. Where metering is not available, wastewater flows may be estimated on the basis of population and land use using standard literature reference factors. Because literature reference-generated values are only estimates, they should not be relied on as the sole basis for determining existing or projecting future flows. Rather, as it becomes available, actual flow data should be used in place of literature reference values. [1]

Metered flows that include hourly data for both dry and wet weather conditions provide the most reliable basis for existing flow conditions. Given actual data, base dry weather flows, I/I, and wet weather and peak flows may be obtained and used as a basis for determining available system capacities, model calibrations, and future flow projections.

3.2.2.1.1 Existing Flow Metering Locations

Existing wastewater flows are metered by flow measurement devices at several locations in the Central Kitsap wastewater system. These locations include Bangor, Keyport Navy, Poulsbo, Lift Station 24 (LS-24), Aeration Station 1 (AS-1), and the CKWWTP. Metering locations are identified on Figure 3-1 (all Chapter 3 figures are provided at the end of the chapter). Existing flow metering locations, equipment, and available historical flow parameters are summarized in Table 3-2.

Wastewater flow data from each measurement location for 2002–06 were obtained from Kitsap County Public Works Operations (Operations) staff. Weekly total flows are available for all locations. Daily totals for the time period are available for the CKWWTP only. Northern and Southern Service Area flow measurements have been recorded on a per-minute basis for about 1 year. Historical peak hour flows are not available at the CKWWTP; however, meters for the Northern and Southern Service Area flows at LS-24 and AS-1, respectively, will provide this information in the future.

[1] For example, the PWWF is the primary design parameter for collection facilities. Peak flows may be dominated by I/I, which is the seepage of groundwater into the system. I/I values typically fluctuate. When using literature reference estimates, the first step in determining PWWF is to estimate ADWF (usually based on population). Next, a literature reference peaking factor is applied to the dry weather flow. The peaking factor accounts for diurnal and seasonal population behaviors, and omits I/I. PWWF values are then obtained by adding I/I estimates. Literature reference values for I/I are typically expressed on an annualized gpd/acre basis, and therefore do not represent seasonal and storm-related peaks or local system conditions.

Table 3-2. 2006–07 Flow Meters for the CKWWTP Service Area				
Source of measured flows	Measurement location	Measurement equipment	Data format and limitations	Availability of flow parameters
Bangor base (contract)	LS-17	One 12" Parshall flume; ultrasonic transducer	Chart recorder and totalizer reported as weekly totals only.	Peak day and peak hour unavailable
Keyport base (contract)	LS-67	One 3" Parshall flume; ultrasonic transducer	Chart recorder and totalizer reported as weekly totals only/ inconvenient access to flume and meter manholes.	Peak day and peak hour unavailable
Poulsbo (contract)	Upstream of Lemolo siphon	One 9" Parshall flume; ultrasonic transducer	Chart recorder and totalizer; flume is submerged at flows >2.0 mgd per 1994 facility plan; reported as weekly totals only.	Peak day and peak hour unavailable
Total Northern Service Area flows	LS-24	One 24" pipe spool; magmeter	Totalizer downloaded weekly prior to strip chart recorder installation in summer 2006.	Since the summer 2006 hourly flow data has been recorded; all necessary design parameters may be determined
Total Southern Service Area flows	AS-1	One 24" pipe spool; dual path transit time; four ultrasonic transducers	Totalizer downloaded weekly prior to strip chart recorder installation in summer 2006.	Since the summer 2006 hourly flow data has been recorded; all parameters may be determined
Total CKWWTP flows	Existing CKWWTP headworks	Two 18" Parshall flumes; two ultrasonic transducers	Circular chart recorder and totalizer; peak events exceed the maximum recordable flow of 11.6 mgd (5.8 mgd through each flume).	Historical peak day and peak hour unavailable
CKWWTP effluent		Two 54" rectangular weirs; two ultrasonic transducers	Not recorded on a regular basis.	None

3.2.2.1.2 Northern Service Area Flows

Wastewater flows generated in the Northern Service Area are measured at several locations. The Navy operates flow metering stations at the Bangor and Keyport naval bases. Poulsbo measures its contribution at a Parshall flume located just north of the Lemolo siphon. These three locations are reported to the County as weekly totals. A 5-year data set from 2002–06 was used to determine average flows, peak month flows (PMFs), dry season flows, and wet season flows.

The County has a flow meter at the discharge of LS-24, where weekly flows have been recorded since 2004. Operations staff installed a data logger at the meter in September 2006 and are now able to tabulate flows on a per-minute basis. These data are used for I/I analyses.

Peak flows from Poulsbo and the Poulsbo UGA were estimated in the City of Poulsbo Comprehensive Sewer Plan 2008 Update at 2.7 mgd in 2006.

3.2.2.1.3 Southern Service Area Flows

The County has historically relied on the total flow data at the CKWWTP to estimate flows from the Southern Service Area. Total Northern Service Area flows, with the exception of the Keyport community, are estimated by adding the flows from Bangor, Keyport Base, and Poulsbo. An estimate for Southern Service Area flows plus the Keyport community is obtained by subtracting this total from the flows measured at the CKWWTP influent flow meter. A 5-year data set from 2002–06 was used to determine average flows, PMFs, dry season flows, and wet season flows.

Wastewater flows that are generated in the Southern Service Area are measured at the inline flow meter near AS-1. Similar to the LS-24 meter, weekly flows have been totaled at this location since its installation 5 years ago. These values, when compared to those estimated by subtraction, would be equivalent if flow measuring devices had near-perfect accuracy. Because they are not equivalent, the County prefers the subtraction method so that when all flows are combined, they equal the CKWWTP total.

Operations staff installed a data logger at AS-1 in July 2006 and are now able to record flows on a per-minute basis at this location. The flow meter at AS-1 measures the aggregate flows from the entire Southern Service Area. These data are used for I/I analyses. Currently, separate flow measurements for the Central Kitsap and Silverdale UGAs are not possible.

3.2.2.1.4 Plant Influent

The interceptors from the Northern and Southern Service Areas deliver flow to the headworks of the CKWWTP via two main interceptors, a 24-inch-diameter and 24/30-inch-diameter interceptor, respectively. Flows combine at a “tee,” discharge into a common channel, and are then routed through parallel Parshall flumes for measurement and concurrent recording of the measurements. The flumes have a throat width of 18 inches and are therefore expected to measure flow rates up to 15 mgd each, for a total capacity of 30 mgd.

Instantaneous flows are recorded on 7-day circular pen charts, one for each flume. Although they are difficult to read with accuracy due to pumping and turbulence fluctuations, approximate hourly flows may be ascertained from these charts. The charts are scaled to record flow rates as a percentage of the rated hydraulic capacity of the plant, which is 11.8 mgd. Therefore, the maximum recordable flow rate is 11.8 mgd, and any flow rates that are in excess of this rate are omitted and recorded at 100 percent, or 11.8 mgd total.

Daily and weekly total flows at the Parshall flumes obtained from Operations staff for 5 years beginning in 2002 and ending in 2006 were used to determine average flows, PMFs, dry season flows, and wet season flows. Circular pen charts were reviewed for the 14 highest-volume days for 2002–06. Peak flow rates exceeded the 11.8 mgd maximum recordable flow rate for 1 hour or longer on five occasions. The missing data are necessary to estimate peak hour flows, which are required for designing wastewater infrastructure.

However, the available hourly data were used for this document. Even though peak day and peak hour flow rates are not available, AAFs and PMFs (ADF) can be calculated and are useful.

3.2.2.2 Hydraulic Peaking Factor Overview

Reliable hydraulic peaking factors are required to effectively design wastewater facilities. There are two acceptable methods for determining hydraulic peaking factors: examining historical flow records and developing estimates based on generally accepted engineering sources.

The first method includes examining actual flow records to determine the ratio of a peak flow parameter to an average flow rate parameter. The peak hourly flow to ADWF ratio, or peak hour hydraulic peaking factor, is one such ratio. However, with the exception of Poulsbo (Poulsbo Sewer Plan), sufficient historical data were not available from any of the metering stations to develop a peak hour hydraulic peaking factor. While 1 year's worth of per-minute flow data are now available for Northern and Southern Service Area flows (LS-24 and AS-1), the recorded data did not capture a storm event that would be considered appropriate to use as a design basis. The event selected to support peak hour design flows should have a minimum of a 5-year recurrence interval, and preferably be a 10- to 20-year event. Because peak hour flows were not available, the peak hour hydraulic peaking factor could not be determined based on historical flow records.

The second method to determine hydraulic peaking factors is to estimate them from information found in generally accepted engineering sources. The American Society of Civil Engineers (ASCE) publishes curves that express PDWF to ADWF ratios as a function of ADWF. A copy of these curves is located in Appendix 3A.

Discussions of specific peaking factors developed for the Facility Plan are included throughout the subsequent sections.

3.2.2.3 Historical Wastewater Flows

Table 3-3 summarizes existing Central Kitsap wastewater flows for 2002–06. The flows are developed from the flow measurement data as discussed in Section 3.2.2.1.

Table 3-3. Summary of Central Kitsap Wastewater Flows from 2002–06 for the CKWWTP Service Area

	Southern Service Area	Northern Service Area			Total system
Flow parameter	Central Kitsap and Silverdale (mgd)	Poulsbo (mgd)	Bangor (mgd)	Keyport (base) (mgd)	CKWWTP (mgd)
AAF	2.36	0.66	0.48	0.13	3.63
ADWF	2.09	0.59	0.44	0.10	3.22
AWWF	2.70	0.79	0.52	0.19	4.21
ADF	2.88	0.91	0.58	0.22	4.58
PDF	N/A [a]	2.70 [b]	N/A [a]	N/A [a]	N/A [a]

a. Existing flow data are insufficient to estimate peak hour flow.

b. From Poulsbo Comprehensive Sanitary Sewer Plan 2008 Update *(Parametrix, 2008).*

3.2.2.4 Infiltration and Inflow Analyses

An evaluation of I/I is required for the Facility Plan under the General Sewer Plan requirements (WAC 173-240-050). For this evaluation, two approaches are presented for estimating I/I. The first is Ecology's guidance document, publication 97-03 prepared by the EPA, *I/I Analysis and Project Certification*,(May 1985). The EPA approach establishes maximum allowable per capita flow rates that, when surpassed, trigger requirement for additional analyses. The second approach provides an estimate of per-acre I/I that may be considered when calibrating the forthcoming hydraulic model of the collection system. In order to meet these requirements, the following I/I evaluation is provided.

In reviewing overall system performance with Operations staff, no specific infiltration problems were noted and there were no occurrences of wet-weather-related overflows or discharges. The County maintains a database for inspections and maintenance of the collection systems. The County uses this database to direct a rigorous video inspection and repair program emphasizing repair of broken or leaky connections and pipes.

The following service areas are the focus of I/I analyses for the Facility Plan:

- total Southern Service Area flows based on limited flow data at AS-1
- CKWWTP Service Area: plant influent flows.

The Northern Service Area is not analyzed separately. The two primary contributors to the Northern Service Area flows are the naval bases and the Poulsbo area. The demography of the naval bases is unknown; therefore, per capita flows cannot be determined to estimate I/I. Poulsbo is currently addressing a known I/I problem, and this Facility Plan takes this concerted I/I reduction effort into account. Because these areas are included in the CKWWTP influent data, their I/I contribution on an overall basis is discussed, where appropriate, in the following sections.

3.2.2.4.1 Ecology I/I Guidance: EPA-Prescribed I/I Analysis

The following guidance was used to define the flow data requirements, analysis, and thresholds to determine excessive I/I, as specified in Ecology Publication 97-03:

- Infiltration: "If the average daily flow per capita (excluding major industrial and commercial flows greater than 50,000 gpd each) is less than 120 gpcd (i.e., a 7- to 14-day average measured during periods of seasonal high groundwater), the amount of infiltration is considered non-excessive."
- Inflow: "If the average daily flow during periods of significant rainfall (i.e., any storm event that creates surface ponding and surface runoff; this can be related to a minimum rainfall amount for a particular geographic area) does not exceed 275 gpcd, the amount of inflow is considered non-excessive."

The data needed for this analysis for each of the two study areas are summarized as follows:

- existing sewered population equivalents, including commercial, industrial, and institutional
- dry weather, wet season, and average daily wastewater flows (no rain/high groundwater)
- wet weather and wet season average daily wastewater flows (rainfall event/high groundwater).

The I/I analysis for the study areas was completed using concurrent data—flow data for the same time period and using the same rainfall event. Concurrent daily flow data for the study areas are available only from June 2006 through July 2007; therefore, the time frame for the I/I analysis is limited to the winter and spring of 2006–07. This period is considered representative based on a review of rainfall data, plant flows, and total Southern Service Area weekly flows for the 5-year study period (2002–06).

CKWWTP Service Area flows include the Keyport and Bangor naval bases. The actual populations of the military bases are not known, so in cases where a population is needed, a placeholder or literature reference per capita flow of 100 gpcd is assigned and then divided into the flow. The AAFs for these areas are 140,000 and 480,000 gpd, respectively, so the populations of the Keyport and Bangor bases are established at 1,400 and 4,800, respectively. When these values are aggregated with the rest of the equivalent populations (for Poulsbo, Central Kitsap, Silverdale, and the Keyport community) and the flow per capita is estimated, the resulting value is considered conservative because the per capita flows for the unknown areas are considerably higher than the flow rates for the known areas.

Determination of Non-Excessive Infiltration

For total Southern Service Area flows, three 2-week periods of dry weather during the wet season were selected from the available flow measurements at AS-1 and averaged on a daily basis. Evaluated on a per capita basis using the equivalent sewered population of 32,200 (Chapter 2), the average daily per capita flow during the 2006–07 wet season was 85 gpcd. This flow rate is well below the EPA recommended maximum per capita flow rate of 120 gpcd.

For total CKWWTP Service Area flows, a similar analysis was performed using the daily influent flow meter for the same time frame. The equivalent sewered population for the entire CKWWTP service area (including naval bases as estimated above) was estimated at 44,476 (Chapter 2). Dry weather flows during the 2006–07 wet season averaged 3,880,000 gpd. This equates to 87 gpcd, also well below the EPA criteria of 120 gpcd. Thus, based on the Ecology guidance, infiltration is considered non-excessive for both areas.

Determination of Non-Excessive Inflow

Limited data were available to evaluate the influence of rain-induced inflow. One significant rainy period of several days was found for which Southern Service Area flow meter data were available. (Other periods of significant rainy weather occurred during the study period; however, these occurred on days for which the flow meter data were absent.) The rainy period used in the Southern Service Area analysis occurred on December 11–14, 2006. The event produced rainfall totaling 2.30 inches and 0.59 inch, respectively, on the first 2 days. The first 2 days were followed by a 0.29-inch and 1.83-inch event, for a total rainfall of just over 5 inches over the 4 days.

The peak flow day of the selected rainfall event occurred at both the Southern Service Area flow meter and the CKWWTP on December 14, 2006. Southern Service Area flows were recorded at 3.95 mgd and the CKWWTP flows were 6.77 mgd. This 4-day event is considered a qualifying event for the EPA analysis because the flow records indicate saturated soil conditions that would cause infiltration and/or inflows into the sewer system.

For the total Southern Service Area, using the equivalent sewered population of 32,200, the highest per capita daily flow over the period was 125 gpcd. This flow rate compares to the EPA-recommended maximum per capita flow rate of 275 gpcd.

For total CKWWTP Service Area flows, a similar analysis was performed using daily influent flow meter data for the same time frame and the same December 11–14, 2006, rainfall event. The daily total wastewater flow on the highest day was 6.77 million gallons. The equivalent sewered population for the entire service area was estimated at 47,500, which equates to 142 gpcd. Thus, based on the Ecology guidance, inflow is considered non-excessive for both study areas.

3.2.2.4.2 Acreage-Based I/I Analyses

Base sewage flow, wet season base infiltration, and peak day I/I were evaluated on a per-acre basis for the sewered areas. Typical values for I/I on a per-developed-acre basis range from 500 to 1,000 gallons per day per acre (gpd/acre) for systems in good to average condition. These numbers can be much higher for older systems and/or for those in poor condition. For planning purposes, Kitsap County uses a value of 1,500 gpd/acre with a 7 percent increase for every decade of service life.

Hourly flow data required for these analyses were available for the total Southern Service Area, including data collected at the AS-1 flow meter on the southern interceptor. Hourly flow readings for AS-1 were available for approximately 1 year, from fall 2006 through summer 2007. While readings for some days were absent, there were adequate periods of wet and dry weather recorded during the wet season for I/I analyses. Several multiple-day periods in 2006 and 2007, representing dry weather flows and rainy weather flows, were selected for analysis.

Total wet season peak day I/I is the sum of two components: the wet season base infiltration volume and the rainfall induced I/I storm volume that exceeds the average wet season daily flow volume. This measure is illustrated graphically on Figure 3-2.

The wet season base infiltration component was found by reviewing daily rainfall measurement data to find extended periods of dry weather during the wet season. The hourly Southern Service Area flows for these periods were averaged on a daily basis to develop a wet season average day flow rate curve. From this curve, the minimum daily flow rate was found. The minimum hourly flow rate during each day typically occurs in the early morning, when little water usage presumably occurs. Therefore, this minimum flow rate is presumed to be primarily infiltration. The minimum flow rate over a 24-hour period provides a daily wet season base infiltration rate. For the Central Kitsap and Silverdale UGAs, the wet season base infiltration rate was estimated to be 410 gpd/acre. Similarly, a dry season average day was also plotted. The minimum flow rate for the dry season was about 300 gpd/acre.

To determine the rainfall-induced I/I component, daily rainfall measurements were reviewed to find a significant period of rainy weather during the wet season. For this analysis, the 4-day period of wet weather occurring from December 11–14, 2006, which produced a total of 5.01 inches of rain, was used. Hourly flows for the period were averaged on a daily basis to develop peak day hourly flow rates. The difference in the peak day and the wet season average day flow rates is assumed to be the rainfall-induced I/I. For the Central Kitsap and Silverdale UGAs during the 4-day period reviewed, the rainfall-induced I/I was estimated at 417 gpd/acre based on a sewered (permitted) area of 2,890 acres (excluding right-of-way). This value, summed with the wet season base infiltration, gives a total wet season peak day I/I of 829 gpd/acre, which is within the low end of the range reported previously.

3.2.2.4.3 Infiltration and Inflow Conclusion

It should be recognized that limited data were used to analyze I/I. Ideally, several years of flow data correlated with rainfall would be used to evaluate the effects of I/I on the wastewater system. However, based on the data currently available, a rigorous inspection and repair program, and the observations of Operations staff, I/I does not appear to be a significant problem for the CKWWTP. No specific infiltration problems have been noted, nor have any occurrences of wet-weather-related overflows or discharges occurred. Wastewater collection systems tend to degrade over time and an allowance for additional I/I has been included in the projected flows, discussed in the next section.

3.2.3 Wastewater Flow Projections

Future wastewater flow projections for AAF and ADF consider historical per capita flows and literature reference per capita flows. Future wastewater flow projections for peak hour flows consider historical flows and literature reference methods for estimating peaking factors.

3.2.3.1 Per Capita Flows

Existing per capita flows were used to estimate future wastewater flows. The historical AAF and ADF for each of the 5 years from 2002–06 were divided by the associated ERU population for that year to obtain the historical per capita flows. The annual per capita flows were then averaged to determine the 5-year average per capita flow, which is used with the calculated future ERU population to estimate future sewage flow rates. These flows for the Southern Service Area are presented in Table 3-4.

Table 3-4. Per Capita Wastewater Flows for the Southern Service Area						
	Equivalent	AAF		ADF (peak month)		
Year	population	gpd	gpcd	gpd	gpcd	ADF/AAF
Central Kitsap/Silverdale						
2002	30,000	2,310,000	76	3,150,000	104	1.36
2003	30,700	2,500,000	81	2,885,000	94	1.16
2004	31,200	2,300,000	74	2,725,000	87	1.19
2005	31,700	2,200,000	69	2,500,000	78	1.13
2006	32,200	2,500,000	78	3,150,000	98	1.26
Average	31,220	2,362,000	76	2,882,000	92	1.22

The historical per capita AAF of 76 gpcd includes roughly 60 to 66 gpcd of sewage along with I/I as averaged over the entire year. Future 2030 wastewater flows were estimated based on the assumption that the average annual per capita flow rate would remain at 76 gpcd. A peaking factor of 1.22, based on the historical ADF-to-AAF ratio, is used to estimate the per capita ADF of 92 gpcd for future flows generated from the Southern Service Area. The ADF to AAF peaking factor for Poulsbo is 1.37 as shown in Table 7 of Appendix 7B.1. The results in a flow weighted composite ADF to AAF of 1.26 for the entire service area.

It is noted that a "full development" scenario was analyzed as part of the Facility Plan process that included using a higher average annual per capita flow rate of 100 gpcd for future connections to the County sewer system. The 100 gpcd is recommended by Ecology's *Criteria for Sewage Works Design* (Orange Book) (August 2008). The flows for the Southern Service Area projected using the higher per capita values are documented in Appendix 7B.1.

3.2.3.2 Peak Design (Hour) Flows

Peak design (hour) flows for this Facility Plan were estimated on a population basis, using literature reference values as described below.

The future peak hour flow rate was calculated using an ADF peaking factor of 3.3. Because of limited current measured flow data, a historical peak hour hydraulic peaking factor was not available. Therefore, the peaking factor value of 3.3 is based on ASCE's *Design and Construction of Sanitary and Storm Sewers* (ASCE/WPCF, 1969) flow ratio curve (Appendix 3A).

Existing per capita flow characteristics and the peak hour hydraulic peaking factor, described above, were assumed to be appropriate to develop the future flow estimates. Flow projections were estimated for the Southern Service Area for Central Kitsap and Silverdale, and for the Poulsbo city and UGA in the Northern Service Area. It is assumed that the AAF and ADF per capita flow characteristics for the Southern Service Area are applicable to both Central Kitsap and Silverdale individually. Therefore, future AAF and ADF were estimated individually for each UGA.

Population estimates and projections for the Bangor and Keyport naval bases were not available; however, historical flows were reported. These values are well below the capacity contracted or set aside for these facilities; nevertheless, the historical flows from Bangor and Keyport were used for the 2030 flow projection.

Future flows from the City of Poulsbo and Poulsbo UGA were estimated for 2030 conditions by extension of the flows presented in the *City of Poulsbo Comprehensive Sanitary Sewer Plan 2008 Update.* Wastewater flows in the 2008 Update were developed for the 2005–25 planning period and extended to 2030 in Appendix 7B.2 using an annual growth rate of 2.7 percent.

3.2.3.3 Hydraulic Peaking Factor Summary

From the discussion in the previous sections and data contained in Table 4 of Appendix 7B.2 the aggregate hydraulic peaking factors used to generate year 2030 projected wastewater flows at the CKWWTP are shown in Table 3.5. These factors are used to project future flow profiles at the CKWWTP.

Table 3-5. Composite Hydraulic Peaking Factors for Year 2025 Flow Projections at the CKWWTP

Ratio	Hydraulic peaking factor
ADWF/AAF	0.89
ADF/AAF	1.25
MDF/AAF	2.71
PDF/AAF	3.45

3.2.3.4 Overall Projected Flows at the CKWWTP

Table 3-6 summarizes the proposed projected wastewater flows projected for 2025 and 2030 in this section. These values will be used as the most probable flow projections for this Facility Plan.

Table 3-6. Summary of Projected Wastewater Flows

Flow parameter	Central Kitsap UGA (mgd)	Silverdale UGA (mgd)	Southern Service Area total [a] (mgd)	Poulsbo total [b] (mgd)	Navy set-aside [b] (mgd)	CKWWTP influent (mgd)
2025 projected flows						
AAF	2.00	2.11	4.21	1.16	0.61	5.98
ADWF	NC	NC	NC	NC	NC	5.32
ADF, max month	2.42	2.55	5.10	1.59	0.80	7.49
Peak day flow	NC	NC	NC	NC	NC	16.2
Peak hour flow	NC	NC	13.9	4.20	2.69	20.8
2030 projected flows						
AAF	2.18	2.33	4.61	1.34	0.61	6.56
ADWF	1.94	1.87	4.10	1.19	0.54	5.84
ADF, max month	2.63	2.81	5.58	1.84	0.80	8.21
Peak day flow	NC	NC	NC	NC	NC	17.8
Peak hour flow	NC	NC	15.21	4.75	2.69	22.7

a. *Southern Service Area flows include flows for served populations outside the UGA and are calculated by difference (CKWWTP – Navy – Poulsbo). The flows are split equally between Central Kitsap UGA and Silverdale UGA as per the equal split shown in Table 6 of the August 1, 2008, technical memorandum "Central Kitsap Wastewater Facilities Plan Wastewater Flow Projections 2005–25" (in Appendix 7B.1).*

b. *The Poulsbo and Navy flows for 2030 are documented in Table 4 of the January 10, 2011, technical memorandum Revisions to "Central Kitsap Wastewater Facilities Plan Wastewater Flow projections 2005–25" (in Appendix 7B.2).*

NC = Not calculated.

3.3 Wastewater Composition and Loadings

Wastewater characteristics that are significant to the design of treatment facilities include concentrations of suspended solids and oxygen-demanding substances in the wastewater stream. Knowledge of the concentration of various other chemical constituents such as minerals and toxicants are also required to reclaim water or to estimate effects on downstream water uses. The parameters used most often to quantify wastewater strength produced from municipal sources are TSS and 5-day biochemical oxygen demand (BOD_5), sometimes referred to simply as BOD.

The effluent concentrations of TSS and BOD_5 serve (along with the effluent concentrations of other wastewater constituents) as the basis for evaluating treatment plant performance through the NPDES.

3.3.1 Wastewater Loading Parameters

Suspended solids are a measure of particulate and insoluble matter transported in the wastewater. The quantity of suspended solids is determined by filtering a sample of wastewater and weighing the material retained by the filter. TSS refers to both the organic volatile suspended solids (VSS) and inorganic fixed suspended solids.

Oxygen-demanding substances, usually measured in BOD_5 concentration, consist of soluble and insoluble organic matter that, as a result of bacterial activity, causes the removal of dissolved oxygen (DO) from the wastewater.

3.3.2 Wastewater Loadings Projection

Plant influent BOD_5 and TSS loadings were projected based on predicted ADWF and concentrations determined from the historical plant data analysis. Detailed discussions of methods used to determine the wastewater loading projections are described in Appendix 3B. Using the average dry weather BOD_5 and TSS concentrations of 289 and 245 milligrams per liter (mg/L), respectively, loadings under the various seasonal conditions were calculated from historical peaking factors. The projected 2030 flows and BOD_5 and TSS loadings are summarized in Table 3-7. The loadings include septage and sludges from the Kingston, Manchester, and Suquamish plants. Septage loads were estimated assuming that they remain about the same as those measured in 2006. Sludge loads from the three Kitsap treatment plants were estimated from 2004 data, as a baseline, and assuming an annual increase of 3 percent in sludge production rates.

Table 3-7. Projected Flows and Loadings at CKWWTP

Parameter	Current design [a]	2030
Raw influent:		
AAF, mgd	4.6	6.6
ADWF, mgd	4.3	6.0
ADF, mgd	6.0	8.2
MDF, mgd	11.0	17.8
PDF, mgd	15.0	22.7
Annual average TSS, ppd	8,844	13,200
Average peak month TSS, ppd	11,400	15,800
Maximum day TSS, ppd	-	23,900
Annual average BOD_5, ppd	8,403	14,800
Average peak month BOD_5, ppd	14,100	16,500
Maximum day BOD_5, ppd	-	19,200
Septage:		
AAF, gpd	26,900 [b]	8,300 [c]
Average annual TSS, ppd	5,830 [b]	1,410 [c]
Average peak month TSS, ppd	-	2,270 [c]
Average annual BOD_5, ppd	1,570 [b]	390 [c]
Average peak month BOD_5, ppd	-	630 [c]

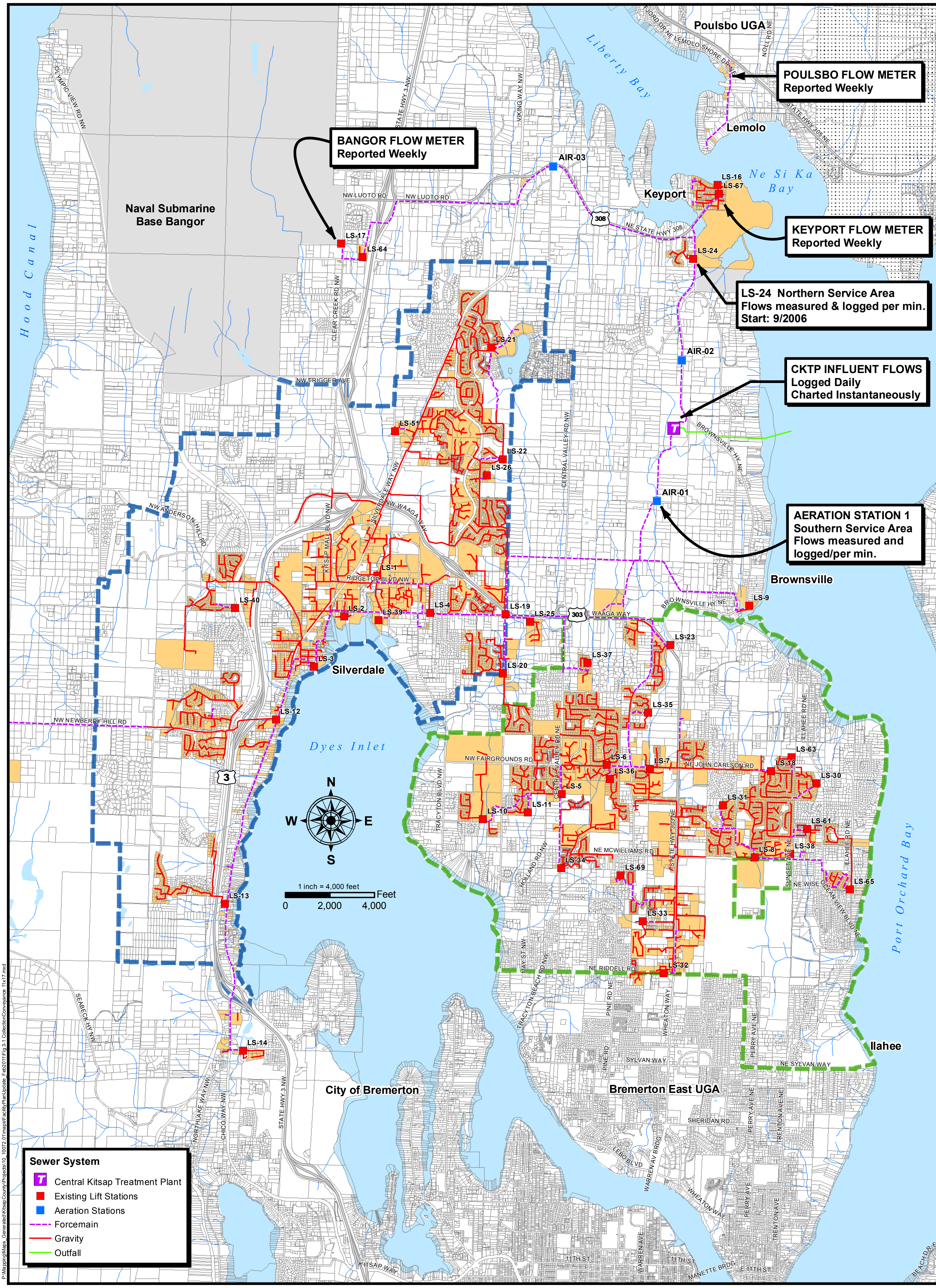
Table 3-7. Projected Flows and Loadings at CKWWTP		
Parameter	Current design [a]	2030
Sludge from other plants:		
AAF, gpd	13,300 [b]	6,500 [d]
Average annual TSS, ppd	900 [b]	1,390 [d]
Average peak month TSS, ppd	-	1,920 [d]
Average annual BOD_5, ppd	390 [b]	270 [d]
Average peak month BOD_5, ppd	-	370 [d]

a. *Corresponds to Contract I design flows and loads, except for average peak month TSS and BOD_5 loadings, which correspond to the design loadings shown in the current NPDES permit. The ADF for the secondary treatment system has been re-rated from 6 to 7 mgd per letter from Ecology, July 28, 2008.*

b. *Values shown reflect original design criteria in Contract I. Actual observed values of these parameters were historically much smaller than the design criteria values listed.*

c. *These values are estimated from 2006 observed values. Although septage flows and loads are expected to diminish over time, reduction of septage is not included for conservatism.*

d. *Escalated in proportion to population growth from current observed values.*



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Permitted Properties (Sewer Service)
Central Kitsap UGA
Silverdale UGA
Water Bodies
Water Courses
State HWY/Route

Sewer System: Kitsap County, March 2010
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COLLECTION & CONVEYANCE SYSTEM FLOW MEASUREMENT LOCATIONS

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure
3-1

Figure 3-2 Daily Southern Flow Pattern for Estimation of Infiltration and Inflow

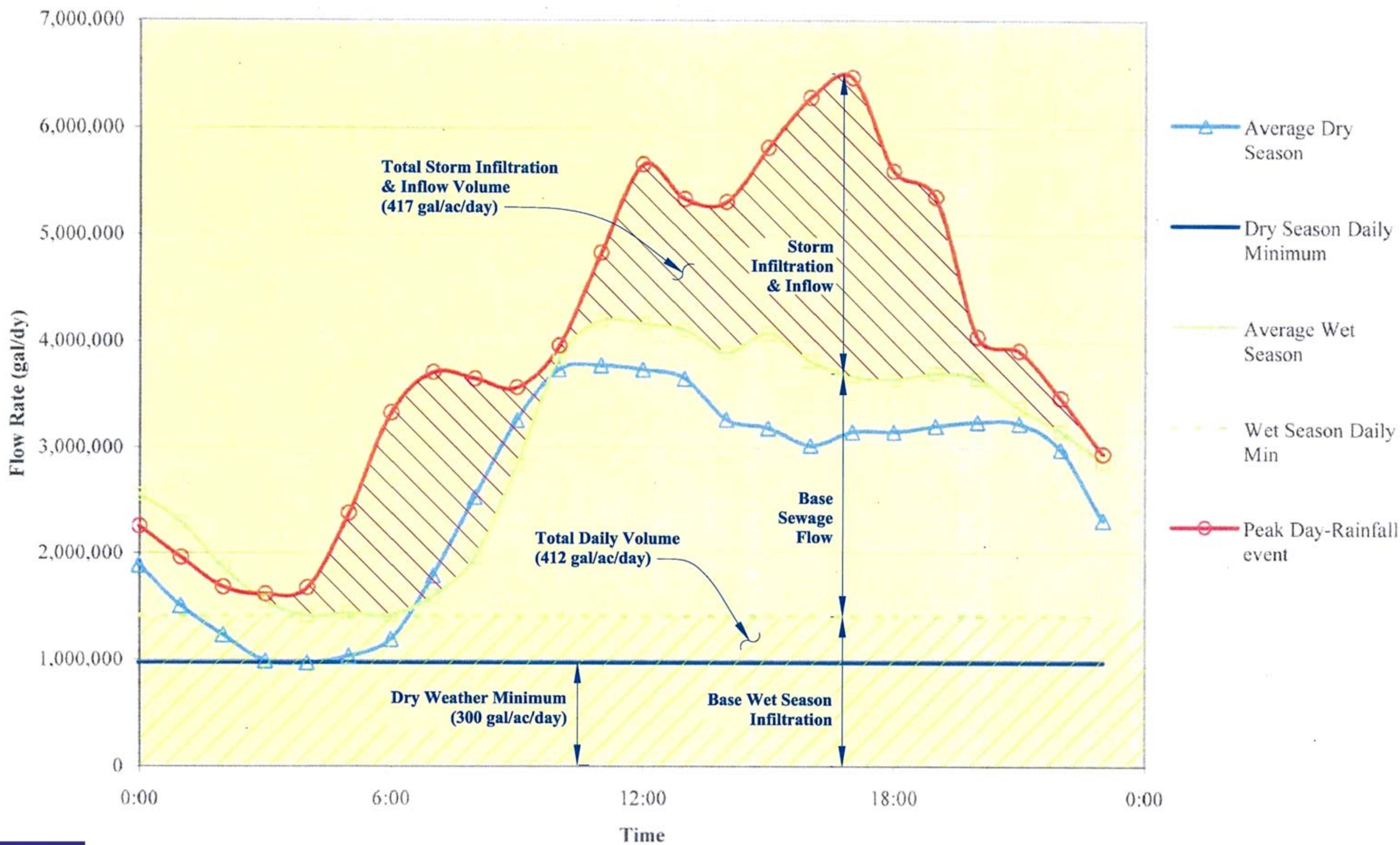

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Figure 3-2
Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

CHAPTER 4

DESCRIPTION AND CONDITION OF EXISTING WASTEWATER SYSTEM

A key feature of a cost-effective wastewater program is optimizing the performance and usage of the existing infrastructure. Facilities discussed in this system include wastewater collection, conveyance, and treatment facilities. Accordingly, information regarding the condition of components comprising the existing system was analyzed to define each component's potential role in the long-term program. Information in this chapter is, in part, derived from the following sources:

- interviews with officials of the governing public agencies
- interviews with operators of the existing systems
- reviews of existing engineering plans and reports
- pumping station test results
- operational performance test data
- other field investigations.

4.1 Overview of Chapter Contents

The purpose of this chapter is to describe the functioning and current condition of the wastewater system. The first major section of this chapter addresses the collection and conveyance system including flow routing, piping, and lift stations. The second major section addresses the wastewater treatment and disposal facilities at the CKWWTP. Major problem areas and existing, known system deficiencies are identified; these deficiencies will form the basis for system upgrade and expansion programs detailed in subsequent chapters.

4.2 Existing Collection Facilities

The collection system receives wastewater from the city of Poulsbo, the U.S. Navy stations at Bangor and the Keyport community, and the Central Kitsap and Silverdale UGAs. Wastewater from these areas is conveyed to the CKWWTP. Because of the hilly terrain over much of the service area, a network of 44 lift stations is necessary to bring flows to the treatment plant site, which is approximately 155 feet above mean sea level (MSL). With capacities exceeding 1,000 gpm, 11 of the lift stations are considered major facilities. Of the remaining 33 lift stations, only 2 have design capacities between 500 and 1,000 gpm; 31 lift stations have capacities less than 500 gpm.

The system is divided into the Northern and Southern Service Areas. Flows generated from the Northern Service Area are primarily from contracted users and therefore capital improvements are the fiscal responsibility of other entities. However, operation and management of these facilities are the responsibility of the County.

The existing system consists of lift stations, gravity and force mains, trunks, and interceptors. Flow routing in the collection system is described in the following section establish a basis for evaluating the existing system's capacity. The Southern Service Area served by the County collection system is illustrated on Figure 4-1. System modeling is discussed in Chapter 7.

4.2.1 Flow Routing

Figure 4-2 shows the collection system flow diagram for central Kitsap County. Flows arrive at the CKWWTP through two major force mains from the northern and southern sections of the Central Kitsap service area. The Northern Service Area force main serves the city of Poulsbo, the naval bases at Bangor and Keyport, and the Keyport community. Unincorporated areas of Kitsap County are served by the Southern Service Area force main.

4.2.1.1 Northern Service Area

LS-24 is the primary collection and flow measurement point for all flows generated in the Northern Service Area. Flows from the Northern Service Area are conveyed to the CKWWTP from LS-24 via a 24-inch force main. Lift stations tributary to LS-24 are listed below:

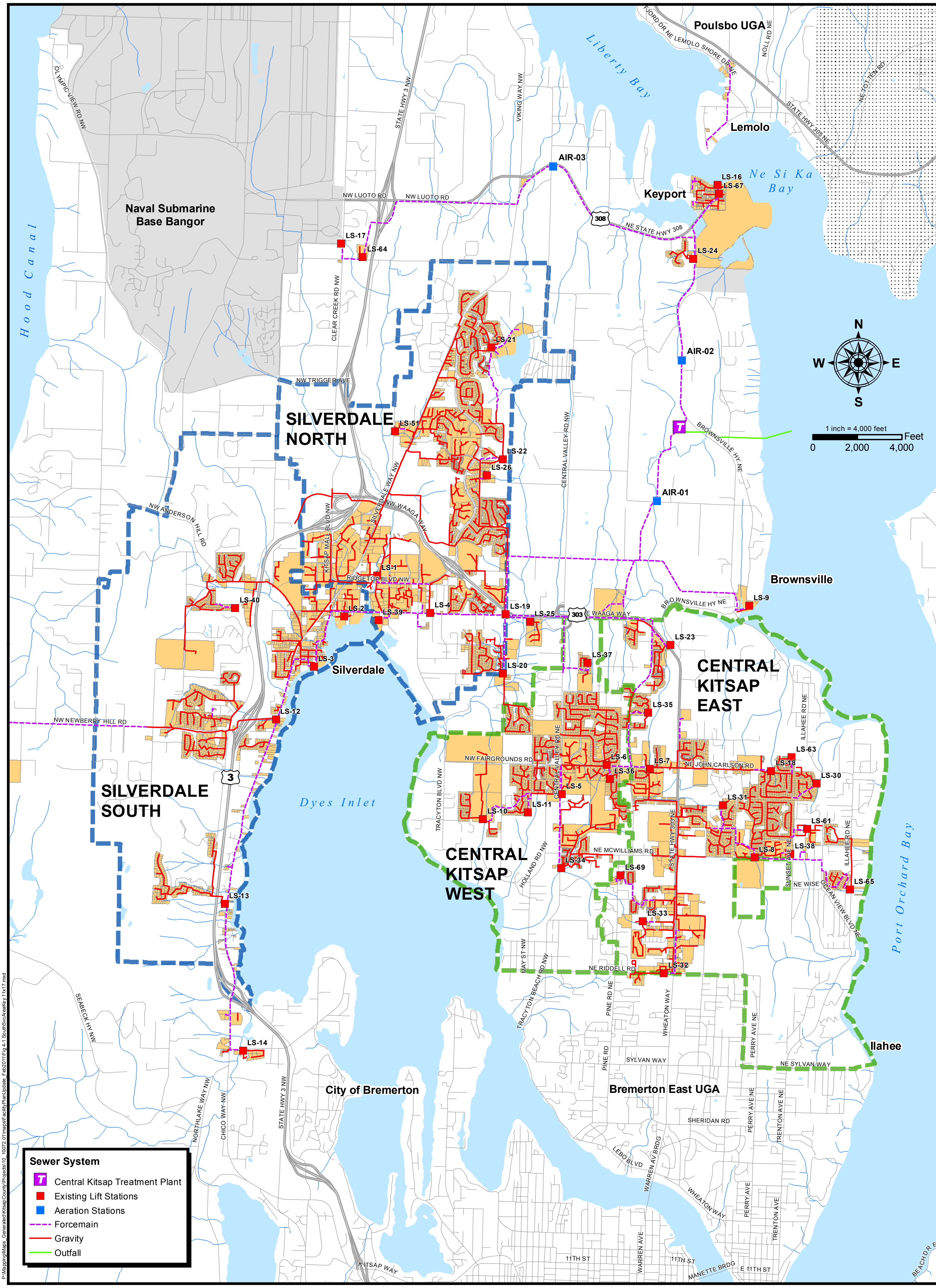
- LS-16 is tributary to LS-24 and receives flows from the Keyport community and Keyport naval base, as well as from Poulsbo. Wastewater from the city of Poulsbo is conveyed from Lemolo under the mouth of Liberty Bay to LS-16 in Keyport via a 12-inch-diameter, twin-barrel siphon. Flows are measured at a flow station on the Lemolo side.
- LS-67 is tributary to LS-16.
- LS-17 is tributary to LS-24 and receives flow from the Bangor naval base. Flows are metered at this station.
- LS-64 is tributary to LS-24 and discharges to the force main from LS-17.

4.2.1.2 Southern Service Area

For the purposes of this Facility Plan, the Southern Service Area has been divided into four sub-areas: Central Kitsap East, Central Kitsap West, Silverdale North, and Silverdale South. These delineations, illustrated on Figure 4-1, are used as a key for the individual maps of each sub-area, as shown on Figures 4-3 to 4-6. These maps show the existing collection system, lift stations, and their respective basins.

4.2.1.2.1 Wastewater Basins

As illustrated on Figure 4-1, the Southern Service Area includes the Central Kitsap and Silverdale UGAs. These UGAs were each divided into two parts: Central Kitsap East and West, and Silverdale North and South, each comprising a large number of basins and sub-basins. The basins are generally defined as being the area served by a particular lift station and are identified by lift station number. Basin delineations for the Southern Service Area are shown on Figures 4-3 to 4-6.



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Permitted Properties (Sewer Service)
Central Kitsap UGA
Silverdale UGA
Water Bodies
Water Courses
State HWY/Route

Sewer System: Kitsap County, March 2010
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SOUTHERN SERVICE AREA KEY MAP

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure
4-1

FILE NAME (UPDATED BY) | PLOT DATE & TIME
S:\CAD\KITSAP COUNTY\10-10072 CAPITAL IMP 2010\DWG\F10-10072 FIG_4-2.DWG (PLS) | FEB 28 2011 08:22:12
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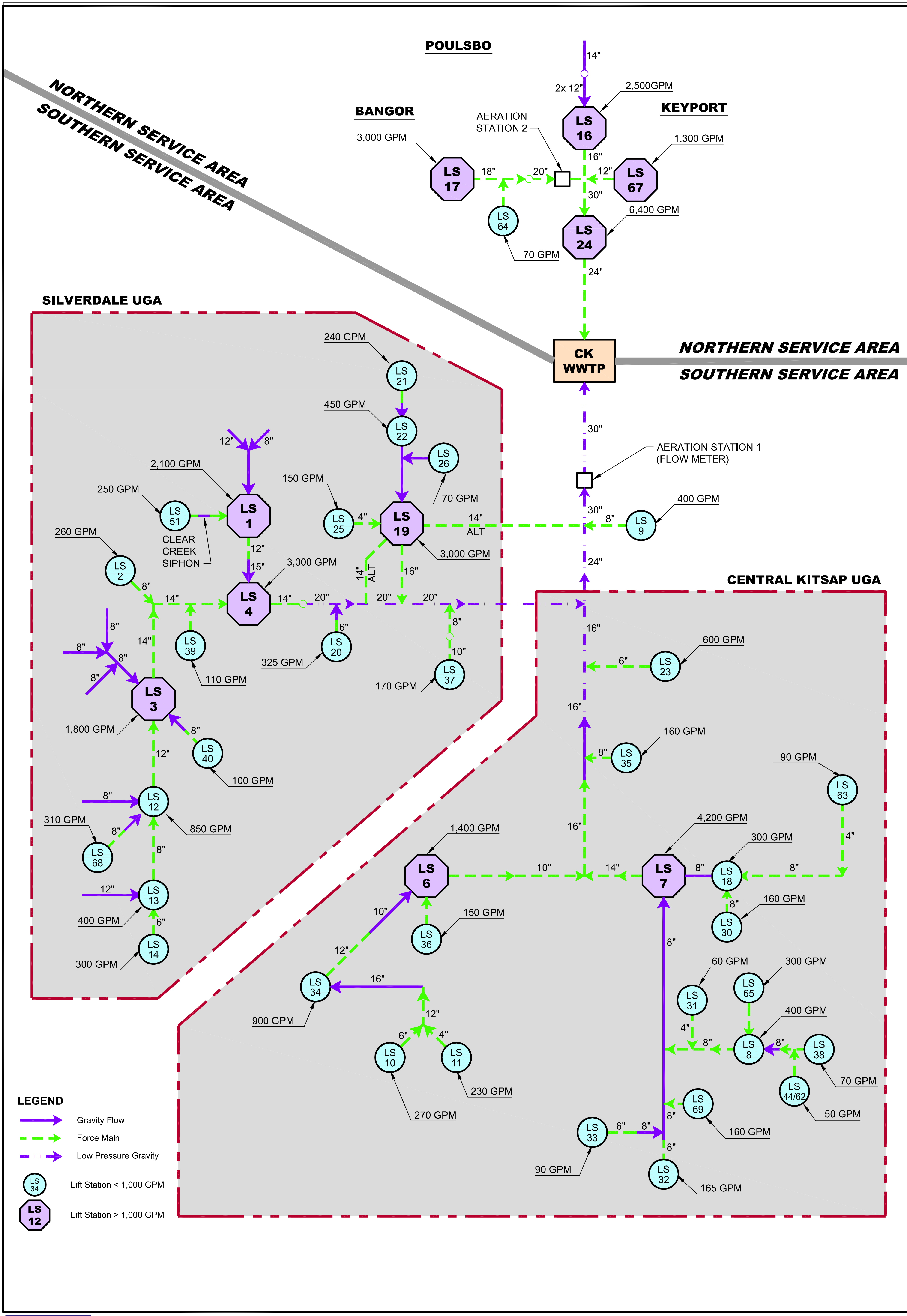

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Existing Conveyance System Schematic

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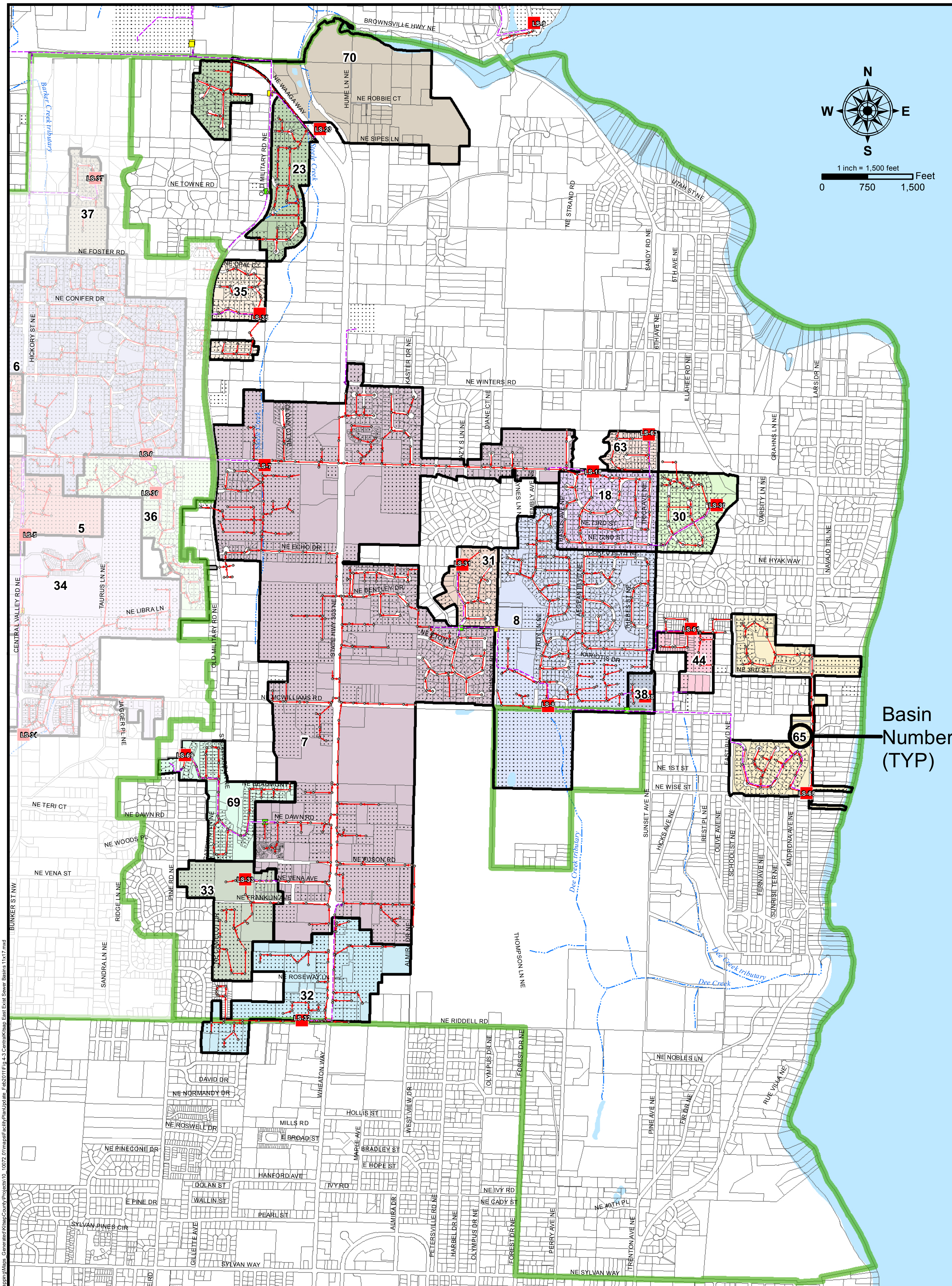
Figure
4-2



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- Treatment Plant
- Lift Stations
- Manhole
- Air Vac
- Gate Valve
- Forcemain
- Gravity
- Outfall
- Silverdale UGA
- Central Kitsap UGA
- Permits - Sept 2007
- Basin Boundaries

Aerial Photo: Kitsap County 2007 Sewer System: Kitsap County, March 2010
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CENTRAL KITSAP - EAST EXISTING SEWER BASINS

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
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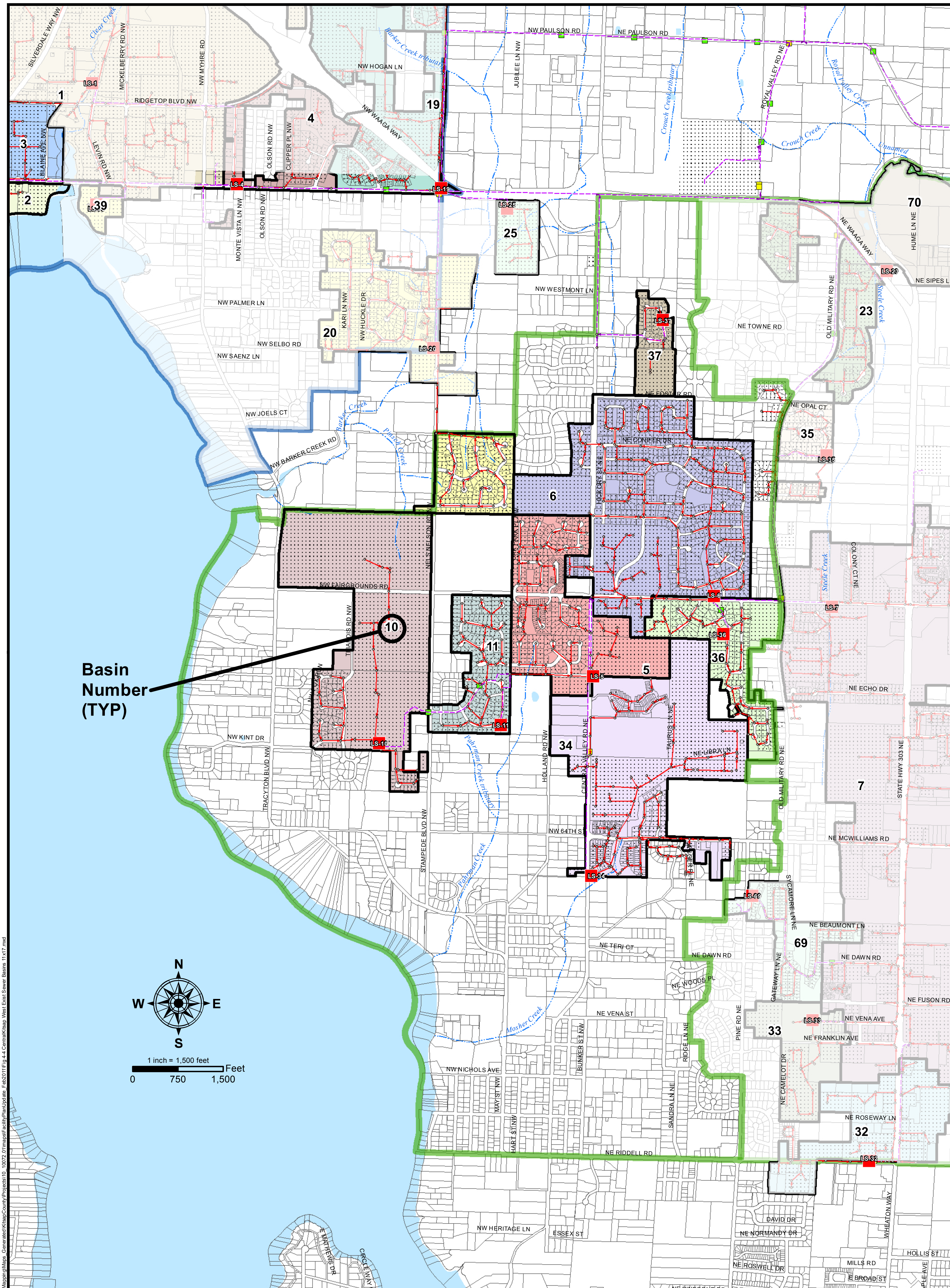
Figure

4-3



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CENTRAL KITSAP - WEST EXISTING SEWER BASINS

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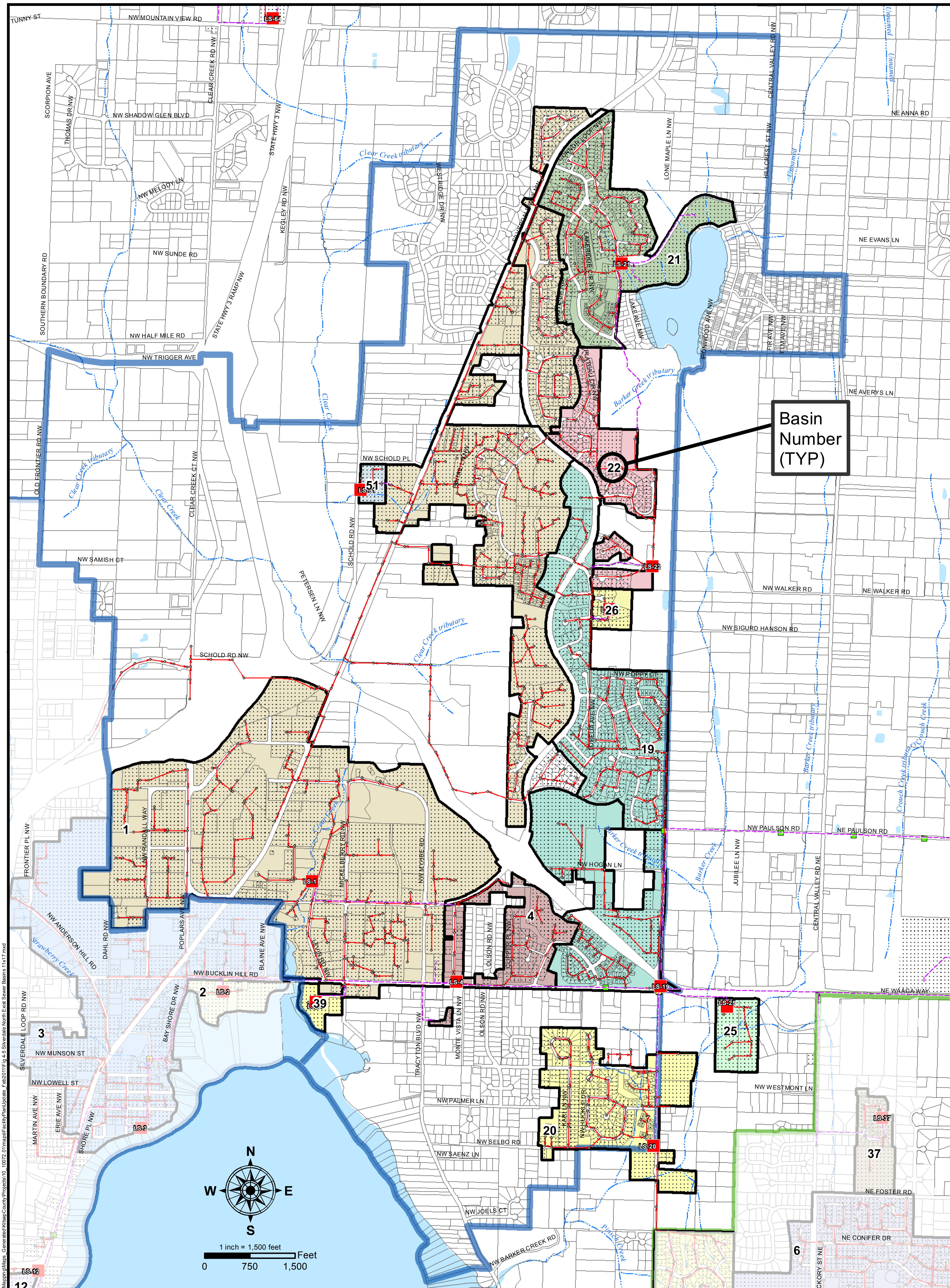
Figure

4-4



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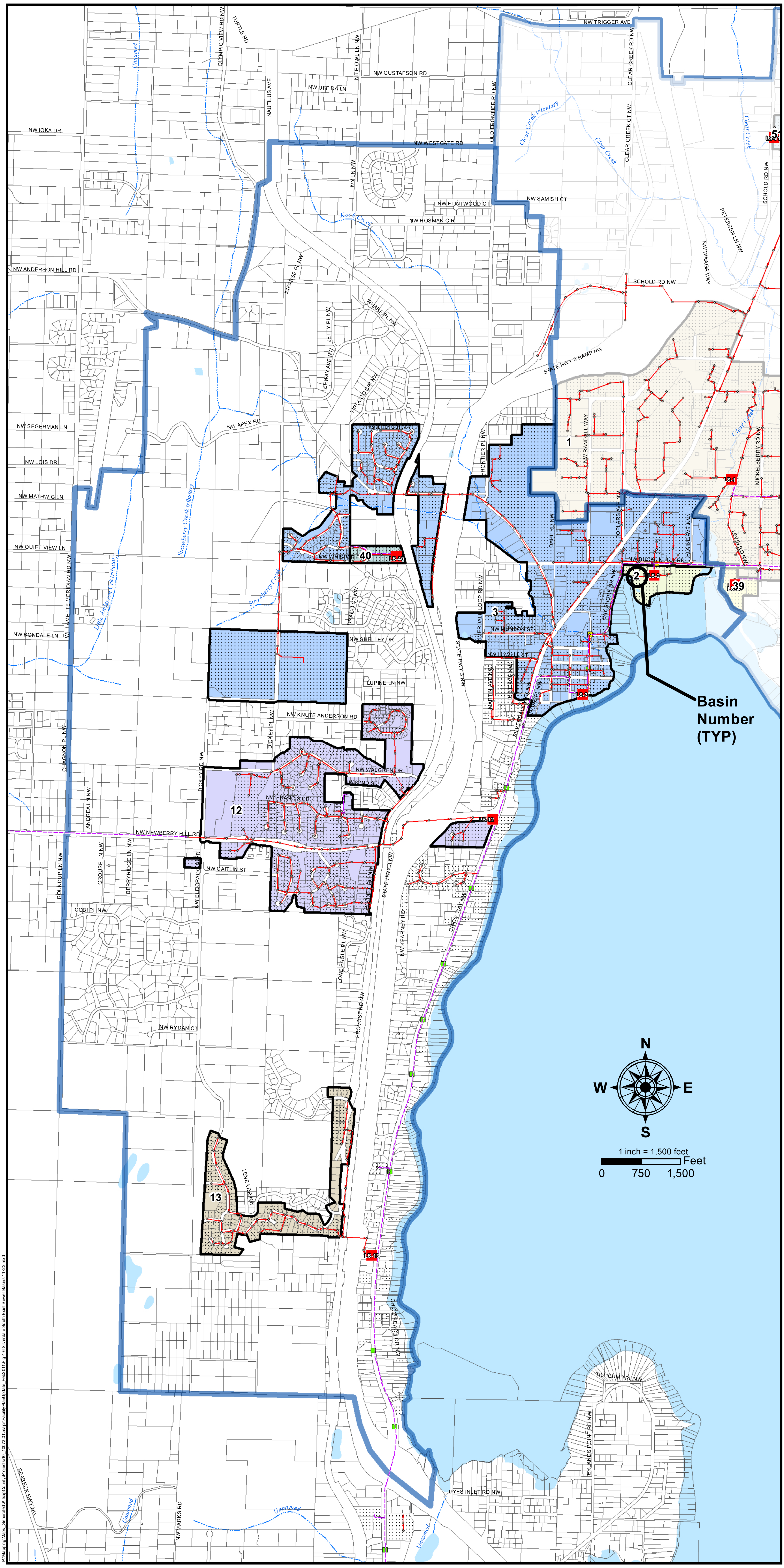
SILVERDALE - NORTH EXISTING SEWER BASINS

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure

4-5



P:\Mapping\Maps_Generated\KitsapCounty\Projects\10_10072.01\maps\FacilityPlanUpdate_Feb2011\Fig 4-6 Silverdale South Exist Sewer Basins 11x22.mxd

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SILVERDALE - SOUTH EXISTING SEWER BASINS

Central Kitsap Wastewater Facility Plan
Kitsap County Public Works
February, 2011

Figure
4-6

4.2.1.2.2 Primary Collection Facilities

The Southern Service Area has a number of primary lift stations to which a large number of tributary lift stations pump. The primary lift stations include LS-7 in Central Kitsap East; LS-6 and LS-34 in Central Kitsap West; LS-1, LS-4, and LS-19 in Silverdale North; and LS-3 in Silverdale South.

All flows generated in the Southern Service Area are delivered to the CKWWTP via a low-pressure gravity system. The system consists of two upstream reaches of 16- and 20-inch-diameter pipe that transmit flows to a 24-inch-diameter followed by a 30-inch-diameter interceptor that delivers the flows to the plant. The 16- and 20-inch-diameter interceptors deliver flows from Central Kitsap and Silverdale, respectively. Detailed system information follows.

Flows from the Central Kitsap UGA, LS-6 and LS-7, are discharged through a 10- and 14-inch-diameter force main (respectively) to a junction at the intersection of Fairgrounds Road and Old Military Road. From this junction, the combined flow is conveyed over a rise along Old Military Road through a series of 16- and 18-inch-diameter gravity pipes and inverted siphons. Seven manholes are located in series near the crown of this hill, connected by the 18-inch-diameter gravity pipeline. Gravity flows from local neighborhoods and from Pumping Station 35 enter at manholes along this reach. At the last manhole, H17-4001, the line diameter is reduced back to 16 inches for pressure flow to the plant.

Flows from Silverdale UGA LS-4 are pumped through a 14-inch-diameter force main along Bucklin Hill Road to a high point in the roadway from which flows are conveyed under a gravity pressure head through a 20-inch-diameter line. At the junction of Nels Nelson Road and Bucklin Hill Road, a 16-inch-diameter force main from LS-19 connects to the 20-inch-diameter line.

Flows from Central Kitsap join with flows from Silverdale at the intersection of Waaga Way and Royal Valley Road NE. The combined flows head north via a 24-inch-diameter low-pressure main. A force main from LS-9 in the Brownsville area connects to the 24-inch-diameter main at Paulson Road. At the same location, the 14-inch-diameter pipe from LS-19 (and LS-4) ties into the system. The pressure main changes to a 30-inch-diameter line and conveys the sum of the Southern Service Area flows into the CKWWTP. The 30-inch-diameter section from Paulson to the plant is slated for replacement in 2009–10. Southern flows are measured along the route at AS-1.

The hydraulics and future requirements of this system are discussed further in Chapter 7. Lift stations tributary to the primary stations listed above are outlined below for each service sub-area.

4.2.1.2.3 Central Kitsap East

The existing collection system and associated wastewater basins for the Central Kitsap East area are shown on Figure 4-3. LS-7 is the primary lift station serving the Central Kitsap East area as described in the previous section. This lift station was recently reconstructed to provide the maximum capacity that could be attained given site constraints. The facility’s firm capacity is 4,200 gpd, which is expected to be adequate to serve the area for about 20 years. Key characteristics of the Central Kitsap East collection system are as follows:

- LS-8, LS-31, LS-32, LS-33, and LS-69 are directly tributary to LS-7. Flows are conveyed to LS-7 via a network of force mains and gravity lines.
- Three smaller lift stations—LS-65, LS-38, and LS-44/62—are tributary to LS-8. LS-44 was upsized in 2009 and is now designated LS-62.
- An emergency gravity overflow pipeline to the Bremerton system is connected to LS-32 at the southern boundary of the service area.
- LS-18 is also tributary to LS-7. Two smaller lift stations—LS-30 and LS-63—are tributary to LS-18.
- Approximately half the existing flow to LS-7 is conveyed to the station entirely by gravity.

4.2.1.2.4 Central Kitsap West

The existing collection system and associated wastewater basins for the Central Kitsap West area are illustrated on Figure 4-4. LS-6 is the primary lift station serving the Central Kitsap West area and conveys sewage to the CKWWTP as described in Section 4.2.1.2.2 above. Key characteristics of the Central Kitsap West collection system are as follows:

- LS-34 and LS-36 are tributary to LS-6. LS-34, located south of Central Valley Road and McWilliams Road, receives flow from the smaller LS-10 and LS-11.
- A force main from LS-34 follows a parallel route along Central Valley Road north to Fairgrounds Road and then east in Fairgrounds Road to LS-6. Approximately 5,600 of 7,800 feet of this force main was either replaced or constructed as a new line to parallel an existing force main in 2009.
- A force main from LS-36 in the Ravenswood neighborhood also discharges to LS-6.
- LS-10 is tributary to LS-34 and serves the Fairview neighborhood, Olympic High School, and the Kitsap County Fairgrounds.
- Additional flow from LS-37 discharges to the 20-inch low-pressure gravity line from LS-4 and LS-19 along Waaga Way.

4.2.1.2.5 Silverdale North

The existing collection system and associated wastewater basins for the Silverdale North Area are shown on Figure 4-5. LS-4 and LS-19 are the primary lift stations serving the Silverdale North Area and convey flows to the CKWWTP as described in Section 4.1.2.2. LS-19 serves the majority of the north and east portion of Silverdale, while LS-4 serves the west. From LS-3, flows from the Silverdale South Area are also conveyed through LS-4. Key characteristics of the Silverdale North collection system are as follows:

- LS-22, LS-25, and LS-26 are tributary to LS-19. LS-22 also receives flow from LS-21.
- LS-1 is tributary to LS-4 and conveys sewage from the northwest part of Silverdale. Gravity flows from this area include two 6-inch-diameter siphon barrels that cross under Clear Creek prior to entering LS-1 on Levin Road.
- Flows from LS-19 normally pump into the 20-inch-diameter line from LS-4 on Bucklin Hill Road. However, a flow-splitter valve can divert flow from LS-4 into LS-19 through an alternate 14-inch-diameter line. In this case, flows from the entire Silverdale UGA are pumped by LS-19 through the alternate 14-inch-diameter force main to an intersection point on the Southern Service Area force main, just south of AS-1.

4.2.1.2.6 Silverdale South

The existing collection system and associated wastewater basins for the Silverdale South Area are shown on Figure 4-6. LS-3 is the primary lift station for the Silverdale South Area. LS-3 conveys flows through a 14-inch-diameter force main to LS-4, located at the intersection of Bucklin Hill and Frederickson Roads. Key characteristics of the Silverdale South collection system are as follows:

- Flows from the central Silverdale area are received by LS-3 through a network of gravity sewers. LS-40, a small lift station in a residential area west of the downtown Silverdale area, discharges to this gravity network.
- LS-12 is tributary to LS-3. LS-12 receives flow from the south and serves the Loretta Heights residential area. Additional flows from the residential areas of Terrace Heights and El Dorado Hills are conveyed to LS-12.
- LS-13 is tributary to LS-12.
- LS-14 is tributary to LS-13. Wastewater is pumped north along Chico Way through a force main to LS-13.

4.2.2 Collection System Piping

The existing collection system piping is summarized in Table 4-1. The existing system includes more than 103 miles of gravity sewer and 12 miles of force mains. A small fraction of the system functions as a siphon.

Table 4-1. Summary of Existing Collection System Piping

	Central Kitsap	Silverdale	Total per size
Force mains (lf)			
2" diameter or smaller	0	4,138	4,138
4"	0	3,171	3,171
6"	5,699	6,923	12,621
8"	6,419	1,694	8,113
10"	1,160	7,075	8,235
12"	1,295	6,854	8,149
14"	6,521	8,901	15,422
16"	7,155	46	7,201
20"	0	1,818	1,818
Total force mains	28,249	40,620	68,869
Gravity (lf)			
6"	3,777	4,919	8,696
8"	243,434	255,371	498,805
10"	2,649	6,491	9,140
12"	4,582	13,257	17,839
15"	5,181	5,272	10,454
16"	3,400	41	3,441
18"	1,038	873	1,911
Total gravity	263,023	285,351	548,375

4.2.3 Lift Stations

Currently 44 lift stations are located throughout the Central Kitsap service area. County staff gathered detailed information, conducted pump tests, and performed analyses on most of the lift stations in 2006. Testing and analyses were conducted in three ways, depending on the priority of the lift station, the desired information, and the information available to correlate with:

- drawdown and influent flow metering
- drawdown and pressure gauge readings
- pump run times and pressure gauge readings.

Many of the lift stations have been in operation for more than 20 years. For a number of these, manufacturers or design data are no longer available. Consequently, pump curves could not always be used to compare with pressure test results to gauge the operating condition of the facility, and the operating condition could not always be determined.

Table 4-2 summarizes the existing lift stations and their firm pumping capacities (FPC). The existing flows at the lift stations were modeled for further comparison with their FPCs as documented in Chapter 7. In general, it appears that most of the lift stations are operating at or below design capacity (see Figure 7-1).

Table 4-2. Existing Lift Stations

Lift station information					Existing conditions				
Lift station	Year installed	No. of pumps	VFD	Constant speed	Capacity		FM length	Static head	FM diameter
					(gpm)	(cfs)	(ft)	(ft)	(in.)
LS-1	1986/1995	3	✓	-	3,200	7.13	2,750	140	12/15
LS-2	1980	2	-	✓	264	0.59	240	125	8/14
LS-3	1980/2005	3	✓	-	1,800	4.01	7,300	135	14
LS-4	1980/2005	3	✓	-	2,865	6.38	1,585	100	14
							1,808		20
LS-5	1980	2		✓	530	1.18	1,800	80	8
LS-6	1980/2004	2	✓	-	1,200	2.67	3,275	65	10
LS-10	1980	2	-	✓	270	0.60	3,000	90	6
LS-18	1977	2	-	✓	301	0.67	800	35	4/12
LS-19	1986/1999	3	✓	-	3,264	7.27	50	70	16
LS-24	1988/2000	3	✓	-	8,000	17.82	8,800	160	24
LS-31	1975	2	-	✓	61	0.14	2,000	35	4/8
LS-38	1972	2	-	✓	70	0.16	400		8
LS-67	1998/1999	3	✓	-	700	1.56	480	40	
LS-11	1979/1985	2	-	✓	230	0.51	2,000	60	4/12
LS-16	1980	3	✓	-	2,000	4.46	4,080	40	16/30
LS-20	1981	2	-	✓	327	0.73	2,700	110	6/20
LS-8	1980	2	-	✓	300	0.67	3,000	40	8
LS-9	1980	4	-	✓	400	0.89	6,480	155	8
LS-12	1980	2	-	✓	250	0.56	1,900	15	12
LS-13	1980	2	-	✓	400	0.89	1,600	20	8
LS-17	1980	3	✓	-	3,000	6.68	22,000	40	18/20
LS-21	1986	2	-	✓	240	0.53	2,650	90	8
LS-22	1986	2	-	✓	380	0.85	1,050	120	
LS-23	1985	2	-	✓	600	1.34	1,250	105	
LS-25	1989	2	-	✓	150	0.33	1,250	30	4
LS-26	1990	2	-	✓	70	0.16	425	30	
LS-30	1993	2	-	✓	160	0.36	1,450	145	8
LS-32	1983	2	-	✓	165	0.37	2,500	30	8
LS-33	1983	2	-	✓	90	0.20	550	50	8
LS-34	1989	2	-	✓	900	2.01	6,000	130	12/10
LS-35	1983	2	-	✓	160	0.36	950	85	8
LS-36	1979/1999	2	-	✓	150	0.33	2,000	30	4

Table 4-2. Existing Lift Stations									
Lift station information					Existing conditions				
Lift station	Year installed	No. of pumps	VFD	Constant speed	Capacity		FM length	Static head	FM diameter
					(gpm)	(cfs)	(ft)	(ft)	(in.)
LS-37	1983	2	-	✓	170	0.38	3,500	25	13/8
LS-39	1994	2	-	✓	110	0.25	700	25	
LS-40	1993	2	-	✓		0.00	875	90	8
LS-44	1995	2	-	✓	50	0.11	1,200	80	
LS-51	1995	2	-	✓	250	0.56	500	40	
LS-64	2003	2	-	✓	70	0.16	50	40	
LS-65	1994	4	-	✓	300	0.67	5,950	275	
LS-69	1998	2	-	✓	160	0.36	2,700	95	
LS-14	1981	2	-	✓	300	0.67	6,880	25	6
LS-7	2006	3	✓	-	4,200	9.36	850		14
LS-63	2006	2	-	✓	90	0.20	750	35	4/8
LS-68		2	-	✓	310	0.69	8,360	50	8

While the modeling effort will reveal future system requirements based on future flows, this summary of existing lift station facilities, just by referring to the age of the facilities, may be used as an indicator of future upgrade needs. Because this Facility Plan considers infrastructure needs for the next 20 years and the lift station service life is between 20 and 30 years, many of the existing facilities are expected to require major overhauls or replacement by 2030. Several stations have undergone a range of rehabilitation in the recent past; others are new. The following stations are not expected to require replacement based on service life, but could be included for improvement based on future flows:

- LS-3: received new pumps and motors in 2005
- LS-4: received new pumps and motors in 2005
- LS-5: taken out of service
- LS-6: received new pumps and motors in 2006
- LS-7: rebuilt in 2006
- LS-34: upgraded in 2009 (surge tank only)
- LS-63: new in 2006
- LS-44/62: upgraded in 2009.

4.3 Existing Wastewater Treatment Plant

The CKWWTP has been providing full secondary treatment to much of Kitsap County since 1979. The performance, characteristics, and condition of the treatment plant are described in this section. This information serves as the basis of recommendations for improving plant performance and providing for future system growth. Wastewater treatment recommendations are provided in Chapter 8.

4.3.1 Location

The CKWWTP is located on the west side of SR 303, approximately 1.5 miles north of the community of Brownsville, as shown on Figure 4-1. The overall plant site consists of about 62 acres, with the existing facilities occupying about 8.5 acres. The remaining area is set aside for future expansion and 150-foot buffer zones. Plant access is from SR 303 by a 25-foot-wide access road. The plant site is extensively landscaped, and public view is limited to that along SR 303.

4.3.2 Treatment Processes

The CKWWTP has a total plant capacity of 6.0 mgd and secondary treatment capacity of 7.0 mgd, both expressed as ADF. The current design peak hour flow is 15.0 mgd. The plant liquid stream facilities include coarse screening, primary clarification, activated sludge, secondary clarification, and ultraviolet (UV) effluent disinfection. The plant effluent is discharged into Port Orchard Bay.

The plant solid stream facilities include cyclone sludge degritting, gravity thickening, primary and secondary sludge digestion, and dewatering via a centrifuge. Currently, as an interim measure, dewatered sludge is sent to Fire Mountain Farm in Chehalis, Washington, where it is composted into a Class A product. The County is seeking a more economical, long-term strategy for sludge disposal.

The CKWWTP also receives septage hauled in by trucks and sludges generated at the other three Kitsap County WWTPs at Kingston, Manchester, and Suquamish. Septage and the other sludges are screened, diluted, degritted, and sent to the gravity thickeners. Each of the liquid stream and solid stream unit processes is discussed in further detail in the following sections.

4.3.2.1 Existing Process Design Criteria

The CKWWTP was designed in 1977; construction was completed in 1979. Some systems were updated in 1995 and 1996, and then in 2000–01, additional upgrades were implemented. Figure 4-7 shows the process flow diagram for the existing plant after these improvements. Design criteria for the existing facilities are presented in Table 4-3. Table 4-4 summarizes the current NPDES permit limits regarding flows, influent loadings, and effluent limitations. A copy of the NPDES permit and its associated Fact Sheet are included in Appendices 4A and 4B, respectively.

Table 4-3. CKWWTP Existing Process Design Data

Parameter	Unit	Existing plant rating or design
Raw sewage flow		
AAF	mgd	4.6
ADWF	mgd	4.3
ADF	mgd	6.0 (7.0 for secondary system only[a])
MDF	mgd	11.0
PDF (hour)	mgd	15.0
Raw sewage loadings		
Annual average BOD_5	ppd	8,403
Average peak month BOD_5	ppd	14,100
Annual average TSS	ppd	8,844
Average peak month TSS	ppd	11,400

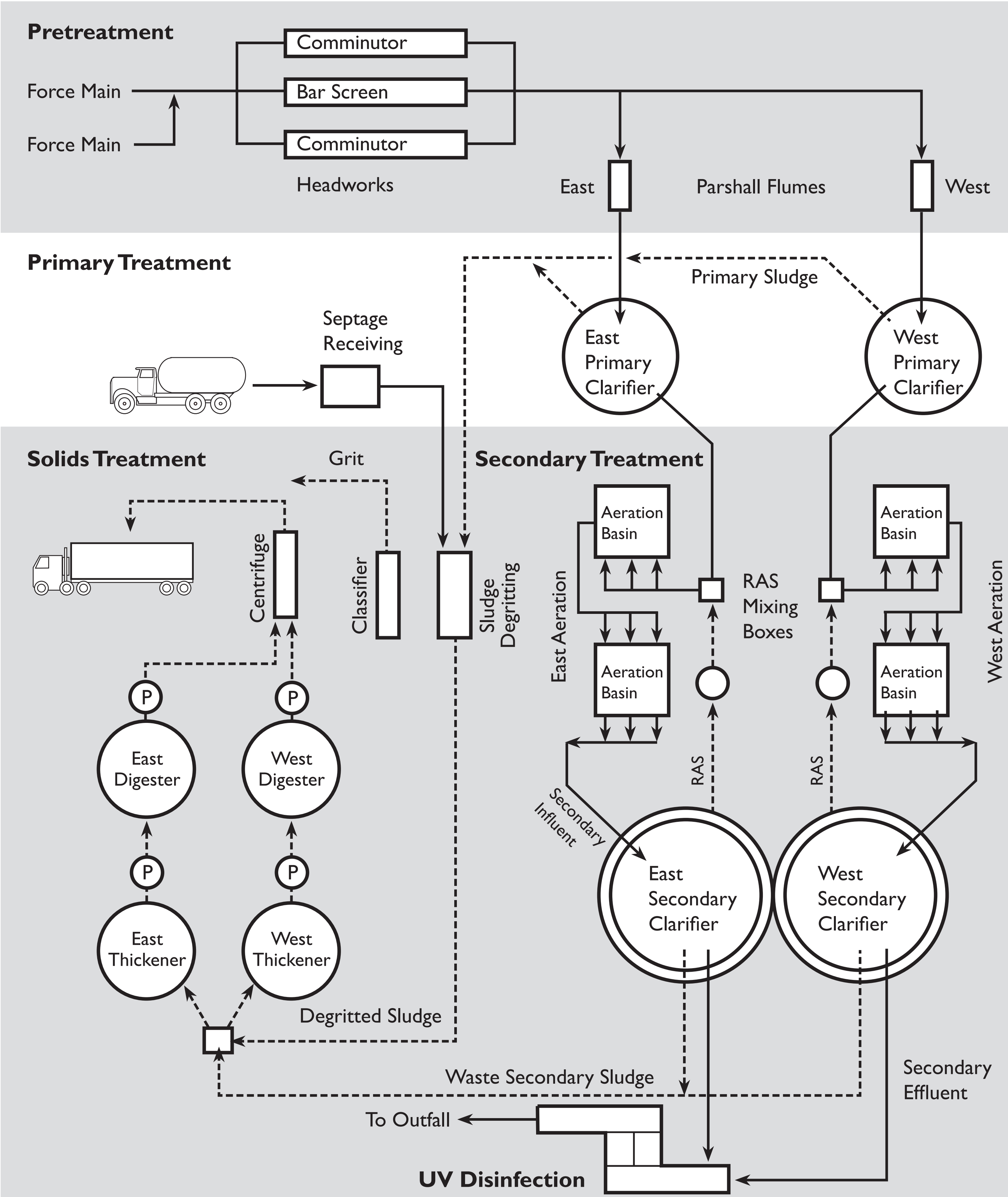

Figure 4-7 Existing CKWWTP Process Flow Schematic

Table 4-3. CKWWTP Existing Process Design Data		
Parameter	Unit	Existing plant rating or design
Comminutors		
Number		2
Channel width	ft	4.0
Capacity, each	mgd	17.0
Motor size	hp	2
Bar screens		
Number, mechanical		--
Number, manual		1
Peak hydraulic capacity, each	mgd	b
Primary clarifiers		
Number		2
Diameter	ft	65
Depth	ft	10.5
Total surface area	sq ft	6,600
Overflow rate		
@ ADF	gpd/sq ft	909
@ PDF	gpd/sq ft	2,260
Detention time		
@ ADF	hrs	2.1
@ PDF	hrs	0.8
Primary sludge pumps		
Number		2
Capacity, each	gpm	200
Activated sludge basins		
Number		2
Volume, total	MG	1.62
Depth	ft	14.66
Hydraulic detention time @ ADF	hrs	6.5
Mixed liquor suspended solids (MLSS)	mg/L	2,300
Sludge retention time (SRT)	days	4.5–6
RAS-to-influent flow ratio	%	42–77
Loading @ADF		
BOD_5	ppd	7,940
NH_3-N	ppd	1,140
Oxygen demand		
@ ADWF	ppd	11,110
@ ADF	ppd	13,260
Maximum day	ppd	14,430
Air flow requirements		
@ ADWF	scfm	4,770
@ ADF	scfm	5,690
Maximum day	scfm	8,180
Aeration blowers		
Number, firm/total		2/3
Capacity, each	scfm	4,800
Total air flow, firm capacity	scfm	9,600

Table 4-3. CKWWTP Existing Process Design Data

Parameter	Unit	Existing plant rating or design
RAS pumps		
Number, firm/total		4/5
Capacity, each	mgd	1.3
Capacity, total	mgd	4.6
WAS pumps [c]		
Number		2
Capacity each	gpm	225
Secondary clarifiers		
Number		2
Diameter	ft	104
Depth	ft	11.5
Total surface area	sq ft	16,990
Overflow rate		
@ ADF	gpd/sq ft	353
@ PDF	gpd/sq ft	883
UV channels		
Number		2
Length	ft	36
Width	ft	4.58
Depth	In.	52
Design flow per channel	mgd	17
Design transmissivity		
Average	%	62
Minimum	%	55
Degritting system		
Number of cyclones		2
Total cyclone capacity	gpm	250
Number of classifiers		1
Total classifier capacity	tpd	10
Septage receiving station		
Number of receiving tanks		1
Volume, each	gal	4,500
Transfer capacity, each	gpm	50
Gravity thickeners		
Number		2
Diameter	ft	45
Depth	ft	10
Solids loading rate		
Annual average	ppd/sq ft	5.4
Peak month	ppd/sq ft	7.5
Anaerobic digesters		
Number		2
Diameter	ft	65
Depth	ft	26
Volume, each	ft^3	86,280
Annual average loadings		
Total solids feed	ppd TS	10,877
Volatile solids (VS) feed	ppd VS	9,336
VS loading	ppd VS /1,000 ft^3	54
Detention time	days	35.5

Table 4-3. CKWWTP Existing Process Design Data

Parameter	Unit	Existing plant rating or design
Sludge dewatering		
Plate and frame press[d]		
Number		1
Filtration area	sq ft	2,800
Number/size of plates	m	55/1.5 x 2
Capacity	pph	---[d]
Centrifuges		
Number		1
Capacity, each	gpm	186[e]

Notes:

a. Secondary system capacity re-rated from 6 to 7 mgd per letter from Ecology, July 28, 2008.

b. Capacity information unavailable. Unit to be removed in CKWWTP 2009 Upgrade project.

c. The existing WAS pumps are used for wasting either mixed liquor or RAS.

d. Plate and frame press is currently not operated.

e. Capacity based on 7 hours per day, 5 days per week dewatering at average annual sludge production.

Table 4-4. CKWWTP NPDES Requirements[a]

Design criteria	Units	Design quantity	
Max month flow	mgd	6.0	
Max month influent BOD loading	lb/d	14,100	
Max month influent TSS loading	lb/d	11,400	
Parameter		Effluent limitations	
		Average monthly	Average weekly
$CBOD_5$[b]	lb/d	1,251	2,002
	mg/L	25	40
TSS[b]	lb/d	1,501	2,252
	mg/L	30	45
Fecal coliform[c]	# colonies/100 mL	200	400
pH		Between 6.0 and 9.0	

a. Effective date of NPDES permit: June 1, 2007.

b. The average monthly effluent concentrations for $CBOD_5$ and TSS shall not exceed 25 and 30 mg/L, respectively, or 15 percent of the respective monthly average influent concentrations, whichever is more stringent.

c. Average limits for fecal coliform are based on geometric means.

4.3.2.2 Overall Process Performance

Plant records were examined to determine overall process performance. Plant effluent quality and overall removal efficiencies are shown on Figure 4-8 and effluent metals concentrations are summarized in Table 4-5. Monthly dewatered biosolids production rates are shown on Figure 4-9.

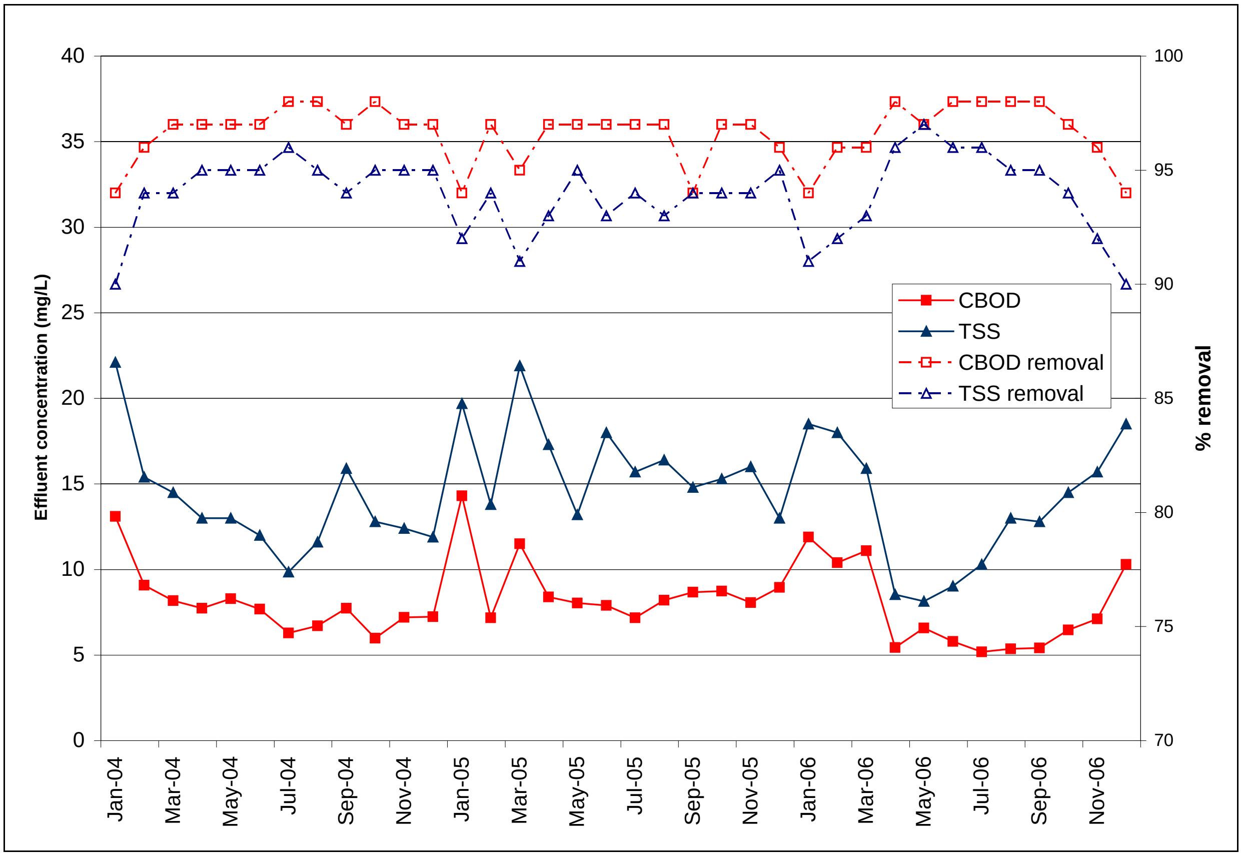

Figure 4-8. CKWWTP effluent quality and overall pollutant removals, 2004–06

Table 4-5. CKWWTP Average Effluent Fecal Coliform, Ammonia, and Metals Concentrations, 2004–06

Month	Fecal col., #/100 mL	NH_3-N, mg/L	Cd, µg/L	Cr, µg/L	Cu, µg/L	Pb, µg/L	Ni, µg/L	Zn, µg/L	Hg, µg/L
2004									
January	10	30.4	< 0.3	0.8	6.5	3.0	4.6	17.0	< 0.2
February	9	37.0	< 0.3	0.9	7.2	< 1.8	2.5	33.2	< 0.2
March	19	30.6	< 0.3	1.2	9.2	< 1.8	2.7	38.9	< 0.2
April	61	39.8	< 0.3	1.2	7.4	3.9	3.5	45.9	< 0.2
May	18	38.8	< 0.3	< 0.8	6.2	2.7	3.0	24.0	< 0.2
June	79	50.4	< 0.3	0.9	6.2	3.7	3.6	27.5	< 0.2
July	42	34.7	< 6.0	< 3.0	12.0	< 8.0	< 7.0	42.0	< 0.2
August	36	34.0	< 0.3	< 0.8	29.0	8.0	4.0	32.0	< 0.2
September	81	38.9	< 6.0	< 3.0	< 7.0	< 8.0	< 7.0	34.0	< 0.2
October	26	23.0	< 0.3	< 0.8	< 6.1	1.8	< 1.9	33.0	< 0.2
November	24	43.6	< 0.3	< 7.0	< 6.0	< 40	< 15	22.0	< 0.2
December	16	39.7	< 0.3	< 7.0	< 6.0	< 40	< 15	170	< 0.2
2005									
January	18	45.1	< 3.0	< 7.0	< 6.0	< 40	< 15	22.0	< 0.2
February	12	44.9	< 3.0	< 7.0	< 6.0	< 40	< 15	64.0	< 0.2
March	12	36.3	< 3.0	< 3.0	< 6.0	< 40	< 15	29.0	< 0.2
April	48	23.5	< 3.0	<13.0	10.0	< 40	< 15	43.0	< 0.2
May	59	15.2	< 0.4	< 1.2	< 10.9	< 4.3	3.2	39.1	< 0.2
June	44	29.2	< 0.4	< 1.2	< 10.9	< 4.3	3.0	23.4	< 0.2
July	47	16.3	< 0.4	< 1.2	< 10.9	< 4.3	3.3	24.1	< 0.2
August	53	33.6	< 0.4	< 1.2	< 10.9	< 4.3	3.0	19.9	< 0.2
September	54	29.6	< 0.4	1.3	< 10.9	< 4.3	4.3	26.4	< 0.2
October	64	31.4	< 0.4	< 1.2	< 10.9	< 4.3	3.9	24.6	< 0.2
November	22	29.5	< 0.4	< 1.2	< 10.9	< 4.3	3.3	29.6	< 0.2
December	11	35.4	< 0.4	<1.2	< 10.9	< 4.3	4.0	26.8	< 0.2
2006									
January	8	31.9	< 0.4	< 1.2	< 10.9	< 4.3	2.7	36.0	< 0.2
February	15	23.8	< 0.4	< 1.2	< 10.9	< 4.3	3.8	41.9	< 0.2
March	31	25.5	< 0.4	< 1.2	< 10.9	< 4.3	3.8	36.4	< 0.2
April	53	32.8	< 0.4	< 1.2	< 10.9	< 4.3	3.0	35.8	< 0.2
May	70	28.9	< 0.4	< 1.2	< 10.9	< 4.3	2.7	30.1	< 0.2
June	54	19.2	< 0.4	< 1.2	< 10.9	< 4.3	2.6	30.3	< 0.2
July	55	18.5	< 0.4	1.4	< 10.9	< 4.3	4.3	23.8	< 0.2
August	37	28.6	< 0.4	< 1.2	< 10.9	< 4.3	2.9	16.1	< 0.2
September	40	34.5	< 0.4	< 1.2	12.2	< 4.3	3.0	18.2	< 0.2
October	45	21.1	< 0.4	< 1.2	< 10.9	< 4.3	2.5	9.7	< 0.2
November	37	20.0	< 8.6	< 5.3	9.2	< 6.0	2.9	26.7	< 0.2
December	12	32.3	< 8.6	< 5.3	7.9	< 6.0	3.4	33.4	< 0.2

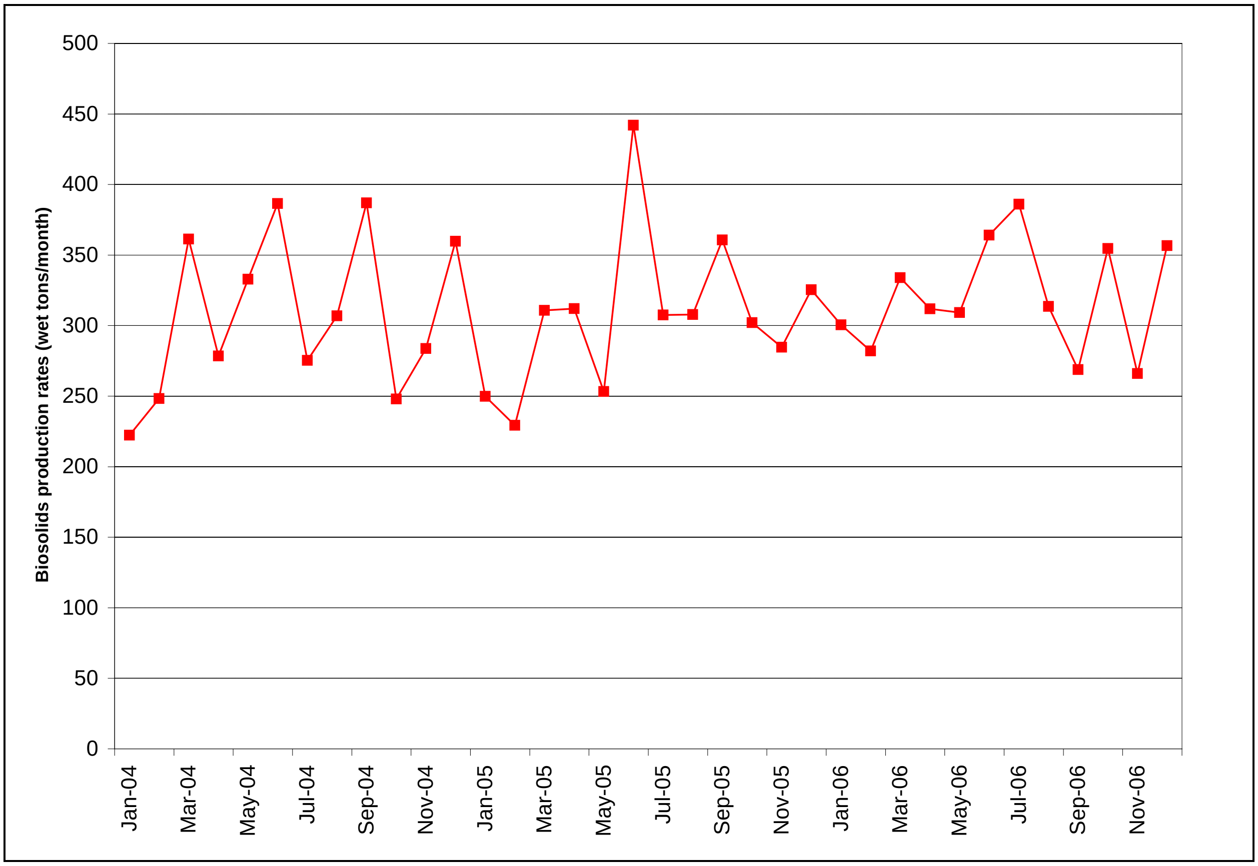

Figure 4-9. CKWWTP monthly biosolids production rates, 2004–06

4.3.3 Unit Process Summary

Each of the CKWWTP unit processes and related systems is discussed in the following sections. A brief description is given, followed by a statement about current performance and physical condition. Additional information about overall plant performance is contained in Section 4.3.4.

4.3.3.1 Liquid Stream Processes

The liquid stream processes of the CKWWTP are described in the sections below.

4.3.3.1.1 Headworks

Description. Raw sewage is conveyed to the plant via north and south force mains, which combine and enter the plant influent structure. The headworks structure includes three parallel channels. Two channels include grit sumps followed by comminutors; the third channel has a manually raked bar screen. The comminutors are no longer operational and all influent flow currently passes through the manually raked bar screen.

The flow can then be divided between two parallel process trains, designated as east and west. Flow through each process train is modulated by a 36-inch channel butterfly gate, followed by an 18-inch Parshall flume. Each flume has a maximum capacity of 8.4 mgd. The east channel flows to the east primary clarifier and the west channel to the west primary clarifier. A refrigerated composite sampler is provided for influent flow sampling.

Performance. The headworks facility can handle the existing flows hydraulically, but has limited provisions for flow measurement and solids handling. The influent force mains cannot be isolated from the headworks or from each other. Repair on one force main requires both force mains to be shut down. There is no high water monitoring at the influent sump, which has only 9.5 inches of freeboard above the slide gates. The grit sump is ineffective. Because the comminutors are no longer operational, all screenings must be removed manually from the bar rack. This process incurs significant operational effort and contributes to odors. The wide spacing between bars (greater than 1 inch) allows many debris items to enter the treatment process, impacting downstream equipment and biosolids quality. The existing headworks does not include grit removal. Grit is removed from the primary sludge that settles out in the primary clarifiers. Also, the existing screens will render the headworks out of compliance with upcoming 2012 Ecology requirements (WAC 173-308-205). These regulations call for finer intake screens to remove more of the inert material (mostly plastics) going into the biosolids.

Condition. Corrosion of metals and controls in the headworks is severe. Odor is also a problem in this area. The composite sampler is reliable, but replacement parts have been hard to obtain when needed. The grit sump upstream of the comminutors requires manual cleaning. This maintenance is labor-intensive and causes excessive grit to be discharged into the plant drain system. Since the level measurement at the Parshall flumes was converted to a conductance probe, the unused stilling wells have become a collection point for scum and debris. The comminutor units are no longer usable.

Current Status. A new replacement headworks was designed as part of the 2009 plant upgrade. The new headworks is currently under construction and will be completed in 2011. This project will remedy the shortcomings of the existing headworks as described above.

4.3.3.1.2 Primary Clarifiers

Description. The raw sewage is routed from each Parshall flume to its respective 65-foot-diameter center-feed primary clarifier. Effluent from the clarifiers passes under a scum baffle and over a peripheral weir into a collection launder, and then to the activated sludge basins. Each clarifier is hosed down daily and scrubbed once a week for odor control.

Primary sludge is collected using a rotating rake mechanism and withdrawn through a 6-inch-diameter sludge line. Two new primary sludge pumps were installed as part of the 1995–96 improvements. The two new pumps replaced the old pump and were cross-connected to allow one to be removed from service. The new pumps are located in the existing utilidor between the aeration tanks. Primary sludge is pumped to the cyclone degritters next to the gravity thickeners. During normal operation, each pump is connected to one of the clarifiers, but piping was installed to allow either pump to operate with either clarifier. The two pumps pump primary sludge continuously to the cyclone degritters.

Floating scum is collected with a skimming mechanism and withdrawn from a separate 6-inch line and routed to the thickener and digester. Chlorinated effluent is used as process water to spray surfaces and assist in scum removal. Two 140 gpm piston pumps are used for pumping primary scum.

The effluent launder is covered, and foul air is conveyed to a small, nearby biofilter installed by the County.

Performance. Operation of the primary clarifiers has been adequate at the average and peak flow rates experienced thus far. However, their shallow circular design limits solids removal capabilities at higher loadings. Measurements of DO concentrations in grab samples collected along the liquid stream treatment train suggested that waterfall effect of the effluent overflowing the peripheral weirs into the launder resulted in DO entrainment, which had a negative impact on the downstream anoxic selector in the aeration basins.

Condition. The concrete tanks for this unit process are considered in generally good condition based on external visual observations. Two new primary sludge pumps were installed as part of the 1995–96 improvements and therefore are in good condition.

4.3.3.1.3 Activated Sludge Secondary Treatment

Description. Primary effluent is routed to the four activated sludge aeration cells, each of which has a volume of 412,500 gallons. The plant was originally designed to operate in a number of activated sludge process modes, including complete mix, extended aeration, step-feed, and contact stabilization. Flow can be routed through the basins in a number of configurations using a network of hydraulic channels and slide gates.

Each of the basins is equipped with inlet/outlet slide gates on three sides to facilitate the various operating modes, with an effluent weir on the fourth side. Sludge that settles in the secondary clarifiers is returned as return activated sludge (RAS) and mixed with primary effluent in the aeration tanks. Sludge is wasted (waste activated sludge [WAS]) from the secondary system either as mixed liquor from the aeration basins or as RAS from the inlet pipe to the RAS pumps. WAS is pumped to the solids stream processes for further treatment.

Oxygen transfer to each of the four basins was originally by two fixed, mechanical mixer-aerators, each equipped with two-speed, 60-horsepower (hp) motors. Hydraulic channels were aerated with coarse bubble diffused air along their length.

The 1995–96 plant expansion included replacement of the aerators with fine bubble diffused aeration equipment. Three new blowers were also installed in the new power/blower building. A new aeration air distribution pipe network connects the power/blower building to the aeration tanks. This distribution system runs underground from the power/blower building to the south side of the existing aeration tanks and then extends above the walkway areas on the aeration tanks.

In 1995–96, a baffle was added in the southwest and the southeast basins to create an anaerobic selector cell in each process train, which enhanced solids removal. In the 2000–01 plant upgrade, two floating mechanical mixers were added in each anaerobic selector cell to allow mixing of the mixed liquor without aeration.

Between the east and west basins is an underground utilidor, which contains the primary clarifier sludge pumps, secondary sludge return and waste pumps, the scum pumps, blowers for the channel air diffusers, and all associated electrical equipment. Above the utilidor are the main basin influent channels and two mixing basins. The utilidor is equipped with a sump pump for drainage and equipment protection.

Performance. As described above, the activated sludge system has considerable flexibility. The plant currently typically operates with the two west basins in series in anaerobic selector mode. Under higher flow conditions, the plant can switch to step feed or contact stabilization mode, which reduces solids loadings to the secondary clarifiers and the potential for solids washout.

Oxygen transfer efficiency of the existing membrane diffusers installed in the 1995–96 upgrade has deteriorated significantly over the years due to aging membranes. The system at times has been unable to maintain adequate DO concentration in the aeration basin. The pressure requirement for the diffuser system has also increased due to the deteriorated diffuser membranes, exceeding the original design pressure for the aeration blowers. This increases the electrical power consumption of the aeration blowers. The need for replacement aeration basin diffusers and the assessment of aeration blower capacity is discussed in Section 4.3.4.

Condition. The physical condition of the aeration basins is good, with very little evidence of corrosion noted. The aeration air blowers appear to be in good mechanical condition. The foam suppression sprays have been found to be unnecessary, and may be removed by plant staff because of freezing problems. The channel air blowers also appear to be in good condition.

4.3.3.1.4 Secondary Clarifiers

Description. Mixed liquor from the aeration basins is routed through hydraulic channels and pipelines to the two 90-foot-diameter, 11.5-foot-deep secondary clarifiers. The original design provided for essentially equal flow distribution between the two clarifiers, with flow from the west aeration basin train going to the west clarifier, and likewise for the east side. Influent flows to a center feed well, and effluent flows under a scum baffle and over a peripheral weir into a collection channel. The launder discharges into a pipe that conveys the secondary effluent to the UV disinfection system. Solids are withdrawn for return to the aeration tanks using a Tow-Bro collector.

Separate pumps are provided for pumping both RAS and WAS. RAS is pumped from a 16-inch-diameter line using two variable-speed pumps for each clarifier. One constant-speed centrifugal pump is provided as a standby unit and can service either of the two clarifiers. Each pump has a nominal capacity of 900 gpm at 22 feet of total dynamic head (TDH). WAS is withdrawn from the RAS line on a variable-timed basis and pumped using two variable-speed-driven centrifugal pumps, each rated at 200/500 gpm at maximum pump speed. Sonic-type flow meters are provided for measuring both waste and return sludge streams. Sludge can also be wasted from the aeration basins as waste mixed liquor (WML).

Scum is captured and collected on the clarifier surface by a skimming device attached to the sludge collector mechanism. Scum collection is aided by use of spray nozzles (utilizing process water), which are attached to the clarifier bridge. The clarifier is either drained by gravity drains or through the WAS pumping systems.

Performance. The activated sludge system has occasionally experienced bulking problems, which reduce performance of the secondary clarifiers and increase effluent solids concentrations. The average sludge volume index (SVI), which is often used as an indicator of the settling capability of the mixed liquor, is about 230 milliliters per gram (mL/g) based on 2003–06 data, and at times exceeds 350 mL/g.

Condition. The clarifiers are hosed down daily and scrubbed each week, and are maintained in good condition. Both the RAS and WAS sonic flow meters have been a continuing maintenance problem. The meters are no longer supported by the manufacturers and need frequent adjustments.

4.3.3.1.5 Disinfection

Description. Two UV channels and connecting inlet and outlet channeling were constructed east of the secondary clarifiers during the 1995–96 plant upgrade. The two channels each contain 60 medium-pressure UV lamps, divided into two banks per channel. The outlet channel from the UV channels is connected to a new 72-inch-diameter effluent pipeline and conveyed to the original outfall. Both the inlet and outlet channels to the UV system were designed to accommodate one additional UV channel, should it be required at a later date.

The concrete tanks for this unit process are considered in generally good condition based on external visual observations.

Performance. As shown by the data in Table 4-5, the UV system provides sufficient disinfection of the secondary effluent, with effluent fecal coliform numbers consistently below the NPDES limit.

4.3.3.2 Solids Stream Processes

The solids stream processes of the CKWWTP are described in the sections below.

4.3.3.2.1 Septage Handling Facilities

Description. Septage and sludge from Kitsap County's WWTPs in Manchester, Suquamish, and Kingston arrive at the plant in tank trucks. Each truckload undergoes preliminary testing prior to discharge. For all deliveries, the pH is measured and a sample is visually inspected by plant staff. Septage is accepted only from haulers registered with the County, and a plant operator must be present during delivery. If the pH is less than 6, the hauler is allowed to add lime to raise the pH. Sludge from the other treatment plants is transported by County staff.

Septage and sludge are discharged by gravity through a bar screen and into a 4,500-gallon pit. One 50 gpm Muffin Monster grinds rags and other solids, and transfers the influent to a 10,000-gallon sludge dilution tank. Process water is pumped into the dilution tank to dilute the solids concentration from approximately 2.75 to 0.5 percent. Aeration is provided in the dilution tank to reduce the septicity of this stream. Spent air is passed through a carbon filter prior to discharge to the atmosphere. The diluted sludge/septage is pumped to the gravity thickener control structure, where it is degritted by cyclone separators. The stream is then pumped to the thickener splitter box where it combines with the primary sludge and WAS and enters one of the gravity thickeners.

The amount of septage and liquid sludge hauled to the plant averaged 25,000 gpd in 1991, and currently averages closer to 12,000 gpd because much of the sludge from the other plants is now thickened. The existing quantity of septage and sludge received at the CKWWTP represents approximately 50 percent of the solids loading to the plant. The average concentration of solids in the septage is 2 percent. Sludge from Kingston and Manchester has an average concentration ranging between 3 and 4 percent solids. Sludge from Suquamish averages about 2 percent solids. In 2006, the average monthly solids loading from sludge and septage combined was approximately 60,000 pounds per month.

Performance. In general, the existing septage receiving station and associated facilities are inadequate to meet the current needs of the CKWWTP. This process has the following specific disadvantages:

- The station is under capacity. The capacity limitations are associated with the transfer of septage from the receiving pit to the sludge dilution tank. The existing 50 gpm Muffin Monster is undersized for the amount of septage being delivered in a given tank load, up to 200 gpm. With only one unit, no redundancy is available for maintenance.
- The process requires considerable maintenance. Solids accumulate in the receiving pit at a rapid rate. Solids accumulation necessitates weekly cleaning. Approximately 2 cubic yards of grit and debris are removed manually or by vactor truck, if available, each week. Between 35 and 50 cubic yards of solid material are manually removed from the sludge dilution tank each year. This high frequency and intensity of cleaning is time-consuming for plant staff.
- Odors from this area are severe. Discharge onto the bar screen exposes septage to the atmosphere under turbulent flow conditions. As a result, odor problems are significant.
- The process does not effectively remove debris. The existing septage receiving station does not provide adequate facilities for screening. Comminuted rags and other stringy material present in septage tend to accumulate in downstream processes, increasing wear on solids handling pumps and labor costs associated with more frequent cleaning and repair. Rags, plastic, and other debris are not removed by the existing process. These materials ultimately end up in the sludge, lessening the aesthetic appeal of a future composted product.
- The septage receiving station is poorly located. A steady stream of haulers arrive at CKWWTP and await their turn to discharge. The trucks form a queue on the main asphalt pad between the sludge processing and vehicle maintenance buildings, and along the central access road. Haulers must back into the discharge location, which blocks the south end of the "drive-through" truck bay of the sludge processing building. In general, the lineup and movement of these tank trucks interfere with plant operations.

Condition. Facilities at the receiving station are in fair condition. The large volumes of septage received at the CKWWTP are largely responsible for odor and corrosion problems associated with the gravity thickening process.

Current Status. A new septage receiving station is included in the 2009 Upgrade project, in conjunction with the new headworks. Construction is expected to be completed in 2011.

4.3.3.2.2 Scum Handling

Description. Scum from the primary and secondary clarifiers and the gravity thickeners is collected in sumps at each facility. The scum from the primary and secondary sumps is pumped directly to the digesters by a Marlo double-piston pump followed by a grinder. The thickener scum sumps operate in a similar manner, being serviced by two Moyno pumps and a grinder, one pump being a redundant pump, and pumping directly to the digesters. The primary and secondary scum sumps are pumped at least once per day.

Performance. The scum handling system is working well, although the primary and secondary clarifier scum sumps can sometimes become overloaded. More frequent scum pumping is used to mitigate those conditions rather than increasing the size of the sump.

Condition. The scum collection is generally in good working condition. By modifying operations to the current model, odors from the facility have been reduced relative to the original design.

4.3.3.2.3 Sludge Thickening

Description. Primary sludge is withdrawn from the primary clarifiers at a rate sufficient to maintain a concentration of less than 1 percent solids for optimum operation of the degritting equipment. The sludge is pumped with variable-speed primary sludge pumps in the aeration basin utilidor. Primary sludge is pumped to the cyclone degritter/classifier located between the two sludge thickeners. Degritted sludge is then injected with sodium hypochlorite for odor control (an optional step), and flows by gravity to the thickener control structure. Grit is washed and collected in a grit hopper for offsite disposal. The wash stream is routed back to the plant headworks.

Degritted primary sludge is combined with degritted septage sludge and mixed liquor, from the secondary process, at the thickener control structure, where sludge can be routed to either or both thickeners by gravity. The 45-foot-diameter thickeners operate in similar fashion to the main process clarifiers.

Thickener supernatant (effluent) is returned to the plant headworks downstream of the Parshall flumes. Provisions for scum removal are provided. The thickener mechanism speed is somewhat faster than clarifier operation, and the rakes extend a greater distance into the sludge blanket. The sludge withdrawal line is equipped with a sonic-type density meter and sludge grinder on the suction to the progressing cavity thickened sludge pumps. These 7.5 hp pumps are rated at 150 gpm capacity, and are located on the lower level of the digester control building. The sludge grinders are similar to the scum grinder, and provide a uniform consistency to the digester feed. The thickeners are provided with fiberglass covers and a ventilation system, which sends the foul air to the biofilter to reduce odors.

Performance. The sludge thickening system has performed as well as can be expected for gravity thickeners, producing thickened sludge at an average concentration of 3.1 percent solids. The system is currently near capacity and would be easily overloaded by large increases of grit arriving at the plant during the first few storms of the winter. This condition can lead to unacceptable amounts of grit entering the digesters. Currently, a significant quantity of odorous foul air is removed from these thickeners and treated in adjacent biofilters. This, coupled with the current design of the fiberglass domed covers, creates an extremely corrosive atmosphere within the gravity thickeners, making it difficult to adequately operate and maintain these unit process vessels.

Condition. The concrete tanks for this unit process are considered in generally good condition based on external visual observations. The gravity thickeners are operating at or near capacity, which has led to deterioration in the thickening performance. Currently the gravity thickeners receive both primary sludge and WAS. The reduction in the hydraulic load to the gravity thickeners by diverting WAS to a future separate thickening system (e.g., gravity belt thickeners [GBTs]) should allow continued future operation and extend the service life of the gravity thickeners at the facility.

4.3.3.2.4 Sludge Digestion

Description. The plant has two 65-foot-diameter, fixed-cover digesters with a side water depth of 26 feet (645,389 gallons each). They provide anaerobic digestion of an average of 22,000 to 44,000 gpd thickened sludge to reduce the volatile solids (VS) concentration of the sludge such that Class B biosolids requirements are met for both pathogen reduction and vector attraction. Current average solids loading to the digestion system is approximately 9,335 pounds VS per day. The digesters are designed such that they can be run either in series or in parallel, with the current operation being parallel.

Thickened combined sludge of approximately 3.1 percent solids is withdrawn from the gravity thickeners by two 150 gpm progressing cavity pumps. The raw solids are loaded to the east and west digesters. Piping flexibility is provided to allow sludge to be fed to or withdrawn from the digesters at various levels. Another pair of 150 gpm progressing cavity pumps is provided in the digester building to transfer solids to the centrifuge for dewatering.

A high volume internal mixing system is provided in the digesters, using centrifugal recirculation pumps rated at 4,400 gpm capacity to keep digester contents in uniform suspension. These pumps take suction from a central draft tube at mid level and discharge through two nozzles located opposite each other and about 5 feet above the digester floor. An additional nozzle is located near the top of the digester to assist in breaking/preventing scum blanket formation.

The digesters are maintained at mesophilic temperatures, about 95ºF, as part of the Class B biosolids requirements. The digesters are heated by hot water from the boiler system by circulating sludge through spiral heat exchangers using recessed-impeller centrifugal pumps rated at 250 gpm capacity. Hot water for the digester heat exchangers and plant space heating is supplied by two low-pressure boilers on the upper level of the digester building. The boilers are normally fueled with fuel oil.

Under parallel operation, the digesters have an average solids detention time of 34 to 37 days. This mode of operation provides sufficient detention time without hydraulically overloading the digester. Digester gas resulting from anaerobic decomposition is currently all flared in the waste gas burner.

Performance. The anaerobic digesters are currently operating near capacity. The system is limited by its hydraulic capacity, and taking one unit out of service for cleaning or maintenance is not possible during all times of the year unless provisions are made for liquid sludge to be hauled from the facility for disposal. Each digester currently treats an average of 21,000 to 22,000 gpd of thickened raw sludge, resulting in an average sludge retention time (SRT) of 34 to 37 days. Although these current operating conditions meet the requirements for Class B biosolids, they limit process flexibility. If one unit is taken out service, the average SRT decreases to 16 to 17 days under average annual conditions, just above the EPA minimum for Class B biosolids (15 days without mandatory coliform testing). However, two additional flow and loading scenarios (maximum month scenario and peak 14-day scenario) must be examined to determine the regulated capacity of these digesters. For maximum month conditions and peak 14-day load with one unit out of service, total flows to the digesters are approximately 43,000 gpd and 61,000 gpd, respectively. These correspond to SRTs of 15 and 10.5 days at maximum month and peak 14-day loading conditions, respectively. Therefore, under peak 14-day flow and load condition with one digester out of service, the digestion system will not meet the definition of a process that significantly reduces pathogens (PSRP) according to the EPA. As the peak 14-day flow and load most closely represents the condition under which the running average SRT will deviate below the defined minimum for PSRP (15 days), it is used as the process limiting condition in this evaluation. A more detailed discussion of the need for additional digestion capacity is discussed in Section 4.3.4.

Under current operating conditions the digesters on average reduced the VS concentration by 57 to 65 percent. The reduction in VS results in an average biogas production of 105,800 cubic feet per day, with an average biogas composition of 33 percent carbon dioxide and 66 percent methane.

The digesters have experienced some foaming/scum events that penetrated the oakum seal around the fixed cover, resulting in a loss of material. Retrofits or replacement of the oakum seal will be investigated at a future date to provide a better seal on the fixed-cover digesters.

Condition. Overall, the digesters are in adequate physical and operating condition; however, they have insufficient capacity to accommodate acceptable operation and maintenance (O&M) standards for cleaning and emergency repair. The leakage from the oakum seals on the fixed cover will need to be addressed to improve odor control and ease of operation. The boiler system needs to be replaced so that biogas can be used as fuel rather than heating oil, which should significantly reduce the operating costs of the facility. The waste gas burner was recently replaced and is in satisfactory working order.

4.3.3.2.5 Sludge Dewatering

Description. Digested sludge is pumped to the sludge processing building, where it is prepared for dewatering first by first grinding, and then by conditioning it through the addition of a polymer. This polymer aids in the removal of water. The conditioned sludge is then fed to the centrifuge for dewatering. The dewatered cake exits the centrifuge through a chute to a truck located in the bay below. The plate and frame press remains in place, but is not used because centrifugal dewatering is much more efficient. The plate and frame press essentially serves as a redundant dewatering unit should the centrifuge be taken out of service for a significant period of time.

Performance. The centrifuge is a relatively new unit and is in very good operating and physical condition. The performance of the centrifuge is such that another unit will replace the plate and frame press in the future.

Condition. The centrifuge is in good operating and physical condition and currently meets the dewatering requirements of the plant. The plate and frame press currently serves as a redundant dewatering unit for the facility. However, the age of the unit—and the fact that it has been discontinued by the manufacturer, resulting in difficulty finding parts—are liabilities. The plate and frame press will be replaced in the future by another centrifuge as loadings dictate.

4.3.3.2.6 Grit Removal Facilities

Description. Two sets of cyclone separators and classifiers are used to remove grit from the primary sludge and septage. The degritting facilities are located in the gravity thickener control structure between the gravity thickeners. Each of the cyclones has a capacity of 200 gpm. A total of approximately 5 cubic yards of grit are removed from these process streams each week and collected in the plant waste dumpster.

Performance. The grit removal equipment is performing adequately. No maintenance concerns were expressed by plant staff. The grit is not washed prior to collection and disposal; this condition may contribute to odor problems near the plant dumpster. Odor is a major problem at the sludge junction structure near the thickeners.

Condition. The grit removal equipment is approximately 15 years old. The cyclone and classifier for septage degritting are in relatively good condition. However, the cyclone and classifier for sludge degritting are severely corroded and should be replaced.

4.3.3.3 Ancillary Plant Systems

Ancillary plant systems of the CKWWTP are described in the sections below.

4.3.3.3.1 Instrumentation and Controls

Description. The existing plant control system comprises two different programmable logic controller (PLC) types: Allen-Bradley SLC 500 series and Texas Instruments (Siemens) 505/545 series. Each main controller (designated PLC 7105 and 2984, respectively) has a series of input/output (IO) modules and remote IO (RIO) connected, and the controllers are connected to each other using hardwired interlocks.

RIO for PLC 7105 is distributed throughout the sludge processing building motor control centers (MCCs) and PLC 2984 has RIO distributed throughout the blower and digester buildings. Additional hardwire interlocks to PLC 3000 (UV system), and centrifuge and polymer systems complete the integration of the plant controllers.

Interfacing the controllers with the plant operators, the human-machine interface (HMI) computers running Wonderware's InTouch software are located in the sludge processing building on the first and second floors. The second floor serves as the main plant control room, with a supervisory control and data acquisition (SCADA) master database residing on the workstation. The second floor is also the physical location of the lift station telemetry system. The HMI computers consist of several customized screens used for monitoring and controlling equipment connected to the PLCs.

The SCADA network is a multi-tiered, multi-protocol network used to gather information from each PLC and RIO drop, and pass the information to the master HMI. Most of the network consists of copper wiring; however, a short run is three-pair multi-mode fiber from the point-of-presence (POP) of the County network in a closet adjacent to the east laboratory, to the second floor in the process building. This protocol is Ethernet/TCP. The other networks are Ethernet to PLC 7105, RS-232, RS-422, and Allen-Bradley's proprietary Data Highway Plus (DH+). In addition to these networks, PLC 2984 has a proprietary network presently in use for communication to its RIO.

Distributed throughout the plant are a variety of instruments, motor controllers, valves, and other miscellaneous items. Many of these are connected to the PLCs in one form or another, and they allow the system to intelligently control the flow and treatment of wastewater through the plant. Variable-frequency drives (VFDs) are connected to some motors to allow finer control of motor outputs, which allows pressures or flows to be set more precisely. These drives also allow motors to operate more efficiently, using only the amount of power needed to accomplish the equipment's function under varying load conditions.

Condition. The existing SCADA system has deficiencies requiring repair, and is currently exposed to Internet and internal hackers through the existing connection to the County network. Upgrades to the existing system are recommended because equipment having reached end-of-life is prone to unexpected failure and could cause loss of data or plant control. For example, if the HMI workstation fails, which is common in computers of that era, the entire control system is only operable in manual mode until the workstation can be restored to operation. The cost impact of not implementing these upgrades could be thousands of dollars in unexpected overtime and emergency equipment expenditures.

4.3.3.3.2 Potable Water

Potable water is supplied to the plant from the North Perry Water District through an 8-inch-diameter water line that enters the plant near the northeast corner. The supply is metered, passed through a reduced pressure backflow preventer, and then split to two plant fire hydrants and a circulation loop to the plant buildings.

4.3.3.3.3 Process Water

The process water system supplies chlorinated secondary effluent throughout the plant for hose bibs, irrigation, aeration basin foam sprays, and similar uses. A portion of the secondary effluent from the UV effluent structure is injected with sodium hypochlorite and then conveyed to the utilidor, where the process water pumps are located. Process water is pumped using three pumps: two constant-speed pumps and one with a VFD. The VFD pump is dedicated to the sludge filter press feed pumps, and the other two pumps serve the remaining facilities at the plant. Each pump is rated at 350 gpm. The pump discharge is equipped with automatic self-cleaning strainers and a 6-inch-diameter propeller meter.

The existing process water pumps will not have adequate capacity for the future process water requirements. Therefore, new pumps will be required in the next plant expansion.

4.3.3.3.4 Communications

A new intercom system was installed in 1993. The plant operators generally use portable radios for most site communications.

4.3.3.3.5 Electrical System

The plant receives its primary electrical supply from Puget Sound Energy. The plant is served by a 12.47/7.2-kilovolt (kV) line, which enters the plant adjacent to its entrance and SR 303. Power is metered by Puget Sound Energy at the 12.47 kV primary service level at a metering pedestal located at the plant entrance. The incoming 12.47 kV service conductor is routed to the plant service entrance equipment located on the north side of the administration and laboratory building. The service entrance equipment consists of two fused load interrupter switches. One switch serves a 112-kilovolt-ampere (kVA) transformer for the administration and laboratory building. The other switch is for a feeder to switchgear (SWGR 2950) located north of the standby power generators. SWGR 2950 consists of two fused load interrupter switches that supply a pair of 2,000 kVA transformers. These transformers supply a switchboard (SWBD 2960) that provides 480-volt power distribution to the rest of the plant facilities. From SWBD 2960, power is distributed to plant MCCs in the power blower, sludge processing, and digester buildings.

Backup for the Puget Sound Energy supply is provided by 500- and 600-kilowatt (kW) diesel-powered, standby generators. These generators have sufficient capacity to meet the primary power needs of the existing essential plant components. Automatic transfer circuit breakers contained within SWBD 2960 transfer the power supply between the utility and standby generators during power interruptions. Plant loads are presently controlled to automatically sequence online following a power outage in a manner that allows ramping of load onto the generators. This sequential loading is accomplished through the SCADA/PLC system. The history of power outages indicates that the plant experiences an average of four 4-hour power outages per year, and one 24-hour outage approximately every 2 years. In 1990, the plant was operated on standby power for 1 week as a result of a severe windstorm that affected the entire central Kitsap County area. The plant more recently operated for an extended period on standby power after a December 2006 storm.

A dual-feed power distribution system is provided for supplying SWBD 2960 and all of the MCCs from SWBD 2960. SWBD 2960 is configured with a normally open tie breaker, which divides the switchboard. The automatic transfer circuit breakers can be manually configured to have either of the 2,000 kVA transformers supply the entire switchboard. When utility power is not available, the tie breaker is normally open, and one standby generator is connected to each side of the switchboard. In the event that one of the standby generators is not able to operate, the transfer circuit breakers and tie breaker can be manually configured to have either of the standby generators supply the entire switchboard. When the tie breaker is closed, caution must be exercised to ensure that the transformer or standby generator supplying the entire switchboard is not overloaded. Each MCC fed from SWBD 2960 is supplied with a feeder from one side of the switchboard and has a secondary supply from an MCC that is fed from the other side of the switchboard, resulting in a dual feed for each MCC. The dual-feed power distribution system allows the distribution of power to continue during routine maintenance and inspection of electrical equipment as well as in the event of equipment failure.

The administration and laboratory building is normally powered from the 112 kVA transformer located in the service entrance switchgear, SWGR 1. A limited-capacity standby power feed from MCC 2972 in the power/blower building is routed to the manual transfer switch at the administration and laboratory building.

In the event of a utility power loss, the manual transfer switch can be used to switch standby power to the administration and laboratory building distribution panels.

Nine MCCs are located throughout the CKWWTP:

- MCC 2 is located in the digester building.
- MCCs 2981, 2982, 2983, and 2984 are located in the sludge process building and serve that location.
- MCCs 2971 and 2972 are located in the power/blower building and serve the aeration, utilidor, and secondary clarifiers.
- MCCs 2973 and 2974 are located in the power/blower building and serve the UV system and heating, ventilation, and air conditioning (HVAC) loads.

4.3.3.3.6 Heating, Ventilating, and Air Conditioning Systems

Plant heating is provided through a hot water circulation system, with heat supplied by boilers in the digester building. Hot water is circulated to the plant buildings by eight circulation pumps, ranging in capacity from 8 to 250 gpm. All of the buildings are equipped with separate space heaters and thermostats.

Ventilation is provided by exhaust fans in the digester and sludge processing buildings. A forced-air heat recovery unit is provided in the administration and laboratory building.

4.3.4 Overall Plant Assessment and Trigger Points for Expansion

The CKWWTP is currently operating within its NPDES discharge permit limitations. Effluent quality has been satisfactory. Currently, the most pressing capacity and/or operational issues are related to the deteriorated performance of the aeration diffusers, the limited capacity of the anaerobic digesters, and the need to identify a long-term biosolids disposal option.

Table 4-6 compares the existing plant design values against the 2006 actual flows and loads. The analysis suggests that while the plant may have a reasonable level of excess hydraulic capacity, its current loadings are approaching the design capacities. A more detailed evaluation of the individual unit process capacities has been conducted to determine the maximum capacity at the plant as a whole and resulting expansion needs. This more detailed evaluation is shown in Appendix 4C.

Table 4-6. CKWWTP Estimated Plant Remaining Capacity

Process element	Units	Existing design capacity [a]	2006 actual loads	Remaining capacity
Raw sewage flow				
AAF	mgd	4.6	3.9	0.7
ADF	mgd	6.0 [c]	5.1	0.9
PDF (hour) [b]	mgd	15.0	11.8	3.2
Raw sewage BOD_5 loadings				
Annual average	ppd	8,403	8,738	-335
Average peak month	ppd	14,100	9,877	4,223
Raw sewage TSS loadings				
Annual average	ppd	8,844	7,430	1,414
Average peak month	ppd	11,400	9,080	2,320

a. Existing design values correspond to design flows and loads for 1995–96 upgrade, except for peak month TSS and BOD loadings, which correspond to the design loadings shown in the current NPDES permit.

b. Instantaneous flows are recorded on circular pen charts. The maximum recordable flow rate is 11.8 mgd. Any actual flow rates that exceed 11.8 mgd are recorded as 11.8 mgd. From 2002 to 2006, peak flow rates were at or above 11.8 mgd for an hour or longer on five occasions.

c. 7.0 for secondary system only.

Per Ecology requirements, treatment plants must start planning for the next phase of plant expansion whenever 3 consecutive months of average monthly flows exceed 85 percent of the plant rated ADF capacity. The current rated ADF plant capacity for the CKWWTP is 6 mgd and the 85 percent trigger point is approximately 5.1 mgd. A projection of 3-month consecutive flow averages for the CKWWTP is shown in Figure 4-10.

The data in this figure indicate that the next round of general plant expansion planning (based on a simple comparison to the existing plant capacity rating as determined by Ecology) is nominally triggered in 2011. This is based upon a compound growth rate of 2.39 percent calculated from the existing (2005) annual average flow of 3.63 mgd and the projected 2030 annual average flow of 6.56 mgd. This Facility Plan itself addresses plant expansion planning at a schedule consistent with that shown on Figure 4-10. From this approach, the new treatment expansion would need to be in service by 2018, depending on actual observed flow increases. However, it is too simplistic to expand the entire plant upon achieving a single flow-based trigger. Ecology requires that individual treatment processes be shown to be expanded as needed. As explained in the following sections, plant expansion planning has already started and recommendations for expansion of specific treatment processes are identified. A further discussion of this information related to 3-month consecutive flow projections are contained in Appendix 7B.1.

However, it is important to note that the suggested plant expansion timing information contained in Figure 4-10 is based solely on a comparison of plant flow projections against the current plant rated capacity of 6.0 mgd. It is common for plants to be re-rated at higher capacities given sufficient engineering analysis and subsequent acceptance by Ecology. In fact, this re-rating process has already been accomplished for the secondary treatment system at the CKWWTP, in which the rating for this process has been officially increased by Ecology from 6.0 to 7.0 mgd. With this approach, specific unit treatment processes can be expanded at different schedules, based on a comparison of their projected loading rates to Ecology-accepted maximum unit loading rate criteria or results of process modeling analyses. This more detailed comparison of individual unit process loading projections versus maximum operating limits is shown in Appendix 4C.

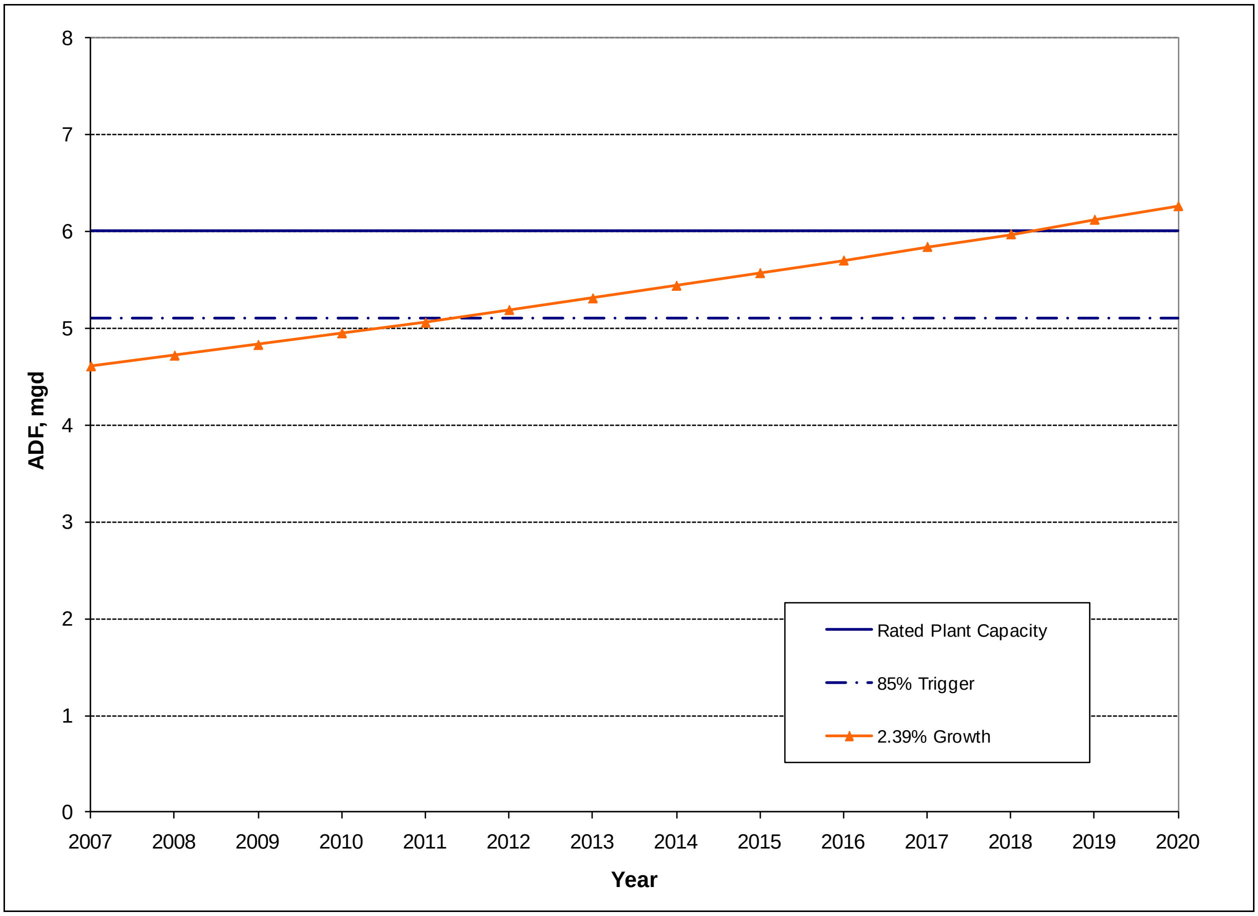

Figure 4-10. Trigger point for nominal hydraulic capacity expansion at the CKWWTP based on the current plant capacity rating

By using this approach, specific unit processes may be re-rated to identify specific projected dates when these processes must be expanded. Two different scenarios were evaluated with respect to the plant configuration. In the first scenario, considered the base case, the existing plant configuration was assumed. In the second scenario, a new GBT is assumed to be included for WAS thickening. Addition of the GBT reduces the water content of WAS and greatly increases the hydraulic capacity of the digesters. In addition, it was also assumed that the aeration diffuser membranes will be replaced with new membranes. For the purposes of this Facility Plan, these two assumed new improvements were considered the most critical in terms of their impact on plant capacity. They are fully described and evaluated in the *Engineering Report and Basis of Design for Central Kitsap Wastewater Treatment Plant Phase III Expansion* (Brown and Caldwell, November 2007).

From Appendix 4C, a summary of the expansion needs of each major unit treatment process per these two scenarios is developed in Table 4-7.

Table 4-7. CKWWTP Unit Process Projected Expansion Timing [a]

Unit treatment process (limiting criterion)	Year when capacity is reached: Scenario 1 (existing configuration)	Year when capacity is reached: Scenario 2 (new GBT and aeration diffusers)
Primary clarifier (surface overflow rate)	2023	2023
Aeration basin channels (hydraulic loading)	>2030	>2030
Aeration air blowers (capacity)	>2030	>2030
Secondary clarifiers (solids loading rate)	2019	2021
UV inlet channel (hydraulic loading)	>2030	>2030
UV channel (effluent weir hydraulics)	>2030	>2030
Gravity thickeners (solids loading rate)	>2030	>2030
Digester (hydraulic retention time: 1 unit) [b]	Already exceeded [c]	2025
Digester (hydraulic retention time: 2 units) [b]	2027	>2030
Centrifuge (operating schedule) [d]	2013	>2030

a. Based on partial summer nitrification only.

b. Based on the criterion of a 15-day hydraulic retention time.

c. To meet the 15-day hydraulic retention criteria, both digesters must be kept in service at all times with the existing thickening scheme.

d. Based on one shift per day, weekdays only. Additional hours of operation will be needed for Scenario 1 to dewater biosolids.

The most immediate key unit processes that should be expanded and upgraded or added in the next plant expansion program include the following:

- aeration diffusers (replace existing)
- gravity belt thickeners (new)

The timeline for improvements suggested by Figure 4-10 and Table 4-7 will be used as the basis for the analysis of alternative future upgrades, which is presented in Chapter 8.

4.4 Outfall and Diffuser

A 36-inch-diameter outfall pipeline conveys treated effluent approximately 3,500 feet from the CKWWTP to a 30-inch-diameter submarine pipeline and diffuser section. The submarine portion of the outfall consists of a 3,170-foot section of 30-inch-diameter ductile iron pipe with Class 50 Tyton fittings. The discharge location is approximately 3,170 feet offshore in the northern section of Port Orchard Passage. The diffuser section is 120 feet long and 30 inches in diameter. Discharge occurs at a depth ranging from 41.2 feet at mean lower low water (MLLW) to 52.9 feet at mean higher high water (MHHW), with an average depth of 47.8 feet at mean tide level (MTL). The diffuser is oriented perpendicular to the prevailing north-south currents, at latitude 47° 40' 35", longitude 122° 36' 05", with the centerline of the diffuser oriented at about 65 degrees (true north). The diffuser has twelve 5-inch-diameter ports, spaced in an alternating pattern, with six ports spaced 10 feet on center on each side.

The Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A) discusses the requirements for discharge of treated wastewater. Ecology specifies the geometry of the chronic and acute mixing zones in the NPDES permit as 602 by 482 feet, and 168 by 48 feet, respectively, where the first dimension in each case represents the width of the mixing zone perpendicular to the shoreline and the second dimension represents the length parallel to the shoreline. Concentrations of priority pollutants and toxics are to be diluted to or below WAC 173-201A standards outside these mixing zone boundaries. A recent sediment study (*Sediment Characterization Report for Kitsap County Public Works,* GeoEngineers, Dec. 27, 2010), conducted in compliance with these regulations, evaluated the area around the discharge pipe. No negative impacts were discovered within the sediments surrounding the outfall.

An outfall evaluation was conducted in 1996 and summarized in the *Central Kitsap Wastewater Treatment Plant Outfall Evaluation Report* (Brown and Caldwell, December 1996). A more recent evaluation was conducted in 2006 to reflect current design flows (as shown in Table 4-3) and modified requirements from Ecology, summarized in the letter report titled *Central Kitsap WWTP Dilution Analysis* (October 2006). The 1996 study recommended inspection of the on-land and offshore portions of the outfall to ensure structural integrity (e.g., restrained joints on marine section) and that minor modifications be made to the diffuser to improve dilution for the future design flows. The 2006 evaluation, conducted based on current design flows, predicted the worst-case effluent dilution ratios of 47:1 and 84:1 at the acute and chronic mixing zone boundaries, respectively, based on aquatic life criteria. The worst-case dilution ratio based on human health (carcinogen) criteria was predicted to be 91:1. The results of this study were incorporated into the current NPDES permit. Based on the results of the dilution study and reasonable potential calculations performed by Ecology, no contaminant approached the maximum allowable limit at the current design flows.

Using the 2030 projected flows, the worst-case effluent dilution ratios were predicted to drop to 31:1 and 79:1 at the acute and chronic mixing zone boundaries, respectively, based on aquatic life criteria. The worst-case dilution ratio based on human health (carcinogen) criteria was predicted to drop to 82:1. These ratios are noticeably lower than the ratios corresponding to the current design flows given above. Any potential future effluent nutrient limits will most likely be attributed to ammonia toxicity as the plant flow increases and the corresponding dilution ratios decrease. Potential effluent ammonia requirements will be determined by Ecology in a reasonable potential analysis during the next permit cycle. Historical plant effluent ammonia data and projected plant flows for the next 5 years will be used as inputs to the analysis. Based on results from the last reasonable potential analysis conducted for the current NPDES permit, any ammonia limit will likely be due to exceedance of the chronic exposure threshold rather than to the acute threshold.

Besides ammonia toxicity, the CKWWTP may also be subject to effluent total inorganic nitrogen limits. As part of the ongoing *South Puget Sound Dissolved Oxygen Study*, Ecology is evaluating nitrogen contributions from WWTPs discharging into the south and central Puget Sound. The results so far show that CKWWTP is considered a second-tier discharger (in terms of daily nitrogen loads). Depending on whether reduction in nitrogen loads from the first-tier dischargers is adequate to improve the water quality, nitrogen limits might be imposed on the CKWWTP. If CKWWTP is upgraded to provide reclaimed water, it will likely also comply with any potential future nitrogen limits due to the improved effluent water quality and reduced effluent discharge into Puget Sound.

The land-based portion of the outfall at the treatment plant site was identified in the 1994 Facilities Plan to have hydraulic limitations to handle future flows. Results of the 1996 outfall evaluation indicated that the diffuser and outfall have adequate hydraulic capacity to convey a PDF of 29.3 mgd. However, depending on the exact location of the new digesters in future plant expansion, the existing 36-inch-diameter pipe located south of the existing digesters may need to be replaced, along with a new effluent junction structure. If this 36-inch-diameter pipe is to be replaced, it will be made larger (72 inches in diameter) than the existing pipe to accommodate future flows. This new 72-inch-diameter outfall pipe segment would connect to an existing 72-inch-diameter pipe stub located east of the UV channels.

CHAPTER 5

REGULATORY REQUIREMENTS AND OTHER DRIVERS IMPACTING THE FACILITY PLAN

Just as the planning area, wastewater characteristics, and existing wastewater system all guide the key criteria by which project alternatives are evaluated in this Facility Plan, various regulations, policies, and other drivers play an important role in this process. Numerous federal, state, regional, and local regulations, laws, plans, policies, and programs affect the design, construction, and operation of wastewater facilities in Kitsap County.

Kitsap County, in conjunction with its consultants, has developed this Facility Plan to meet applicable laws, plans, and policies. These regulations and other drivers are subject to change over time; the evaluations in this chapter are based on those in effect at the date of publication of this Facility Plan. This chapter summarizes various regulations, policies, and drivers that relate to wastewater planning; it represents the major laws, plans, and policies applicable to wastewater planning; however, it is not intended to be an exhaustive list.

5.1 Overview of Chapter Contents

This chapter provides a summary of the leading regulations, policies, and drivers affecting wastewater planning, including federal, state, and local requirements. The first part of this chapter is devoted to the most significant federal requirement for wastewater treatment, the NPDES permit, which sets the necessary conditions for wastewater treatment compliance. Other federal, state, regional, and local regulations and programs affecting collection and treatment systems, including those related to biosolids, nitrogen concentrations, reclaimed water, and GHGs, are also discussed in this chapter and in Appendix 5A.

5.2 Federal Requirements

A few of the most significant federal requirements impacting this Facility Plan are described in the following section.

5.2.1 NPDES Permit

In general, the discharge of any wastewater, except domestic wastewater going to a municipal treatment plant, requires a wastewater discharge permit. The discharge of pollutants into the state's surface waters requires an NPDES permit. Discharges to groundwater and industrial discharges to a municipal treatment plant require a state wastewater permit. A discharge permit also may be required for stormwater from industrial and construction sites and some municipal sites.

The EPA has authorized Ecology to administer the wastewater discharge program in Washington State. RCW Chapter 90.48 defines Ecology's authority and obligations in administering the wastewater discharge permit program. The regulations adopted by Washington State include procedures for the following:

- issuing permits (WAC 173-220)
- technical criteria for discharges from municipal wastewater treatment facilities (WAC 173-221)
- water quality criteria for surface water and groundwater (WAC 173-201A and 173-200)

- sediment management standards (WAC 173-204).

These regulations establish the NPDES permitting system and are the basis for effluent limitations and other requirements to be included in the permit.

An individual NPDES permit from Ecology is required for wastewater discharges to surface waters from a municipal sewage treatment plant. An NPDES permit typically places limits on the quantity and concentration of pollutants that may be discharged. An NPDES permit also includes monitoring schedules and reporting to verify that the treatment process is functioning correctly and that the effluent limitations are being achieved. The NPDES permitting process includes public review and comment on a draft permit before the final permit can be issued.

CKWWTP is a conventional activated sludge (CAS)-type, secondary treatment system. The disinfected secondary-treated effluent is discharged to Port Orchard Bay, which is designated as a Class AA Marine Water in the vicinity of the outfall. An NPDES permit is required for discharge into Port Orchard Bay.

The dewatered sludge from the CKWWTP is transported by truck to Fire Mountain Farms in Chehalis, Washington, for land-application and in 2010 a portion of the biosolids started to be trucked to EMU Composting facility in Hansville, Wash., for producing compost material. The CKWWTP currently has no discharge to groundwater and therefore no limitations are required based on potential effects to groundwater.

NPDES Permit WA-003052-0, the current permit for the CKWWTP, became effective on June 1, 2007, and expires on May 31, 2012. This permit is the basis for the design in this Facility Plan and is shown in Appendix 4A and the associated Fact Sheet is shown in Appendix 4B. The current effluent limitations in the NPDES permit are provided in Table 4-4.

As shown in Table 4-4, the current NPDES permit for the CKWWTP does not include any limitations on ammonia. In the future, Ecology may limit ammonia because of potential total maximum daily load (TMDL) requirements. The TMDL is the maximum amount of a pollutant that can be discharged to the water body in a 1-day period without violating the water quality standard for that pollutant. TMDLs can be implemented through NPDES permits for discharges to that water body. Potential NPDES-driven limitations on ammonia for the CKWWTP, if any, likely would occur in the future NPDES permit cycle, possibly starting in 2017.

The NPDES permit is based on the flow or waste loadings at the treatment plant. The flows for the CKWWTP shall not exceed the loadings shown in Table 4-4.

An NPDES permit may include both general and special conditions. Special conditions are specific to the site and the treatment plant, and consider the water quality of the receiving waters. The key conditions in the NPDES permit for the CKWWTP are briefly identified below:

- **Discharge limitations:** The effluent limitations are provided in Table 4-4. The discharge limitations also specify the dilution ratios and maximum boundaries of the mixing zones.
- **Monitoring requirements:** The NPDES permit includes the monitoring schedule and sampling and analytical procedures.
- **Reporting and recording requirements:** Kitsap County is required to monitor and report in accordance with the conditions in the permit. Monitoring results shall be submitted monthly on Ecology's Discharge Monitoring Report form.
- **Facility loading:** The flows or waste loading for the CKWWTP are shown in Table 4-4.
- **Operation and maintenance:** Kitsap County must institute an O&M program for the entire sewage system. The O&M program includes operator certification, adequate laboratory controls, appropriate quality assurance procedures, and operation of backup or auxiliary facilities.

- **Residual solids:** Kitsap County must store and handle all residual solids in a manner designed to prevent their entry into state groundwater or surface waters. The NPDES permittee shall not discharge leachate from residual solids to state groundwater or surface waters.
- **Pretreatment:** All commercial and industrial users of the CKWWTP must comply with the pretreatment regulations and obtain applicable discharge permits. The plant receives discharges of pretreated industrial wastewater from the Bangor and Keyport naval bases, both of which are regulated under state waste discharge permits issued by Ecology.
- **Acute toxicity:** The effluent limit for acute toxicity is "no acute toxicity detected" in a test concentration representing the acute critical effluent concentration (ACEC). The NPDES permit also includes monitoring and reporting requirements for acute toxicity.
- **Chronic toxicity:** The final effluent must be tested twice during the permit term. The NPDES permit specifies the species and protocols for the chronic toxicity tests.
- **Sediment monitoring (marine):** The permit conditions include a sediment sampling and analysis plan for sediment monitoring in the vicinity of the discharge location. The purpose of the plan is to re-characterize the nature and extent of biological toxicity and/or chemical contamination in the vicinity of the discharge location.
- **Outfall evaluation:** Kitsap County must periodically inspect the submerged portion of the outfall line and diffuser to document its integrity and continued function.

5.2.2 Biosolids Regulations

All WWTPs produce sludges as part of the treatment process (typically primary and secondary sludges). As required by the Clean Water Act amendments of 1987, EPA developed a regulation governing certain pollutants present in biosolids. This regulation, *The Standards for the Use or Disposal of Sewage Sludge* (Title 40 CFR Part 503) is often referred to as the Part 503 Rule. In Washington State, Ecology prefers that utilities beneficially reuse wastewater sludges for their organic and nutrient content (phosphorus and nitrogen), rather than disposing of them in a landfill. The most common method of beneficial use in the state of Washington is land application.

Prior to land application solids must be stabilized to one of two quality levels, Class A or Class B; the only difference is the pathogen content within the solids. Class A solids have the lowest pathogen content and when criteria metals limits are met they are termed exceptional quality and can be given away to the public without restriction. Class B biosolids have a higher pathogen content than Class A and cannot be given directly to the public but are suitable for land application at permitted sites. Class B biosolids are the most common biosolids product produced in Washington.

The CKWWTP currently produces a Class B biosolids product and will continue to do so under the planned expansion, as there is currently no significant demand for a Class A biosolids product in the region. However, facilities will be designed to be upgradable or expanded to produce a Class A product if market or regulatory conditions shift. By taking the retrofit approach the County can monitor any regulatory changes and technology developments over time and select the one that best fits the new condition, rather than speculating at this time.

5.3 State Requirements

Kitsap County is bound by numerous other federal, state, regional, and local permits, procedures, and regulations that govern its O&M of wastewater collection and treatment systems. A discussion of these pertinent other permits and regulations is provided in Appendix 5A.

5.3.1 Ecology Review of *Central Kitsap County Wastewater Facility Plan* (Engineering Report/Facility Plan)

According to RCW 90.48, all engineering reports, facility plans, construction plans, and specifications for new construction, improvements, or extensions of existing sewerage systems, sewage treatment, or disposal plants or systems shall be submitted to and approved by Ecology before construction may begin. In general, this review is intended to ensure that facilities proposed to be designed, constructed, operated, and maintained will meet the applicable state requirements to prevent and/or control pollution of state waters.

This plan will first be approved by Kitsap County as part of the capital facilities element of its Comprehensive Plan. The Kitsap County Comprehensive Plan is discussed in Appendix 5A. The final Facility Plan must comply with Ecology regulations for facility plans (WAC 173-240-060). Ecology is expected to review the final Facility Plan in 2011. The requirements for an engineering report are specifically structured for projects that are funded only through local funds or by state funding programs. If a project is to be considered eligible for funding by the EPA, then additional requirements are imposed in this document to conform to a facility plan. A facility plan must also follow the guidelines contained in the EPA publication, "Guidance for Preparing a Facility Plan" (MCD-46), and shall indicate how the special requirements contained in 40 CFR 35.719-1 will be met. One fundamental additional requirement of a Facility Plan is that a discussion of treatment alternatives must be included to document that the most cost-effective solution has been recommended. This document meets the requirements for both a facility plan and an engineering report.

Ecology administers the primary funding programs for planning, design, and construction of domestic wastewater facilities. These two programs are the Centennial Clean Water Fund Program (Centennial) and the Washington State Water Pollution Control Revolving Fund Program (SRF).

5.3.2 State Environmental Policy Act Regulations

SEPA provides a way to identify possible environmental impacts that may result from governmental actions. These decisions may be related to issuing permits for private projects, constructing public facilities, or adopting regulations, policies, or plans. SEPA review is not a permit; it is a process that helps agency decision-makers, applicants, and the public understand how a proposal would affect the environment. This information can be used to change a proposal to reduce potential impacts or to condition or deny a proposal when adverse environmental impacts are identified.

SEPA applies to all levels of state and local government. Kitsap County has adopted its own SEPA regulations in Kitsap County Code (KCC) Chapter 18.04, which generally follows the Ecology SEPA regulations in WAC 197-11. For most projects proposed by the County under the Facility Plan, Kitsap County would be the lead agency under SEPA and would be responsible for completing SEPA review under the County SEPA policies and regulations.

Any proposal that requires a local agency to license, fund, or undertake a project, or the proposed adoption of a policy, plan, or program, could trigger environmental review under SEPA. A proposal with potential significant adverse environmental impacts could require an environmental impact statement (EIS). Proposals without significant impacts likely would require a determination of nonsignificance (DNS) and accompanying environmental checklist. SEPA review includes both preparing environmental documents and public review, the extent of which depends on the location, magnitude, and potential impacts of the proposal. The overall SEPA process is similar to environmental review under the federal National Environmental Policy Act (NEPA) program.

Adoption of the Facility Plan will require SEPA review by Kitsap County prior to its approval by Ecology. The plan would be a non-project action under SEPA, and a non-project or programmatic SEPA document will be prepared concurrently with the plan. Individual capital improvement projects prescribed in the plan would undergo SEPA review at the time they are designed and permitted. If federal funding or permits were required, review under NEPA also may be required.

All projects financed through the federal Clean Water Act-State Revolving Fund (CWA SRF) program administered by Ecology are subject to the State Environmental Review Process (SERP). Ecology has developed a SERP process for the state of Washington that has been approved by EPA. Both NEPA and SEPA are satisfied for SRF projects if a project proponent meets the requirements of SERP.

5.3.3 Removal of Inert Materials from Biosolids

The purpose of the regulation governing the requirement to significantly remove manufactured inerts from biosolids is to ensure that biosolids are fundamentally more aesthetically acceptable to the end user. This regulation controls the size and quantity of deleterious and extraneous materials entering biosolids streams. The current system does not provide adequate protection from debris and grit. Inerts, such as plastics, are contained in the debris that enters the plant. These plastics are identifiable and need to be removed so that they do not become part of the biosolids.

New regulations by Ecology, described in WAC 173-308-205, state that all material prior to dewatering must be screened to a minimum size of 3/8 inch. This screening can occur prior to dewatering or at the head of the plant. The existing manual screen at the CKWWTP has an opening diameter of 1 1/2 inches and do not meet the new inert screenings requirement. The recommended screens for the headworks upgrade would have 1/4-inch openings, meeting the requirements of the new regulations. All facilities must comply with WAC 173-308-205 by July 1, 2012. A project is in construction to provide a new headworks and septage receiving station to intercept these unwanted inert materials. These new facilities are expected to be operational in 2011.

5.3.4 Effluent Nitrogen Concentrations

Regulations governing current effluent nitrogen concentrations are developed by Ecology and are stipulated in the NPDES permit. The current permit requires effluent ammonia concentrations not to exceed established values for toxicity in the outfall acute and chronic toxicity zones. Due to general concerns of water quality degradation within Puget Sound, Ecology has been imposing increasingly restrictive limits for total nitrogen (TN) effluent concentrations in sensitive reaches of Puget Sound, most notably in its southern reaches. It is anticipated that these more restrictive limitations for ammonia and TN effluent concentrations may eventually be imposed on the outfall discharge for the CKWWTP. To be prudent and proactive in this regard, the facilities to be evaluated in this Facility Plan should be capable of reducing year-round TN and ammonia effluent concentrations not to exceed 10 mg/L as nitrogen and 1 mg/L, respectively. Note that these effluent nitrogen and ammonia concentration limits are compatible with the reclaimed water uses as described below.

5.3.5 Reclaimed Water

Current regulations governing the generation and use of reclaimed water are referenced in the *Water Reclamation and Reuse Standards* (Reuse Standards), Washington Departments of Health and Ecology, September 1997. While it is likely that these standards may be modified at the end of 2011, the general aspects associated with the current regulations for the generation and use of reclaimed water will likely remain unchanged for the purposes of this Facility Plan. These regulations describe the requirements for several classes of reclaimed water quality (Classes A, B, C, and D) and several types of general usage—namely irrigation, commercial, and industrial use; groundwater recharge by surface percolation; stream flow augmentation; and wetlands and direct aquifer recharge. For the purposes of this Facility Plan, all these potential uses are envisioned, with the exception of direct aquifer recharge.

To meet the general requirements for most of these types of anticipated Kitsap County applications (e.g., irrigation, commercial, and industrial use) the reclaimed water must qualify as Class A. Class A reclaimed water must be at all times oxidized, coagulated, filtered, and disinfected wastewater. To qualify, reclaimed water facilities at the CKWWTP must draw water from the UV-disinfected effluent channel and then be subjected to chemical coagulation and filtration, followed by additional disinfection to maintain chlorine residual in any downstream reclaimed water distribution piping and to ensure that the median number of total coliform organisms in the reclaimed water after disinfection does not exceed 2.2 per 100 milliliters for the last 7 days for which analyses have been completed, and that no individual sample exceed 23 organisms per 100 milliliters. Additionally, average monthly effluent turbidity shall not exceed 2 nephelometric turbidity units (NTU), with no sample exceeding 5 NTU.

Additional water quality requirements beyond Class A standards are imposed for reclaimed water uses intended for groundwater recharge by surface percolation of wetlands. These additional requirements for this higher order of reclaimed water use include reducing TN prior to discharge to groundwater. For the purposes of this Facility Plan, the target maximum nitrogen limit is taken to be 10 mg/L as nitrogen.

Specific water quality limits selected for this Facility Plan are intended to allow the County to meet all reclaimed water applications except for direct aquifer recharge, which would require reverse osmosis (RO) filtration. Reclaimed water quality targets for the CKWWTP are described in Chapter 8.

To date, the County has several opportunities to use reclaimed water for several environmentally valuable projects defined in subsequent sections of this Facility Plan. The County is currently considering a large-scale reclaimed water project to deliver reclaimed water to Silverdale for local irrigation use and for groundwater recharge via surface percolation. In conjunction with Silverdale Water District, the County plans to construct a large-diameter pipeline to convey reclaimed water to Silverdale.

5.4 Local Regulations, Policies, and Guidance

Several local regulations, policies, and guidance affect the choices to be made regarding wastewater treatment at the CKWWTP. A few of these select items driving the decisions to be made are described in the following section.

5.4.1 Energy Conservation and Greenhouse Gas Emissions

The field of energy conservation, reduction of fossil fuels and use of renewable fuels, and reduction of GHG emissions has received significant attention in the media to help mitigate increasing scarcity and costs for power and imported fossil fuels as well as mitigating the effects of climate change linked to GHGs. The upcoming CKWWTP expansion and upgrade projects can be managed to help reduce dependence on imported power and fuels, as well as reducing its overall carbon footprint. Although currently not regulated at the federal or state level, these concerns are often left to local jurisdictions for consideration. It is possible that cap-and-trade legislation will be enacted to enable and require communities to buy and trade carbon credits on the open market. Kitsap County has indicated a strong interest in further protecting the environment by implementing these forward-thinking approaches in advance of future regulations.

The CKWWTP uses an antiquated system to heat anaerobic digesters with imported heating oil and to burn and waste all digester gas produced on site. This creates a dual problem in that two fuel sources are combusted, generating GHGs (mainly carbon dioxide)—whereas in most new plants, digester gas alone is used to heat the digesters rather than using imported heating oil. Additionally, communities with anaerobic digesters are increasingly using cogeneration engines to burn digester gas both to produce electricity for general plant use and for export to the local power grid with waste engine heat used for digester heating. Energy grants are currently available (e.g., from Puget Sound Energy) to offset the capital costs of these energy-based projects.

These modern concepts of minimizing the plant's energy and carbon footprint are addressed in subsequent sections of this Facility Plan.

5.4.2 "Water as a Resource" Policy

Kitsap County has enacted a far-reaching resolution (Resolution 109-2009, dated June 22, 2009) to conserve and protect the county environment by enlightened stewardship of local county water resources. These aquatic resources and assets include wetlands, stormwater, groundwater, streams, lakes, and Puget Sound. The County has declared its policy to reuse wastewater effluent and minimize flow and nutrient loading to Puget Sound while preserving and conserving precious groundwater resources. This resolution articulates the County's environmental leadership to preserve and protect its resources. A copy of this resolution is included in Appendix 5B.

CHAPTER 6

FACILITIES DESIGN AND EVALUATION CRITERIA AND METHODOLOGIES

Once the hard data related to population and flow projections, existing infrastructure, and regulations have been compiled, the next step is to identify an array of future projects to meet future needs.

A menu of alternative projects is developed based on best engineering practices; these projects are then assessed against a list of key criteria to come up with a final selection of preferred projects.

The key criteria used to assess alternative projects, listed on Table 6-1, include considerations involving asset management, land use, cost, environmental engineering parameters, energy efficiency, wastewater reclamation and reuse, and environmental sustainability.

The challenge of the selection process is, wherever possible, to overcome the limitations of some of the more standard engineering design criteria to meet Kitsap County's commitment to move in a more environmentally sustainable direction.

Finally, the evaluation processes for collection/conveyance and wastewater projects differ somewhat. The two different methodologies are presented in this chapter. This chapter explains this selection process.

6.1 Overview of Chapter Contents

This chapter presents a thorough discussion of the criteria and methodologies used to evaluate specific future collection and treatment projects to meet the County's needs over the next 20 years. The first half of the chapter explains the criteria and methodologies used to select collection system project alternatives; the second half explains the same parameters used to select treatment system projects.

6.2 Key Criteria and Methodologies Used to Identify, Evaluate, and Rank Projects

This section broadly describes the key criteria used and methodologies applied to project alternatives to develop a final set of recommendations. A listing of the key criteria used to identify, evaluate, and rank projects is shown in Table 1-1.

These key criteria are discussed in more detail as shown in Appendix 6A and are applicable to both collection and treatment system projects.

Details on the assumptions used for planning-level total project costs (capital costs), O&M costs, and NPV analyses are included in Appendix 6B.

The key criteria are then applied to all potential wastewater infrastructure project alternatives to identify, evaluate, and rank them according to established methodologies. Figure 6-1 provides a general graphical depiction of the methodology that was employed to reach the final recommendations. This methodology is explained in detail in the following sections.

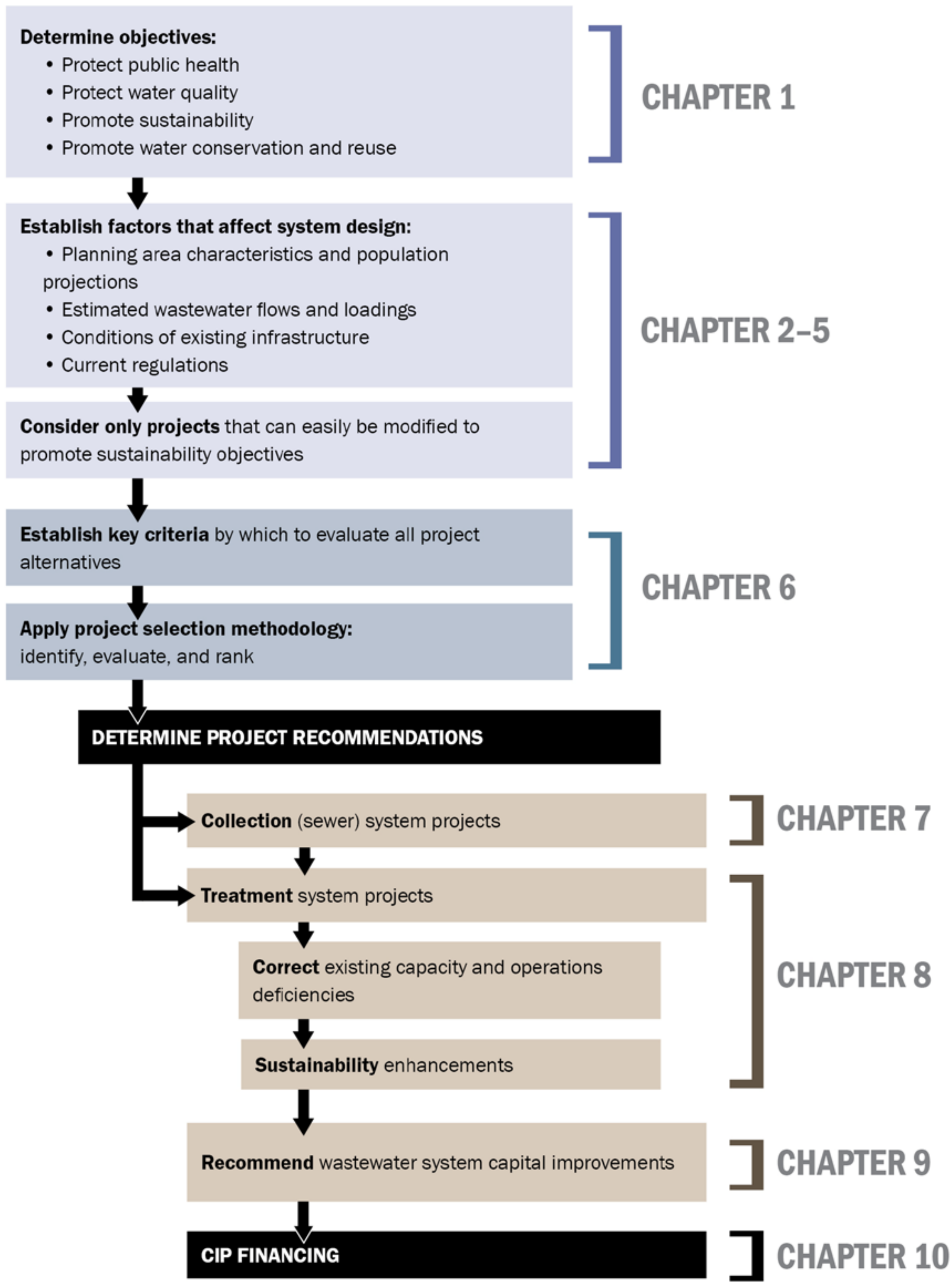

Figure 6-1. Facility planning methodology

6.3 Collection System Projects

This section describes the identification, evaluation, and ranking of collection system projects. Some of the key criteria listed in Table 1-1 were used to identify projects and others were used to evaluate projects.

There are two types of collection system projects: those required to correct the shortcomings in the existing system and those required to serve areas of the UGAs extending beyond the current collection system.

6.3.1 Project Identification

Collection system projects are identified and developed to meet the criteria presented in Section 6.2 and Table 1-1. Different methodologies were used to identify the two types of collection system projects. Existing sewer system projects were identified based on input from Kitsap County staff and the initial results of a detailed sewer system model. Projects required to serve the UGA beyond the existing sewer system were identified based on service area topography and a spreadsheet analysis of flow capacity requirements.

The identification of all projects was based on satisfying Key Criteria 1–6 and 13 shown in Table 1-1. The specific problem areas and issues used to define projects relative to the key criteria are as follows:

- At some pipe locations, excessive sewer cleaning is required or pipe material has weakened and failed or is considered likely to fail. At some lift stations, equipment has reached the end of its useful life and requires more than routine maintenance (Key Criteria 1 and 2).
- All projects must comply with GMA requirements, which means that the conveyance system must be designed to provide sewer service for the predicted 2030 population and other users connected to the sewer system (Key Criteria 3, 4, and 5).
- At some locations, hydraulic conditions fail to meet several engineering design factors (Key Criterion 6), including the following:
  - Locations in sewers where slopes are too flat or are reverse grade, causing low velocities or areas where wastewater ponding may occur and solids may settle. Increased cleaning is usually required and the potential increases for pipe deterioration.
  - Locations where flow exceeds 7 feet per second (fps). High velocities cause increased scouring and wear of pipe materials and shorten the useful life of pipe. High velocities also cause turbulent flow conditions and higher energy requirements for pumping equipment.
  - Locations in sewers where the pipes are flowing full and manholes where wastewater depth rises above the tops of the connecting pipes. Both conditions indicate that the sewer has reached flow capacity and hydraulic flow characteristics have worsened.
  - Lift stations where the firm capacity is reached. The firm capacity of a lift station is the pumping capacity of the station when the largest pump is out of service.
- Surcharging of wastewater at manholes and lift stations that overflow the structures is a public health hazard and a source of contaminants that adversely impacts the water quality of streams, lakes, marine waters, and groundwater (Key Criterion 13).

6.3.2 Project Evaluation

The evaluation of potential collection system projects was based on additional detailed modeling and further discussions with Kitsap County staff. The projects were further defined and developed to evaluate the severity of existing or potential future system hydraulic problems and operations issues that would be mitigated by construction of the projects. Additional evaluations included determining when the projects would be required, project costs, and potential environmental issues including mitigating measures.

Specific factors evaluated for each project related to the key criteria are as follows:

- **Type and extent of problems:** For the existing sewer system, lift station projects were evaluated in terms of the magnitude of future required capacity vs. existing firm capacity at lift stations with 85 percent as the threshold to implement improvement projects. Surcharging of manholes and pipelines during peak hour flows is to be avoided and the threshold for requiring a sewer improvement is when manhole surcharging exceeds 50 percent of the manhole depth. These thresholds were established in consultation with Kitsap County Public Works staff.
- **Timing of projects:** Implementation of existing sewer system projects was determined based on those already at capacity or with known O&M issues. Estimates were also made of the year when projected flow would cause the thresholds to be exceeded for the firm capacity criterion at lift stations and surcharging criterion for pipes and manholes.
- **Project cost estimates:** For the existing sewer system projects, detailed project cost estimates were prepared based on the length, depth, and size of pipe determined by the modeling effort. Additional costs were added for special construction requirements such as dewatering near water bodies and jacking or cut-and-bore construction beneath streams or under SR 3 and Waaga Way. Lift station project costs were estimated based on required firm capacity for both the existing lift stations and the new lift stations required in the UGA. The costs for force mains in the UGA were estimated based on average unit costs developed for the existing sewer system improvements.
- **Environmental/permitting issues:** The location of projects to replace a pipeline adjacent to a water body or crossing a stream or to upgrade a lift station adjacent to a stream poses special environmental concerns. These concerns are addressed by providing an additional cost allowance for mitigation activities or special construction factors to avoid potential impacts. The cost allowance is also intended to provide for additional investigation and analysis that would be undertaken during project preliminary engineering and final design to fully address the environmental issues.

6.3.3 Project Ranking

All of the identified and evaluated collection system projects must ultimately be constructed to comply with the requirements of the GMA. However, the projects may be ranked to some extent based on their estimated timing of construction related to increased flows, their relative importance with respect to potential adverse impacts resulting from delaying project construction, and project cost relative to the availability of project funding. Each of these factors is evaluated for project ranking as follows:

- **Timing:** Those projects determined to be required earlier in the planning period are given higher priority for implementation.
- **Relative importance:** The relative importance of a proposed project is evaluated based on the severity of potential failure or inability to provide the required level of service. For example, the failure of an existing major interceptor used to convey wastewater from a majority of the Central Kitsap sewer service area to the CKWWTP would rank higher than the failure of a local sewer that serves a sub-basin within the sewer service area.
- **Project cost:** The impact of project cost is evaluated in the financial chapter (Chapter 10) when user rates are determined to fund all of the required sewer system improvements. Recommendations for implementation of the collection projects will be based on a combination of project needs and affordability.

6.4 Treatment System Projects

This section describes the specific methodologies used to identify, evaluate, and rank wastewater treatment project alternatives, consistent with the key criteria discussed in Section 6.2 and shown in Table 1-1.

6.4.1 Project Identification

At a minimum, all considered treatment projects must meet the requirements of Key Criteria 1–6 and 15 shown in Table 1-1. Projects that can also meet Key Criteria 7–14 should be identified as much as practical.

Key Criterion 4 requires that at a minimum, all of the process alternatives analyzed be capable of meeting the secondary effluent requirements as required by the NPDES permit. Design criteria specific to the operation and performance of individual treatment plant processes are described in Chapter 8. For each process, treatment units are sized for 2030 projected flows and loads, consistent with Key Criterion 3.

In addition to the most basic goals of treating future sewage flow to the minimum secondary treatment standards for discharge into Puget Sound, the County is vitally interested in examining alternatives to provide enhanced treatment and recovery of all wastewater resources (e.g., reclaimed water, biosolids and nutrients, and biogas and energy).

A long-term goal of Kitsap County is to "close the loop," eliminating treated wastewater discharge to Puget Sound. To that end, this Facility Plan evaluates project scenarios that would enable nutrient removal and the production and reuse of wastewater as identified in Key Criterion 10 and Key Criterion 13.

Tertiary treatment technologies that would produce high-quality treated effluent, whether at the CKWWTP site or at one or more satellite facilities, can be easily engineered and implemented. The current limiting factors are the identification of customers and usage sites that will allow for a year-round disposal of the effluent. However, implementing tertiary treatment and continuing to discharge to Puget Sound takes us one step closer to adhering to the County's "Water as a Resource" policy and the improving the water quality of Puget Sound. Governing criteria for reclaimed water production are shown in the Reuse Standards. This Facility Plan examines potential usage sites and wholesale customers as discussed in Chapter 8.

It is important to note that none of the recommended collection or treatment projects, whether associated directly with reuse or other aspects of the treatment processes, will preclude the County from incrementally developing its reuse capacity as sites and customers become available in the future. This condition is consistent with Key Criterion 9.

This Facility Plan examines the best technologies to maximize the County's beneficial use of biogas to reduce energy demand GHG discharges to the atmosphere and to produce "green" power. This is identified as Key Criterion 11.

Treatment processes also produce biosolids. This material is currently fully reclaimed by its use in various types of soil amendments. This practice will continue as a given element in the development of this Facility Plan. Future projects will evaluate additional beneficial uses for this material, as well as projects that may provide some economic returns to the County as identified in Key Criterion 12.

6.4.2 Project Evaluation

The evaluation of wastewater treatment projects involves consideration of a large and complex array of treatment technologies. Some of these technologies are well known; others are new, efficient, innovative, and perhaps unproven.

To facilitate this effort, the evaluation process used for wastewater treatment projects is done in two steps. The first step, initial evaluation, consists of identifying all known reasonable alternatives to achieve the following objectives:

- treat sewage and minimize nutrient emissions into Puget Sound
- produce reclaimed water
- optimize use of biosolids and nutrients

- assess opportunities to conserve and generate energy.

In this first step, all the known and reasonable alternatives are subjected to a qualitative review of the benefits, merits, and shortcomings of each alternative relative to each other. Once this relatively broad array of possible choices is assessed, a much smaller number of feasible alternatives emerge that are then subjected to the second step—final evaluation—consisting of a more rigorous evaluation process.

The initial and final evaluation procedures are based on a composite assessment of economic and non-economic factors and characteristics of each alternative. These initial and final evaluation procedures balance both the economic and non-economic factors to identify the "best" overall treatment approach to meet the County's treatment goals and philosophies with respect to the following goals:

- meet all regulatory requirements
- provide an affordable level of wastewater treatment service to ratepayers
- provide forward-thinking environmental stewardship.

This two-step evaluation procedure is applied to treatment alternatives described in Chapter 8.

In certain circumstances, these two-step evaluation procedures may be circumvented and alternatives may be evaluated and selected by simpler means. By inspection or by the prudent use of applied judgment, some specific alternatives may stand clearly as the preferred alternative, or perhaps some scenarios only produce one viable alternative. In these few instances a more streamlined and direct approach to alternatives selection will be utilized and documented.

A brief description of this two-step evaluation procedure follows.

6.4.2.1 Initial Evaluation

Specific criteria, enhancing the guidance of the key criteria shown in Table 1-1, are developed to perform the initial evaluation for a broad array of treatment technologies at the CKWWTP and at reclaimed water facilities (both at the CKWWTP and at potential satellite treatment plants). These criteria are used as pass/fail checkpoints to eliminate technologies that do not meet basic project requirements. A detailed description of these criteria is shown in Appendix 6C. In recognition that a specific technology may not meet all of these initial evaluation criteria, but may still provide substantial benefit, a "wildcard" nomination is allowed to pass a technology that would have otherwise been eliminated. Technologies meeting the requirements of all initial evaluation criteria, plus any "wildcard" nominations, make up the shortlist of components for final evaluation (the second step).

During an October 2010 workshop with County staff and consultant engineers, some discussions were held concerning the long-term prospects on effluent quality requirements and biosolids disposal/reuse. In terms of nutrient requirements in Western Washington, limitations on nitrogen, and especially ammonia, will likely be imposed in the future for most treatment plants discharging into Puget Sound. Phosphorus requirements will not likely be imposed. Another potential effluent parameter of concern is effluent temperature; the Manchester WWTP has recently been required to monitor effluent temperature. Compounds of emerging concern (CECs), including endocrine-disrupting compounds, pharmaceutical products, and microconstituents, will also likely become a more significant issue in terms of effluent quality in the future.

In terms of biosolids and biogas use, potential future items of concern include the following issues:

- pathogen reactivation and regrowth
- increasing public awareness and concern of land application of biosolids
- sustainability (e.g., GHG emissions and energy recovery from digester gas).

Finally, consideration was given to projects that conserve and generate electrical energy. Most notably, projects such as cogeneration to produce electrical "green" power from combustion of biogas were assessed in this initial evaluation process.

The initial evaluation, as well as the subsequent final alternative evaluation, is discussed in Chapter 8 and incorporates traditional treatment goals along with these new and contemporary issues for WWTPs.

6.4.2.2 Final Evaluation

After the initial evaluation of treatment alternatives described above has been conducted, a shortlist of the most feasible projects for wastewater, reclaimed water, biosolids, and biogas use and energy options emerges. This shortlist was then subjected to a more complete final evaluation process, using several specific criteria including economic and non-economic criteria, to help select the recommended treatment projects. These specific final evaluation criteria are subsets of the key criteria identified in Table 1-1.

The evaluation matrix for treatment alternatives is shown in Table 6-1, along with cross-references to the key criteria discussed in Section 6.2 and shown in Table 1-1. A complete discussion of the evaluation factors listed in Table 6-1 is provided in Appendix 6D.

Table 6-1. Treatment Alternatives Final Evaluation Matrix

Specific final evaluation criteria	Corresponding key criteria in Section 6.2 and Table 1-1	Criteria category weight [a]	Criteria weight [b]	Alternate 1			Alternate 2		
				Rating [c]	Score [d]	NPV	Rating [c]	Score [d]	NPV
Process considerations									
Reliability	7, 8		6	-	-		-	-	
Robustness	7, 8		4	-	-		-	-	
Liquid stream/solids impacts	4, 8	5	2	-	-		-	-	
Process standardization	7, 8		1	-	-		-	-	
Process flexibility	8, 9		4	-	-		-	-	
Ease of construction	13, 14		1	-	-		-	-	
Ease of odor containment	8, 14		2	-	-		-	-	
Process considerations subtotal			20						
O&M considerations									
Operator safety	8		4	-	-		-	-	
Ease of maintenance	8	5	4	-	-		-	-	
Ease of operation	8		4	-	-		-	-	
Operating flexibility	8		4	-	-		-	-	
Operator environment	8		4	-	-		-	-	
O&M considerations subtotal			20						
Flexibility for future expansion or enhancement	9	5	20	-	-		-	-	
Reuse and biosolids utilization	10, 12	10	20	-	-		-	-	
Energy conservation and generation	11	5	20	-	-		-	-	
Environmental/community considerations									
Public safety and security	14		4	-	-		-	-	
Effluent quality and nutrient removal	4, 13	10	6	-	-		-	-	
Site utilization	5, 9		4	-	-		-	-	
Construction community impacts	13, 14		2	-	-		-	-	
Odor, noise, visual, traffic impacts	13, 14		4	-	-		-	-	
Environmental considerations subtotal			20						
Comparative cost, million dollars [e]	15								
Capital		10	15	-	-		-	-	
O&M annual			5	-	-		-	-	
Comparative cost considerations subtotal			20						
NPV						-			-
Total score		50	140						

Footnotes:

a. Criteria category weighting factor: *1 to 10 (10 = most important).*
b. Criteria weighting factor: *1 to 20 (20 = most important and total for each category).*
c. Alternative rating scale (except cost): *5 =excellent*
4 = very good
3 = good
2 = fair
1 = poor.
d. Alternative score = criteria category weighting factor X criteria weighting factor X alternative rating.
e. Comparative costs may not include cost elements common to alternatives.

The scoring of these final evaluation criteria are discussed in Appendix 6D and shown in the footnotes of Table 6-1. All shortlisted alternatives were subjected to the scoring systems identified in this table. This matrix allows the final comparison of all shortlisted alternatives to help identify the "best" alternative for each category assessed. In this matrix, the alternative with the highest overall score is selected for that specific category of treatment. The implementation of this approach is shown in Chapter 8.

6.4.3 Project Ranking

After final projects are evaluated using the matrix shown in Table 6-1, a total score for the value of each of the final project alternatives is developed. This total score includes weighted factors for both economic and non-economic evaluations. Ranking of projects is based on a straightforward listing of project alternatives from the most preferred alternative with the highest score, to the least preferred alternative with the lowest score. Alternatives that generated high scores with an emphasis on water reclamation, nutrient removal, biosolids utilization, and energy conservation and generation were ranked preferentially, as directed by the County's "Water as a Resource" Policy shown in Appendix 5B.

CHAPTER 7

COLLECTION SYSTEM IMPROVEMENTS

This chapter applies the selection methodologies explained in Chapter 6 to identify and evaluate the collection system projects for the 20-year planning period. These projects are required for the existing sewer system and for new infrastructure to provide sewer service to the four areas of concern located in the Silverdale and Central Kitsap UGAs. Wastewater flows from the cities of Poulsbo and Bangor will continue to be conveyed by the collection system through the Keyport area.

These projects are for major pumping and collection facilities only. Local collector sewers and pumping facilities, such as those used for individual households and residential developments, are excluded from this analysis as the details for these local facilities would be determined when an investigation for serving a local area is undertaken.

The projects presented in this chapter are required to serve projected growth through 2030 in the areas currently served by the County sewer and the four areas of concern identified by the Health District, due to failing septic systems. In addition, another analysis was completed to identify collection system improvements to provide sewer service within the Silverdale and Central Kitsap UGAs to all existing and future residences through 2025, including all existing onsite sewage systems in both UGAs. The projects recommended for this "full service" development scenario are presented in Appendix 7F.

7.1 Overview of Chapter Contents

As described in Chapter 6, the following methodologies are applied to collection system improvements. Application of these methodologies is reflected in the structure and contents of this chapter:

1. Project identification
   a. Existing lift station projects
   b. Existing piping system projects
   c. Future conveyance system projects to serve areas of concern
2. Project evaluation
   a. Existing lift station projects
   b. Existing piping system projects
   c. Future conveyance system projects to serve areas of concern
3. Project ranking and prioritization
   a. Existing lift station projects
   b. Existing piping system projects

7.2 Project Identification

Collection system projects identified for the lift stations and collection system piping in the existing sewer system and the areas currently not served by the existing system are presented in this section. The details of the projects are provided in subsequent sections.

A sewer system model (MIKE URBAN) was developed to help identify and evaluate projects (Appendix 7C). Future wastewater flows were estimated for sewer sub-basins throughout the Silverdale UGA and Central Kitsap UGA and used in the model to identify peak flow conditions. Lift station and sewer system piping improvements were determined to convey future peak flows (Chapter 3) throughout the existing system with unrestricted flow conditions. The future peak flows were also used to determine the sizes of future lift stations and major collection piping beyond the existing sewer system.

7.2.1 Existing Lift Station Projects

Fifteen lift station projects have been identified for construction during the 20-year planning period. Thirteen of these projects are based on capacity increases determined by comparing existing FPCs with existing and projected 2030 flows. The FPCs of the existing lift stations compared to existing peak hour flows are shown in Figure 7-1 (all Chapter 7 figures are provided at the end of the chapter). As indicated in Figure 7-1, most existing lift stations have adequate capacity for existing flows.

Only LS-6 and LS-8, both in the Central Kitsap UGA, have inadequate capacity for existing peak hour flows. Additionally, two other lift stations (LS-4 and LS-22 in the Silverdale UGA) have existing peak hour flows greater than the 85 percent threshold of firm capacity.

Improvements to two existing lift stations were also identified based on the condition of existing pumping equipment. These lift stations are LS-1 in the Silverdale UGA and LS-16 in Keyport. Because of significant site constraints limiting the ability to expand it, LS-16 will be converted to a local lift station serving only the Keyport area. Wastewater flows from the city of Poulsbo conveyed through the Lemolo siphon will be diverted to LS-67, which will be expanded for the increased flows.

The firm capacities of the existing lift stations relative to projected 2030 flows are presented in Figure 7-2. In addition to the four lift stations identified above, eight other lift stations have inadequate capacity for future flows and will require upgrade/expansion to increase their capacities. These lift stations are as follows by UGA:

- Silverdale UGA: LS-3, LS-12, LS-13, and LS-21
- Central Kitsap UGA: LS-10, LS-32, LS-34, and LS-65.

7.2.2 Existing Piping System Projects

Eighteen projects are identified as improvements to the existing collection and conveyance piping system. Fourteen collection system piping projects, listed in Table 7-1, will address problem areas identified for existing flows. Four projects, listed in Table 7-2, will address problems associated with future flows. The location of all piping projects is shown in Figure 7-3. In summary, nearly 9.6 miles of pipes are scheduled for replacement in the existing collection and conveyance system.

Table 7-1. Summary of Projects for Existing Collection System Piping Improvements for Existing Flows						
Project name	Problem area	Existing problems	Future problems	Recommended project	Comments	Estimated project cost
Techite Pipe Replacement	From NE Paulson Rd. to CKWWTP	6,500 lf of 30" Techite force main that is deteriorating and subject to failure. All wastewater from CK and Silverdale areas flow through this pipe.	Increased likelihood of failure as pipe material ages	6,500 lf of 30" HDPE force main; project planned for construction in 2011	Includes 6,500 lf of 18" reclaimed water line	$8,710,000
Bayshore Pipe Replacement	Old Town, along shoreline from NW Bucklin Hill Rd. to LS-3	Significant settling of solids requiring frequent cleaning.	1,865 lf of 8" pipe & MH surcharging	1,865 lf of 10" pipe; begin project in 2011	High priority based on comments from Public Works O&M staff	$1,340,000
NE Bentley Drive Pipe Replacement	Upstream from State Hwy. 303 to force main from LS-8 (11a)	1,865 lf of 8" pipe and MH surcharging.	More surcharging as flows increase and LS-8 is upgraded	1,380 lf of 12" and 485 lf 18" gravity pipe; begin project in 2011	Timing related to LS-8 improvements	$1,060,000
Silverdale Way Pipe Replacement	Silverdale Way from NW Misty Ridge Ln. south to Waaga Way (1b)	Surcharging of approximately 1,000 lf of 8" pipe and 7 MH.	Pipe surcharging increases; more MH surcharging with 7 MH overtopped	2,080 lf of 12" pipe and 800 lf of 15" pipe; begin project in 2011	High priority due to existing MH surcharging > 50% depth	$2,080,000
LS-6 Force Main Replacement	From LS-6 to the intersection of Old Military Rd. NE and NE Fairgrounds Rd.		Excessive flow velocities when LS-6 is upgraded	1,150 lf of 12" force main; begin project in 2011	Begin project as part of LS-6 upgrade project	$1,440,000
Mickelberry Road Pipe Replacement	NW Myhre Rd. and Mickelberry Rd. NW in downtown Silverdale (1a)	Minimal pipe surcharging.	Surcharging of about 1,500 lf and 4 MH	70 lf of 12" and 1,350 lf of 18" pipe; begin project in 2017	Timing related to LS-1 upgrade (LS-1 completed first)	$1,260,000
Levin Road Pipe Replacement	Upstream of LS-1 along Levin Rd., Bucklin Hill Rd., and Mickelberry Rd. (2)	2,105 lf of 8" pipe surcharging.	Increased pipe surcharging; 3 MH surcharging > 50% depth	1,750 lf of 10" pipe and 355 lf of 12" pipe; begin project in 2017	Lower priority; minimal MH surcharging at existing flows	$1,470,000
Fredrickson Road Pipe Replacement	Fredrickson Rd. NW, upstream of LS-4 (3)	Some 15" pipe surcharging.	Increased pipe surcharging but minimal MH surcharging	970 lf of 18" pipe; begin project in 2017	Lower priority due to minimal MH surcharging modeled for 2030 flows	$750,000

Table 7-1. Summary of Projects for Existing Collection System Piping Improvements for Existing Flows

Project name	Problem area	Existing problems	Future problems	Recommended project	Comments	Estimated project cost
Old Town Silverdale Pipe Replacement	Old Town area upstream of LS-3 to intersection of Silverdale Way NW and NW Anderson Hill Rd.(4)	Some 8" pipe surcharging; inverse slope near Silverdale Way.	Increased pipe surcharging and MH surcharging	2,140 lf of 18" pipe; begin project in 2018	Remainder of upstream pipe in Anderson Hill Rd should be replaced after this project is completed.	$2,000,000
John Carlson Road Pipe Replacement	East of LS-7 on Fairgrounds Rd. and John Carlson Rd. (5)	Limited 8" pipe surcharging.	Increased pipe surcharging; MH surcharging with 6 MH overtopped	2,700 lf of 12" pipe and 1,675 lf of 15" pipe; begin project in 2018	Project for correcting existing problems low priority due to no surcharging of existing MH	$3,190,000
Fuson Road to Franklin Avenue Pipe Replacement	South of Fuson Rd. along Wheaton Way (Lowes Parking Lot) (7)	About 400 lf of 8" pipe surcharging.	Increased pipe surcharging	890 lf of 12" pipe; begin project in 2020	Lowest priority due to minimal MH surcharging modeled for 2030 flows	$600,000
Southern Old Military Road Force Main Replacement	Old Military Rd. north of NW Fairgrounds Rd to intersection with NE Lombard Ct. (8)	16" and 18" pipe with MH surcharging near intersection of NW Fairgrounds Rd.	All MH overtopped; flow velocities > 9 fps	2,710 lf of 30" gravity and force main pipe"; begin project in 2020	Ultimately entire length from Fairgrounds Rd. to Waaga Way must be replaced with 30" pipe	$5,160,000
Auklet Place Force Main Replacement	Auklet Place NE south of LS-6; replace force main from LS-36 (9)	675 lf of 4" force main with flow velocity > 7 fps.	Velocities increase with higher flows	675 lf of 8" force main; begin project in 2017	Project timing related to LS-36 upgrade	$780,000
Lemolo Peninsula Pipeline Replacement	Lemolo Dr. NE, Brauer Dr. NE and Tukwila Rd. NE north of Lemolo siphon (10)	Some MH surcharging near low end of pipeline.	Surcharging at all MH; limited hydraulic capacity below future requirement	4,450 lf of 18" force main; project to begin in 2017	Project timing after LS-16 and LS-67 upgrades	$7,920,000
Total projects						$37,760,000

Note: Numbers in parentheses refer to the problem area documentation in Appendix 7E.

Table 7-2. Projects for Existing Collection System Piping Improvements for Future Flows					
Project name	Problem area	Future problems	Recommended project	Comments	Estimated project cost[a]
Anderson Hill Road Pipe Replacement	Anderson Hill Rd. west of Silverdale Way to Frontier Rd NW (4)	8" pipe surcharging and MH overtopping	3,750 lf of 10" and 15" pipe; begin project in 2020	LS-3 capacity improvements and Old Town Silverdale Pipe Replacement must be completed first	$2,210,000
LS-7 to State Highway 303 Pipe Replacement	From LS-7 south and southwest to SR 303 (11b)	3,900 lf of 15" and 18" pipe and MH surcharging	3,505 lf of 21" gravity pipe; begin project in 2017	Lower priority; surcharging in 4 MH > 50% depth by 2030	$2,750,000
Northern Old Military Road Force Main Replacement	Old Military Rd. from Foster Rd. to Waaga Way; Waaga Way to NE Paulson (12)	9,793 lf of 16", 18", 20", and 24" pipe; limited capacity below 2030 flow capacity required	8,285 lf of 30" gravity and force main pipe; begin project in 2020	Required after LS-6 upgrade for increasing capacity using available head	$7,710,000
LS-22 Force Main Replacement	From LS-22 to the intersection of Ridgepoint Dr. NW and Quail Run Dr. NW (13)	1,050 lf of 6" force main; excessive velocities at future flows	1,050 lf of 8" force main; project to begin in 2017	Required after LS-22 upgrade to reduce pumping head and flow velocities in pipe	$1,260,000
Total					$13,930,000

a. Costs represent total project costs, not just the portion of cost to be the responsibility of the County.

7.2.3 Future Conveyance System Projects to Serve Areas of Concern

Twelve new lift stations may potentially be needed to serve the four areas of concern for failing onsite septic systems. The schematic location in the existing collection system and estimated design capacity of the new lift stations are provided in Figure 7-4. The general locations of the new lift stations are shown in Figure 7-5.

These future lift stations, which will serve the areas beyond the existing sewer system, are located at the lowest elevations in the sewer service sub-basins. The force mains from these lift stations will generally be located in public rights-of-way or along land parcel boundaries to connect with new downstream facilities or existing sewer system infrastructure.

7.3 Project Evaluation

Projects are evaluated based on the key criteria presented in Chapter 6 with emphasis placed on the following:

- nature and extent of problem corrected by the project
- capacity or size of the facility, which is used to prioritize the project in the subsequent section
- increase in flows at the facility to indicate project need relative to growth
- condition of existing equipment and O&M issues addressed by the project
- total project cost.

7.3.1 Existing Lift Station Projects

Fifteen lift station projects are listed in Table 7-3 with the future FPC required, estimated project cost, and the year when the implementation project is recommended to begin. The recommended date for implementation of projects is generally based on when the inflows to the lift stations are projected to reach 85 percent of FPC and the rate of increase in projected flows. The estimated dates were determined assuming that the projected 2030 flows increase linearly from the 2005 flows. This assumption may be somewhat conservative as population increase is expressed as geometric growth.

However, some projects are scheduled sooner than the estimated date for reaching 85 percent of FPC, based on the poor condition of existing equipment and the need for immediate rehabilitation. Other projects are scheduled later than indicated by the projected date of reaching 100 percent of firm capacity based on anticipated project funding constraints.

The future capacities of lift stations range from 175 to 5,250 gpm. Seven of the lift stations will be major facilities with FPCs greater than 1,000 gpm. Four lift stations will be medium-sized facilities (between 500 and 1,000 gpm) with the remaining four having capacities less than 500 gpm.

The total project cost for the existing lift station projects is $58.5 million. The largest projects are LS-67 and LS-16, located in the Keyport community and estimated at $10.8 million and $4.38 million, respectively, and LS-4 in Silverdale, estimated at $9.7 million. The project costs for the remaining lift station projects are each under $4 million.

LS-16, which is located on a challenging site, is recommended for conversion to a local lift station to serve the Keyport area with LS-67 being upgraded and expanded to serve as the primary lift station receiving wastewater from the city of Poulsbo through the Lemolo siphon. The Lemolo siphon and related collection system improvements are discussed in more detail in Appendix 7G.

Table 7-3. Existing Lift Station Projects

Lift station	Future firm capacity (gpm)	Total project cost	Year project implementation begins	Estimated date at 85% of FPC and 100% of FPC	
				85%	100%
LS-1	2,150	$3,630,000	2011	2013	2028
LS-3	2,550	$3,760,000	2017	2014	2018
LS-4	5,250	$9,700,000	2017	Both exceeded before 2009	
LS-6	2,300	$3,880,000	2011	Both exceeded before 2005	
LS-8	900	$1,280,000	2011	Both exceeded before 2005	
LS-10	350	$2,342,000	2017	2013	2019
LS-12	1,100	$3,760,000	2017	2013	2019
LS-13	500	$2,342,000	2017	2016	2021
LS-16	100	$4,380,000	2011	2006	2011
LS-21	375	$2,342,000	2017	2008	2013
LS-22	550	$2,092,000	2017	2008	2011
LS-32	295	$2,342,000	2017	2006	2010
LS-34	1,250	$3,760,000	2017	2019	2022
LS-65	675	$2,092,000	2017	2013	2015
LS-67	4,000	$10,800,000	2011	Tied to LS-16 project	
Total		$58,502,000			

7.3.2 Existing Piping System Projects

Each of the identified collection system projects was developed using a model of the sewer system to identify hydraulic problems and determine the improvements required to mitigate the problems. The nature and extent of the hydraulic problems caused by existing flows are listed in Table 7-1 and by future flows listed in Table 7-2. The problems are presented in terms of pipe or manhole surcharging, excessive velocity, condition of the pipe material, or excessive maintenance based on the key criteria given in Chapter 6.

The recommended timing of implementation of the collection system projects is also provided in Tables 7-1 and 7-2. Project timing is related either to lift station project construction or to when the pipe and manhole surcharging and velocity criteria will be exceeded. The specific lift station project or criteria for priority collection piping projects are discussed in Section 7.4.2.

Estimated project costs to correct problems at current flows total $37.8 million. Project costs to correct problems at future flows are estimated to be about $13.9 million. The estimated cost for each specific project is presented in Tables 7-1 and 7-2.

7.3.3 Future Conveyance Systems to Serve Areas of Concern

All 12 of the new lift stations are relatively small with a capacity lower than 500 gpm. The number and sizes of lift stations located in each of the UGA areas are as follows:

- Silverdale North: four lift stations; capacity 10 to 35 gpm
- Central Kitsap East: six lift stations; capacity from 5 to 290 gpm
- Central Kitsap West: two lift stations; capacity 60 and 220 gpm.

The estimated project costs for future lift stations required beyond the existing Kitsap County sewer system totals about $13 million (Table 7-4). The cost estimates for future lift stations were made based on FPC required for projected 2030 peak hour flows. A breakdown of the costs by lift station size is shown in Table 7-4.

Table 7-4. Summary of Future Lift Station Costs

Lift station size	Peak daily inflow (gpm)	No. of lift stations	Construction cost/station	Total project cost [a]
Small	< 200	9	$600,000	$7,020,000
Medium	200–500	3	$1,550,000	$6,045,000
Total		12		$13,065,000

a. Costs include 30% contingency for allied costs but no land acquisition costs.

The wastewater collection pipeline facilities (gravity sewers and force/pressure mains) to serve areas of concern within the future growth areas are estimated to total nearly 11 miles in length. The pipelines are generally located in public rights-of-way or along land parcel boundaries to connect with new downstream facilities or existing sewer system infrastructure.

These pipelines approximately consist of the following:

- 19,300 feet of 10-inch-diameter gravity pipe (all in the Central Kitsap UGA)
- 14,900 feet of 8-inch-diameter gravity pipe (1,500 feet in the Silverdale UGA and 13,400 feet in the Central Kitsap UGA)
- 4,100 feet of 8-inch-diameter force main in the Central Kitsap UGA

- 19,000 feet of 6-inch-diameter force mains/pressure mains (6,300 feet in the Silverdale UGA and 12,700 feet in the Central Kitsap UGA).

New piping system project costs are estimated to total nearly $24 million (Table 7-5). These costs were based on average per-linear-foot construction costs of similar piping system project costs developed for the existing system improvements. The unit costs used for the estimates are presented in Table 7-5.

Table 7-5. Summary of Improvements, Construction, and Project Costs
Future UGA Collection System Piping

Pipe diam. (in.)	Type of pipe	lf of pipe	Construction cost/lf ($)	Total project cost[a]
6	Force main/pressure pipe	19,000	$277	$6,842,000
8	Gravity pipe/force main	19,000	$335	8,275,000
10	Gravity pipe	19,300	$350	8,783,000
Total		57,300		$23,900,000

a. Project costs include a 30% contingency for allied costs but no land acquisition costs. Costs represent total project costs, not just the portion of cost to be the responsibility of the County.

Total project costs for all recommended improvements are about $147 million, as summarized in Table 7-6. The costs of these projects are about equally split between lift stations and conveyance piping.

Table 7-6. Summary of Total Collection System Improvements, Construction, and Project Costs

Project category	Total project cost
Existing piping improvements for existing flows	$37,760,000
Existing piping improvements for future flows	13,930,000
Existing lift stations	58,502,000
Future lift stations	13,065,000
Future piping	23,900,000
Total	$147,157,000

7.4 Project Ranking and Prioritization

The projects are ranked and prioritized by groups based on differing levels of criticality. Existing sewer system projects are prioritized for implementation based on a qualitative assessment of several criteria. New sewer system infrastructure beyond the existing system is not prioritized but would be developed in response to actual population growth and resulting development patterns.

The 15 lift station and 18 collection system piping projects for the existing collection/conveyance system are ranked by prioritizing them into groups based on differing levels of criticality. The assignment to a particular group depends on the nature, extent, and severity of the problem corrected or projected to be avoided by the project. The assessment of the problem is qualitative and inherently imprecise. Thus, the assignment of a particular project to a specific priority tier has no bearing on the relative priority to other projects within that tier, but rather suggests the priority of that project relative to projects in the other tiers.

The lift station and collection facility projects identified to provide service in the Silverdale UGA and Central Kitsap UGA beyond the existing sewer system will be constructed when Kitsap County and the Health District determine that the existing onsite systems have failed to the extent that they must be connected to the County sewer system. Thus, only projects within the existing sewer system are prioritized and ranked as described in Chapter 6 sections.

7.4.1 Existing Lift Station Projects

Five lift station projects have the highest priority for implementation in the 6-year CIP based on O&M issues, firm capacity criteria, and relative importance in the collection system. These projects are as follows:

- **LS-1:** This lift station, which serves the northern Silverdale service area, pumps wastewater to LS-4. It is currently a major lift station with flows projected to reach 85 percent of FPC by 2013. It is located next to Clear Creek north of downtown Silverdale and poses significant challenges for expansion and upgrade. It is a high-priority project due to the age and poor condition of existing controls and pump motors. The Mickelberry Road Pipe Replacement project described in Table 7-1 will be completed with the LS-1 project.
- **LS-6:** This major lift station serves the western Central Kitsap service area, which is projected to have significant population growth. FPC is currently exceeded and the existing equipment has outlived its 30-year life. An immediate expansion and upgrade is recommended. The LS-6 Force Main Replacement project described in Table 7-1 will be completed with the LS-6 project.
- **LS-8:** This lift station serves the southeastern area of the Central Kitsap service area. FPC is currently exceeded and existing equipment has outlived its 30-year life. An immediate expansion and upgrade is recommended. The NE Bentley Drive Pipe Replacement project described in Table 7-1 will be completed with the LS-8 project.
- **LS-16 and LS-67:** These major lift stations receive flows from the city of Poulsbo through the Lemolo siphon. The 85 percent threshold of FPC of LS-16 is currently exceeded with the FPC projected to be exceeded in 2011. The lift stations have also been identified by Kitsap County staff as having significant O&M issues due to the age of the pumping and electrical equipment. As discussed previously, it is recommended that LS-16 be converted to a local lift station and that LS-67 be expanded to convey flows diverted from LS-16. These improvements are recommended for immediate implementation.

The second tier of priority projects consists of the upgrade and expansion of seven existing lift stations based on projected flows exceeding the 85 percent threshold after 2010 and the 100 percent of FPC threshold before 2020. The following lift stations are in this category and are recommended for implementation to begin in 2017:

- **LS-3:** This major lift station serves the western Silverdale service area with flows expected to nearly quadruple by 2030. The 85 percent threshold of FPC is expected to be exceeded in 2009 with the FPC to be exceeded by 2011.
- **LS-4:** This major lift station serves the northern Silverdale service area and is expected to experience significant population growth with nearly a doubling of flows by 2030. The 85 percent of FPC criterion is currently exceeded.
- **LS-12:** This lift station serves the southwest Silverdale service area with flows projected to nearly double by 2030. It is currently a medium-sized lift station, but when it is expanded it will become a major lift station with a design capacity of 1,100 gpm.
- **LS-21:** This lift station is located in the northern Silverdale service area. While flows are projected to more than double by 2030, the 100 percent of firm capacity threshold is projected to be exceeded by 2013. The lift station will continue to be a medium-sized facility serving residential areas.
- **LS-22:** This medium-sized lift station is also located in the northern Silverdale area receiving flows from LS-21 and other residential areas. The 85 percent of existing pumping capacity threshold is currently exceeded. The LS-22 Force Main Replacement project described in Table 7-2 will be completed with the LS-22 project.

- **LS-32:** This small lift station is located at the southern edge of the Central Kitsap service area serving the area around SR 303. Flows are projected to exceed 100 percent of FPC shortly after 2010 and more than double by 2030, but it will continue to be a small lift station.
- **LS-65:** This small lift station serves the residential area in the southeast Central Kitsap service area. Flows are projected to increase over tenfold by 2030 and exceed the FPC by 2015. The lift station will likely become a medium-sized facility when it is expanded to have 675 gpm pumping capacity.

The remaining three lift station projects consist of upgrades and expansions with projected flows exceeding the 85 percent threshold after 2015 yet reaching 100 percent of FPC before 2030.

- **LS-10:** This small lift station serves the Meadowdale West area. Flows are projected to increase over fivefold by 2030 and the FPC is projected to be reached by 2013.
- **LS-13:** This medium-sized lift station is located in the Chico area of the Silverdale UGA. Existing flows are projected to more than double to 500 gpm by 2030. The 100 percent of FPC threshold is projected to be exceeded in 2021.
- **LS-34:** This medium-sized lift station will become a major facility by 2030 when flows are projected to increase to 1,250 gpm. Some of the increase in flows is attributed to the diversion of flows from LS-5 to LS-34 as part of the Schedule 1 project completed in 2010. The 85 percent of pumping capacity threshold is projected to be exceeded by 2019.

7.4.2 Existing Piping System Projects

Five existing collection system projects have the highest priority and are recommended for implementation in the 6-year CIP. These projects ranked highest based on pipe material condition, maintenance issues, and excessive manhole surcharging associated with priority lift station projects.

- **Techite Pipe Replacement:** This project replaces 6,500 feet of 30-inch-diameter force main conveying the entire flow from the Silverdale and Central Kitsap service areas to the CKWWTP. The project is high-priority due to potential failure of critical pipeline; it is included in Schedule 2 projects scheduled for construction in 2011.
- **Bayshore Pipe Replacement:** This project replaces 1,865 feet of gravity sewer. The project is high-priority due to excessive cleaning required by Public Works.
- **NE Bentley Drive Pipe Replacement:** This project replaces 1,865 feet of gravity sewer to correct surcharging when LS-8 capacity is increased. The LS-8 improvement project is identified as a high-priority project.
- **Mickelberry Road Pipe Replacement:** This project replaces about 1,400 feet of gravity sewer in downtown Silverdale. Pipe surcharging is currently minimal but will worsen as flows increase. The LS-1 improvement project, a high-priority project, must be completed first.
- **Silverdale Way Pipe Replacement:** This project, which replaces about 2,880 feet of gravity pipe, is high-priority due to existing manhole surcharging exceeding 50 percent of depth.
- **LS-6 Force Main Replacement:** This project replaces 1,150 feet of force main from LS-6. The larger force main is required to correct excessive flow velocities when LS-6 capacity is increased.

The second tier of priority projects for the existing collection system is developed based on the estimated timing of excessive surcharging problems as flows increase or is related to lift station improvements. The following nine projects, which are in this category, are recommended for implementation after 2017:

- **Levin Road Pipe Replacement:** This project replaces about 2,100 feet of gravity sewer that currently has pipe and some manhole surcharging that will worsen as flows increase.

- **Fredrickson Road Pipe Replacement:** This project replaces about 970 feet of gravity sewer that currently has some surcharging.
- **Old Town Silverdale Pipe Replacement:** Some surcharging currently exists and a section of the pipe near Silverdale Way has an inverted slope. This project involves replacing about 2,140 feet of gravity sewer and must be completed before the Anderson Hill Pipe Replacement project can be constructed.
- **John Carlson Road Pipe Replacement:** Currently limited pipe surcharging exists but will worsen as flow increases, including significant overtopping of several manholes. This project involves replacement of about 2,700 feet of gravity sewer.
- **Auklet Place Force Main Replacement:** Excessive flow velocities will occur when LS-36 capacity is increased. About 675 feet of force main would be replaced.
- **Lemolo Peninsula Pipeline Replacement:** Some manhole surcharging currently exists but will become more significant as flows increase. Hydraulic capacity is below projected 2030 flow. About 4,450 feet of pipe will function as a low-head force main.
- **LS-7 to State Highway 303 Pipe Replacement:** This project involves replacing about 3,500 feet of gravity sewer that will have pipe and manhole surcharging as flows increase. Other projects that may be completed prior to this project and affect its timing include the upgrade of LS-8 and the NE Bentley Drive Pipe Replacement.
- **LS-22 Force Main Replacement:** This project replaces 1,050 feet of force main from LS-22 to reduce pumping head for LS-22 when it is upgraded.

The third tier of priority projects are those pipeline projects related to lift station capacity increase projects that are third-tier or lower in priority or will be required as flows increase beyond the capacity of existing pipes sometime after 2020. The following four projects are in this category:

- **Fuson Road to Franklin Avenue Pipe Replacement:** This project replaces about 890 feet of gravity sewer that currently has minor pipe and manhole surcharging. Minor surcharging will continue at future flows.
- **Southern Old Military Road Force Main Replacement:** This project replaces about 3,300 feet of low-pressure gravity sewer that currently has minor pipe surcharging conditions. Major pipe and manhole surcharging will occur in the future as flows increase in the Central Kitsap service area from LS-6 and LS-7.
- **Northern Old Military Road Force Main Replacement:** This project, which replaces about 8,300 feet of pipe for increased flow capacity, will be required after LS-6 capacity is increased and wastewater flows generated in the service area increase due to growth.
- **Anderson Hill Road Pipe Replacement:** This project replaces about 3,750 feet of gravity pipe that will have pipe and manhole surcharging before 2030.

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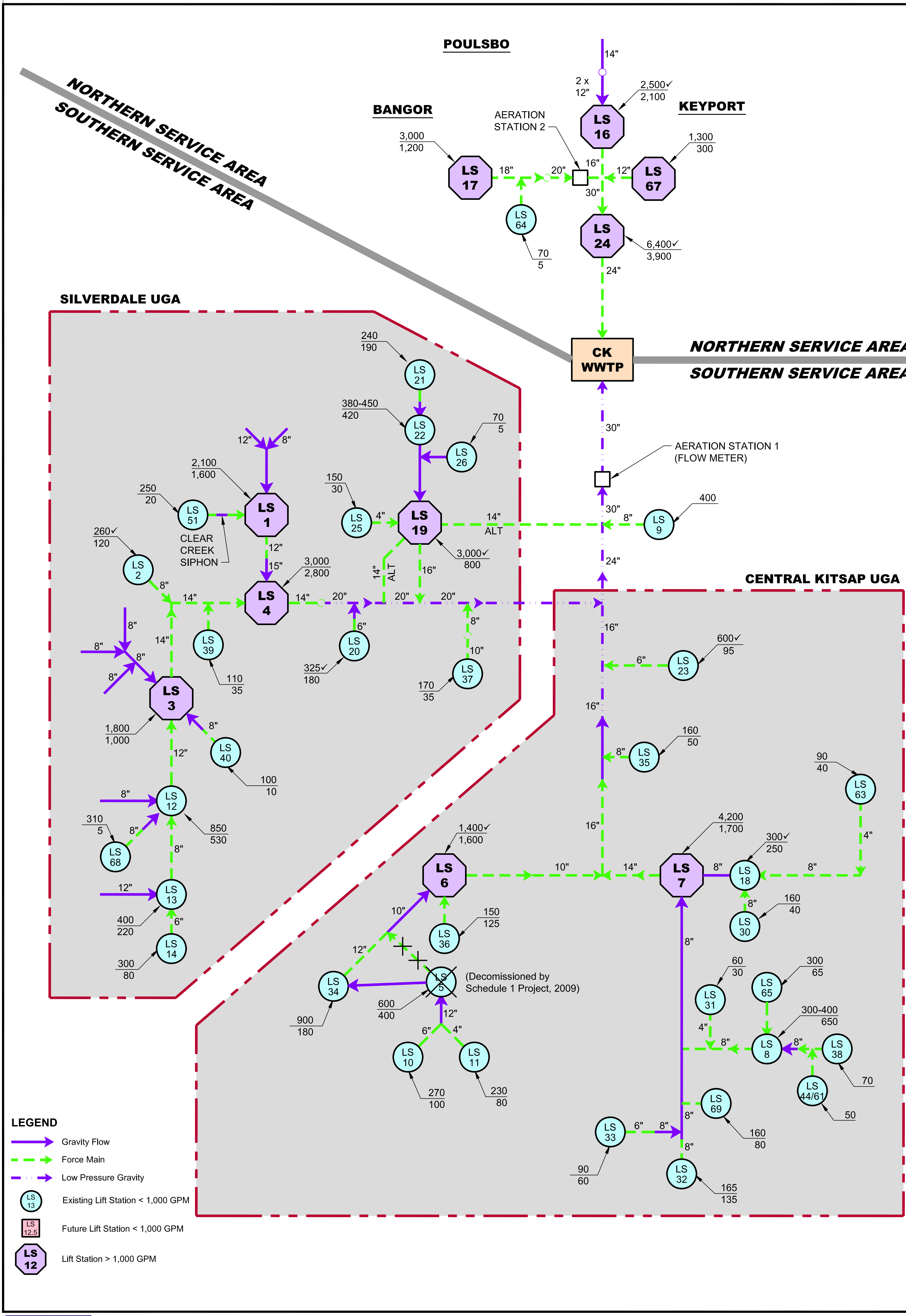

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Existing Lift Station Capacity and Existing Peak Flows
Kitsap County Public Works
02/2011

7-1

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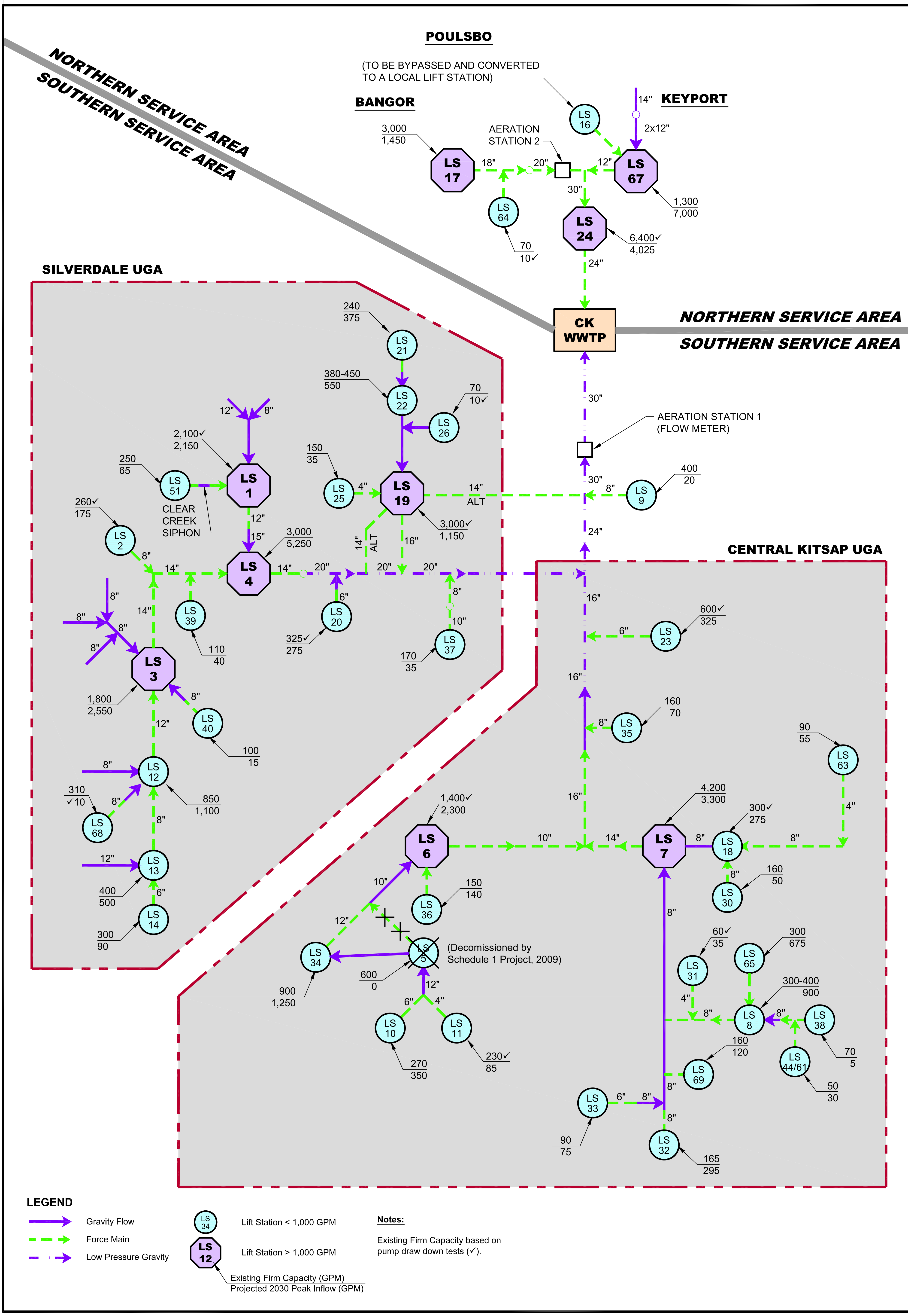

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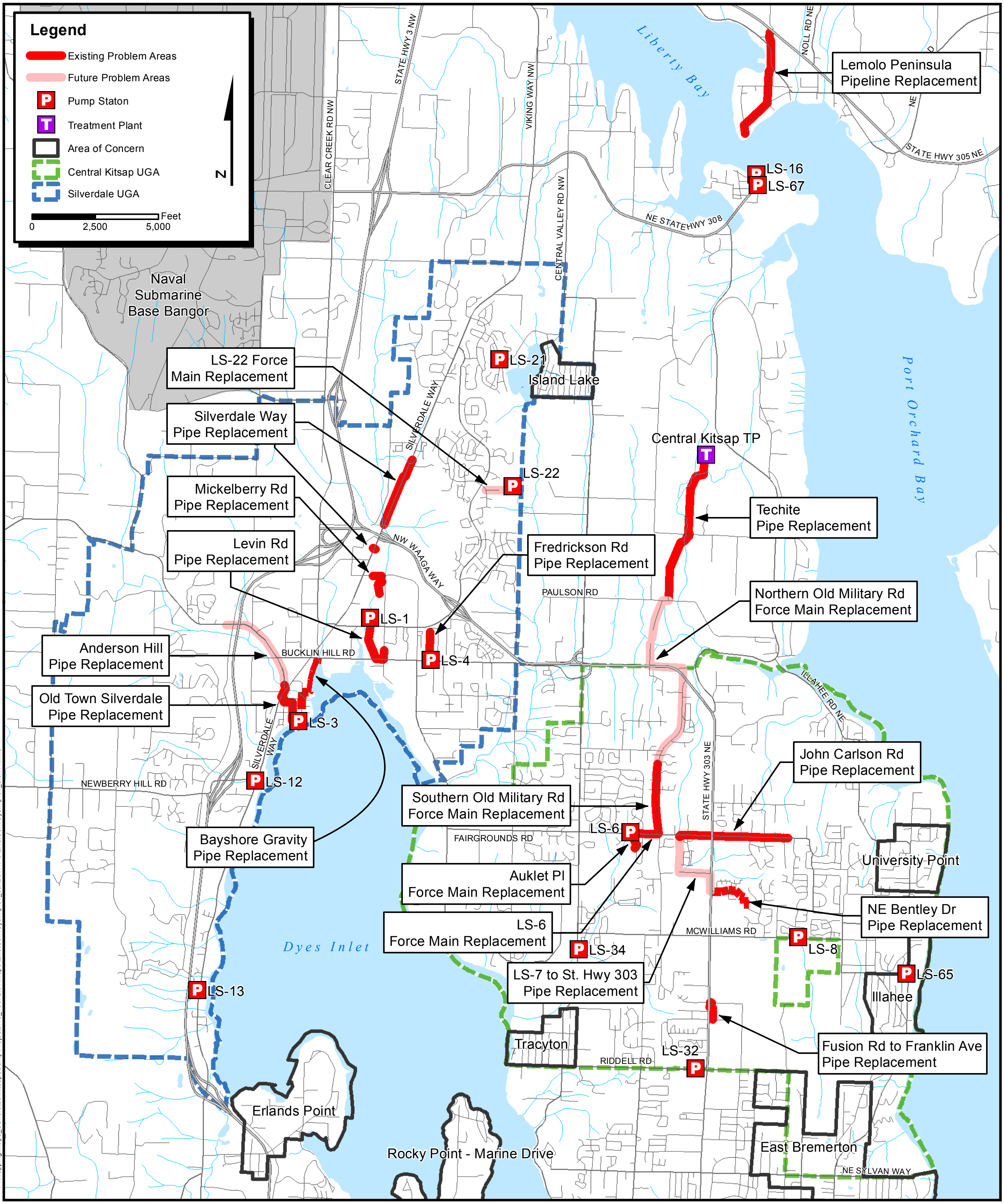
Existing Lift Station Capacity and Future 2030 Peak Flow

Kitsap County Public Works

January, 2011

Figure

7-2



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Map Date: January, 2011

KITSAP COUNTY 1857 WASHINGTON

Existing Conveyance System Improvements

Kitsap County Public Works
January, 2011

Figure
7-3

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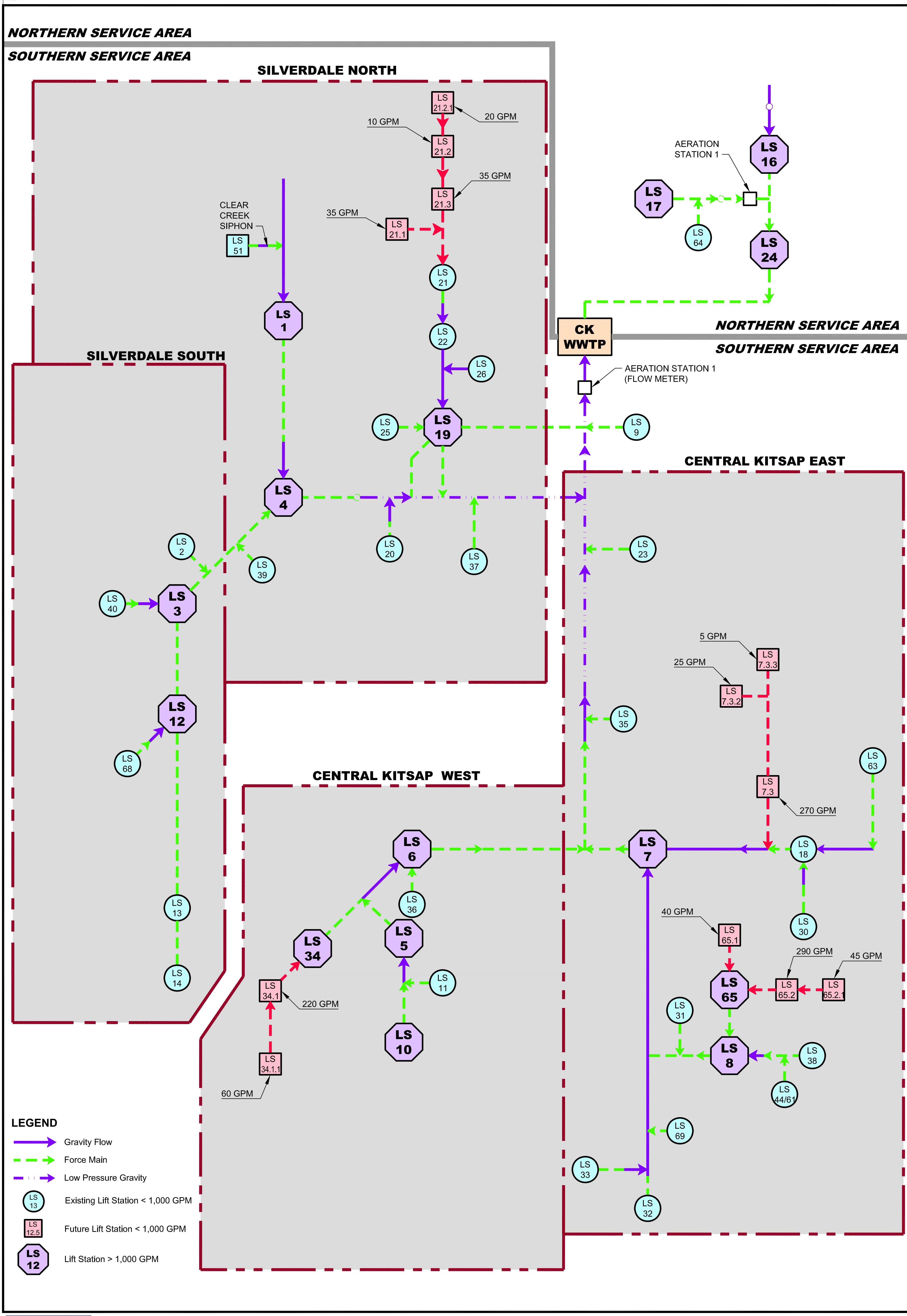

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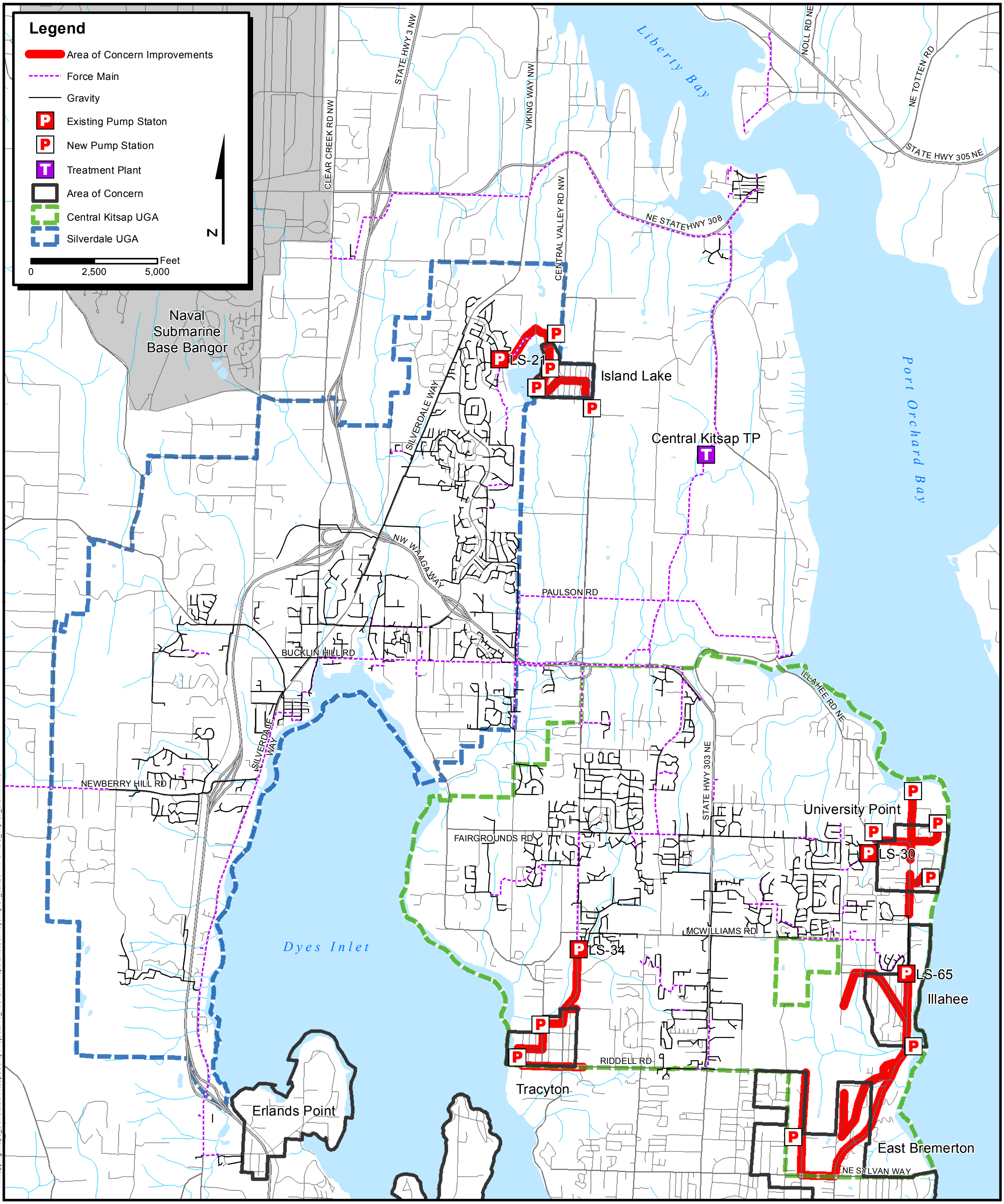
New Future Lift Station Capacity Requirements for 2030 Flow
Kitsap County Public Works
02/2011

Figure
7-4



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KITSAP COUNTY 18 57 WASHINGTON

Areas of Concern System Improvements

Kitsap County Public Works
January, 2011

Figure

7-5

CHAPTER 8

WASTEWATER TREATMENT IMPROVEMENTS, REUSE OPTIONS, AND ENERGY CONSERVATION AND GENERATION OPPORTUNITIES

The earlier chapters of this Facility Plan present information that establishes the foundation for a sound, defensible decision-making process. The key criteria described in Chapter 6 are applied according to a carefully crafted methodology by which project alternatives are identified, evaluated, and ranked. In this chapter, those key criteria are objectively applied to all wastewater treatment system alternatives, resulting in a final set of recommendations.

8.1 Overview of Chapter Contents

This chapter identifies alternatives for the various major unit processes at the CKWWTP. These are categorized into the following:

- liquid-stream treatment (including tertiary treatment for reclaimed water)
- solids-stream treatment (including energy conservation and generation alternatives)
- side stream treatment (e.g., centrate at the CKWWTP).

As described in Chapter 6, the following methodology is applied to treatment system improvements:

1. Project identification (all applicable treatment technologies identified)
2. Project evaluation
    a. Initial evaluation (identified projects subject to a pass/fail examination)
    b. Final evaluation and selection of individual unit processes
        i. Reclaimed water (treatment at CKWWTP and satellite treatment plants)
        ii. Solids thickening
        iii. Solids stabilization (e.g., digestion)
        iv. Solids dewatering
        v. Biogas utilization/energy usage
        vi. Biosolids management
    c. Combined wastewater treatment and reuse alternatives
3. Project ranking
4. Project recommendations
5. Project costs

This approach concludes with a ranking of treatment alternatives, forming a complete treatment train and a description of the recommended treatment plant capital improvements encompassing the best overall treatment strategies and technologies.

8.2 Summary of Initial Process Screening and Evaluation

Project identification and initial screening of the alternatives using simple pass-fail criteria are described in Appendix 8A, with presentation materials for an alternatives development workshop included in Appendix

8B and descriptions of various process elements in Appendix 8C. Table 8-1 summarizes those processes that passed the screening analysis.

Table 8-1. Summary of Selected Liquid-Stream, Solids-Stream, and Side Stream Treatment Technologies for Final Evaluation

Process	Technology
Liquid stream	
Screening	Mahr screen (with room set aside for potential future second stage fine screen)
Grit removal	Aerated grit removal
Flow equalization	Used only in conjunction with MBR for secondary treatment
Primary treatment	Conventionally primary clarification Chemically enhanced primary clarification (CEPT) (if MBR is selected for secondary treatment to allow base loading of MBR with blending under peak flows)
Secondary treatment	Conventional activated sludge (CAS) Integrated fixed-film activated sludge (IFAS) Membrane bioreactor (MBR)
Tertiary treatment	Media filtration using sand or cloth disc filters (with room for RO if needed in the future). Package MBR plants selected for satellite treatment.
Disinfection	UV: medium pressure UV: low pressure, high intensity
Solids stream	
Thickening	Gravity thickeners (for primary sludge thickening) GBT (for WAS thickening)
Stabilization	Mesophilic anaerobic digestion (thermophilic capable) Thermophilic anaerobic digestion Temperature-phased anaerobic digestion (TPAD) Sonics anaerobic digestion (for future only as an add-on to mesophilic digestion) MicroSludgeTM (for future only as an add-on to mesophilic digestion) OpenCEL (for future only as an add-on to mesophilic digestion)
Dewatering	Centrifuge Thermal drying-digested sludge (for future only)
Side stream	
Side stream treatment	Struvite crystallization
Digester gas utilization	Combust in boilers, flare the rest Combust in boilers, use rest for fleet vehicles Cogeneration Supplemental organic feed to digesters Use gas for thermal drying of sludge
Effluent heat utilization	Effluent heat pumps

The following sections describe the final evaluation of the screened alternatives. With the completion of this final evaluation, the preferred technologies and programs are combined with the basic unit processes to develop a list of complete wastewater treatment and reuse projects.

8.2.1 Liquid-Stream Processes

Most liquid-stream unit processes except for secondary and tertiary treatment have been selected as a result of the initial evaluation. Flow equalization and chemically enhanced primary clarification (CEPT) will be evaluated only if MBR is selected for secondary treatment. The three alternative processes for secondary treatment that remain after the initial screening evaluation include conventional activated sludge (CAS), integrated fixed-film activated sludge (IFAS), and MBR. CAS is the current technology employed at the CKWWTP. These processes are combined with reuse options and further evaluated in Section 8.3.

Besides selection of the overall secondary and tertiary treatment processes, the County also evaluated a series of projects that were developed to improve energy efficiency at the CKWWTP. Descriptions of these projects are given in Appendix 8D. Projects related to the liquid-stream processes include the following:

- **Aeration diffuser upgrade:** This project entails replacement of the aeration diffuser membranes, resulting in more efficient oxygen transfer and a decrease in the energy requirements associated with the aeration blowers. The remaining diffuser holders in the basins that are currently blank holders will be equipped with new membranes to increase the overall diffuser air supply capacity.
- **Blower replacement with high-efficiency blowers:** This project involves replacement of the existing multistage centrifugal blower with high-efficiency turbo blowers. Any new blower required to meet future aeration requirements will also be a high-efficiency turbo blower. In addition, the existing aeration control system will be improved by installing new DO probes and new basin air control valves. This will allow proper control and distribution of air flows based on demand in the basins, avoiding over-aeration during low-demand periods.

8.2.2 Water Reclamation Options

At the CKWWTP, water reuse is currently limited to in-plant process uses such as scum spray water at the primary and secondary clarifiers, and flushing and polymer dilution water for the centrifuge. Because UV disinfection is used for effluent disinfection, sodium hypochlorite addition is included as part of the process water system to provide a chlorine residual in the plant effluent reused at the plant.

As guided by Kitsap County's "Water as a Resource" Policy (Appendix 5B), the County aims to reduce pollutant loading to Puget Sound and provide water reclamation to conserve groundwater resources.

An evaluation was conducted to assess reclaimed water production at the CKWWTP versus production at satellite plants. The evaluation is described in more detail in Appendix 8E. During the evaluation, it was found that the largest single potential reclaimed water demand is the Silverdale Water District, which has indicated that up to 3.5 mgd of reclaimed water could be reused for irrigation and groundwater recharge within the district's service area. The analysis indicated that construction of a satellite plant to produce reclaimed water would have a higher capital cost than providing water reuse at the CKWWTP, based on similar reclaimed water production capacity. Also, currently, a satellite plant site that will allow production of 3.5 mgd or higher of reclaimed water to match the Silverdale demand cannot be identified.

Based on these results, construction of satellite plants is not recommended. The treatment technology to produce reclaimed water at the CKWWTP, tertiary filters or MBR, is further evaluated later in this chapter.

8.2.3 Solids-Stream Processes and Biosolids Management

This section summarizes alternatives evaluation for the solids treatment train, including solids thickening processes, anaerobic digestion processes, and biosolids management options.

8.2.3.1 Biosolids Incineration

Biosolids incineration consists of thermal reduction of the sludge to convert the organic solids to oxidized end products, primarily carbon dioxide and water. Sludges processed by incineration are usually dewatered, unstabilized sludges. There are two types of incinerators: multiple-hearth and fluidized beds. The main advantages and disadvantages of incineration are given below.

Advantages:

- maximum volume reduction, thus reducing the disposal requirements
- destruction of pathogens and toxic compounds
- independence of outside conditions such as proximity and capacity of biosolids reuse sites
- energy recovery potential.

Disadvantages:

- no beneficial reuse of biosolids as favored by current regulation trends
- ash must be disposed of only at permitted landfills
- transportation to regional landfills can greatly increase disposal costs
- stringent air monitoring requirements
- difficult to obtain permit for new incinerator construction
- incinerator operator certification required
- exhaust gas treatment potentially required (e.g., for mercury removal).

Biosolids incineration is not recommended at the CKWWTP due to the expected permitting difficulty and the elimination of beneficial biosolids reuse. The existing digestion system will also become a stranded investment (except during incinerator shutdown for maintenance) as the feed sludge to the incinerator is not stabilized.

8.2.3.2 Recommended Processes

A number of analyses were conducted to evaluate the thickening, digestion, and biosolids management alternatives. The detailed summary of these analyses is described in Appendix 8F, with a number of supporting technical memoranda provided in Appendices 8G to 8M. The following summarizes the results of these analyses.

Solids Thickening

- Install a GBT to thicken the secondary sludge and continue to thicken primary sludge in the gravity thickeners

Anaerobic Digestion

- Construct the third digester to be operated under mesophilic conditions but capable of conversion to thermophilic operation through the addition of necessary ancillary equipment
- Future conversion to thermophilic digestion will depend on the need to respond to changing regulatory and market climates for biosolids disposal and energy recovery.

Biosolids Management

- Continue the current practice of hauling Class B biosolids to Fire Mountain Farm and EMU Composting for disposal (beneficial reuse)

- Among the different treatment schemes to produce Class A biosolids, digestion-based processes are currently considered more favorable than sludge drying due to the overall process flexibility and reliability.
- It is recommended that the County regularly update the biosolids management evaluation to keep abreast of any changes in the current practice, sludge processing technologies, and regulatory requirements.

8.2.4 Biogas Utilization, Energy Generation, and Other Ancillary Technologies and Processes

Currently, all of the gas generated at the CKWWP is flared, while fuel oil is used to heat the digestion system. This costly practice results in a sink for available energy and higher GHG emissions. Several scenarios for biogas utilization were reviewed, as described in Appendices 8F and 8G. These include conversion to biogas-fired boilers and flaring the excess biogas, conversion to biogas-fired boilers and using the excess biogas to fuel the County's fleet vehicles, and cogeneration. The following conclusions were reached based on the analysis:

- The option of converting to biogas-fired boilers and using the excess biogas to fuel the County's fleet vehicles was eliminated because the amount of biogas available would be insufficient to make the process economically viable with fleet conversion and equipment requirements.
- Converting to biogas-fired boilers would result in substantial savings in fuel oil cost. With cogeneration, the County would incur about $59,000 in savings over the life of the project through reduced retail power purchase. It is thus recommended that the County implement cogeneration at the CKWWTP.

Other ancillary processes for nutrient recovery, enhancement of biogas generation, and solids reduction were also evaluated. The evaluation is described in Appendices 8F and 8G. The following recommendations are made regarding these processes:

- Co-digestion (adding supplemental organic waste streams to the digesters) is not currently recommended but space should be allocated for a receiving station.
- Nutrient recovery process (specifically struvite precipitation) is not recommended as there is insufficient phosphorus in the plant's wastewater to make the process economically viable.
- Sludge minimization technologies (Sonix™ or Sonolyzer™, MicroSludge™, OpenCel) can greatly enhance the digestion process but currently have limited full-scale application and require expensive equipment. It is recommended that these technologies be further evaluated in the future after the digestion process is optimized. Space will be set aside for potential future installation.

8.2.5 Onsite Systems versus Centralized Treatment

In the course of extending wastewater treatment to a larger service area and a larger service population, the decision needs to be made as to whether areas that are served by septic systems should be connected to the centralized treatment facility (i.e., to CKWWTP) or connected to a local, community-based onsite system. The latter is sometimes also referred to as a satellite or distributed treatment system. Onsite systems could consist of septic tanks for basic treatment or packaged activated sludge or MBR systems for more advanced treatment. The effluent is typically discharged into a drain field or reused for irrigation or groundwater recharge.

Septic tanks are the low-cost option for onsite systems, both in terms of capital and O&M costs. Septic tank effluent is typically discharged into a drain field, thus indirectly recharging the groundwater. However, the effluent quality is low, with BOD and TSS concentrations usually higher than the typical 30 mg/L limit for secondary effluent. Septic tanks also do not provide nutrient removal. In Kitsap County, septic tanks with flows up to 10,000 gpd are regulated by the Health District, while Ecology regulates septic tanks with flows of more than 10,000 gpd. Because Ecology is imposing increasingly restrictive limits on TN concentrations for discharges into Puget Sound, it will also be very restrictive in permitting installation of new septic tanks, where the effluent discharged into a drain field would eventually flow into Puget Sound. Therefore, septic tanks are favorable only for systems with very low flow (no more than 10,000 gpd).

An onsite system with advanced treatment could provide reuse-quality effluent. As described in Section 8.2.2 above, the construction of a satellite plant along the collection system to produce reclaimed water would have a higher capital cost than providing water reuse at the CKWWTP, based on similar reclaimed water production capacity. For treatment capacity of about 2 to 4 mgd and including the costs for reclaimed water conveyance and recharge facility, the unit cost of a satellite MBR plant is about $20 million per mgd versus a unit cost of about $16 million per mgd for an MBR system at the CKWWTP to produce reclaimed water. If the onsite system is constructed to serve communities that are far away from the collection system, land availability is usually not an issue, but the available flows will be so low that the treatment system could be substantially more expensive than centralized treatment on a unit flow basis. However, the centralized collection system will not need to be extended to these areas. Onsite systems are thus more attractive for areas that are very far away from any existing collection system that would otherwise require long sewer pipes and lift stations to connect to the main collection system. The main disadvantages of those systems include system ownership and the management of operations and maintenance. Onsite systems are often directly owned by the local community. In that case, outside contractors would be hired to operate and maintain the facility, which increases the overall costs. If the County owns these facilities, more staff will be required to make regular site visits at these facilities than if all flow is sent to the centralized treatment plant.

The County will continue to work with the Departments of Health and Ecology and the development community to explore viable alternatives to centralized wastewater treatment.

8.3 Evaluation of Combined Wastewater Treatment and Reuse Alternatives

This section combines the basic, unit process treatment elements and reuse options described in the previous sections into comprehensive treatment alternatives for the expansion of wastewater treatment facilities at the CKWWTP. These alternatives undergo final evaluation in the following section.

Based on the screened treatment technologies summarized in Table 8-1 above and the reclaimed water treatment evaluation, eight liquid-stream treatment alternatives were developed for the CKWWTP. These alternatives differ in the level of treatment for outfall discharge and for the extent of reclaimed water production. Currently, the CKWWTP does not have any ammonia limits. However, as mentioned in Chapter 5, in order to comply with the TMDL requirements, an effluent ammonia limit may be added in the future. For the purpose of the alternatives final evaluation, several scenarios were included that range from seasonal nitrification to year-round full nitrification. Comparison of these scenarios thus illustrates the impact of increasingly more stringent effluent ammonia requirements that will potentially be imposed in the future.

Table 8-2 defines the eight alternatives. In all cases, it was assumed that secondary treatment will continue to be preceded by conventional primary clarification and the composition and loadings in the return streams are minimally impacted by any changes in the solids treatment processes. Construction cost for each alternative was developed assuming that solids treatment will consist of gravity thickeners for primary sludge thickening, GBT for WAS thickening, conventional mesophilic anaerobic digesters, and centrifuge for sludge dewatering.

Table 8-2. CKWWTP Liquid-Stream Treatment Alternatives		
Alternative	Effluent quality	Reclaimed water
1. CAS with summer nitrification	NH_3-N < 1 mg/L (summer only)	None
2. CAS with year-round nitrification	NH_3-N < 1 mg/L (year-round)	None
3. CAS with side stream MBR system	Mainstream: NH_3-N < 1 mg/L (summer only) Side stream: NH_3-N < 1 mg/L (year-round)	3.5 mgd
4. Full MBR conversion	TN ≤ 10 mg/L (year-round)	8.2 mgd (peak month) 18 mgd (equalized peak hour)
5. CAS with TN removal and partial flow tertiary filter	TN ≤ 10 mg/L (year-round)	3.5 mgd
6. CAS with TN removal and full flow tertiary filter	TN ≤ 10 mg/L (year-round)	8.2 mgd (peak month) 18 mgd (equalized peak hour)
7. IFAS with TN removal and partial flow tertiary filter	TN ≤ 10 mg/L (year-round)	3.5 mgd
8. IFAS with TN removal and full flow tertiary filter	TN ≤ 10 mg/L (year-round)	8.2 mgd (peak month) 18 mgd (equalized peak hour)

Figures 8-1 through 8-8 show the process flow diagrams for the eight alternatives. Table 8-3 summarizes the design criteria, facility sizing data, operational requirements, and estimated total project costs. These total project costs only reflect elements that are used for comparative purposes between the eight alternatives. They do not reflect all the costs necessary for a complete project. A complete description of cost data is provided in Appendix 8N. More detailed discussions of each of these alternatives are given below.

8.3.1 Alternative 1: CAS with Summer Nitrification

This alternative serves as the base case. While the plant currently does not have an effluent ammonia limit, it is expected that summertime nitrification will be required in the next NPDES permit cycle, due to increasing water quality concerns in Puget Sound. The current CAS system can provide nitrification in the summer by operating at a slightly higher SRT. An internal mixed liquor recycle (IMLR) pump would be added in each aeration basin to pump nitrified mixed liquor from the end of the aeration basin to the anoxic selector cell to allow denitrification. Although there is no nitrate limit for this alternative, denitrification in a pre-anoxic cell reduces oxygen demand, provides alkalinity recovery, and also reduces the potential for denitrification in the secondary clarifiers. In the winter, when nitrification is not required, the system would operate at low SRT to minimize nitrification and thus in anaerobic selector mode. New aeration basins would not be required; however, one new secondary clarifier would be required to accommodate peak flows and solids loadings to the clarifiers. Disinfection would continue to be achieved by UV disinfection, either in the existing medium-pressure system or a system modified to include low-pressure, high-intensity lamps. For this alternative, there would be no reclaimed water production at the plant, except for in-plant uses.

8.3.2 Alternative 2: CAS with Year-Round Nitrification

For this scenario, the CKWWTP would be required to nitrify year-round, but there would be no reclaimed water production (except for in-plant uses). In order for the current CAS system to nitrify year-round, two new aeration basins would be required, thus doubling the existing aeration basin capacity. Just as for Alternative 1, an IMLR pump would be added in each aeration basin to pump nitrified mixed liquor from the end of the aeration basin to the anoxic selector cell to allow denitrification. One new secondary clarifier would be added to accommodate peak flows and solids loadings.

8.3.3 Alternative 3: CAS with Side Stream MBR System

For this alternative, the CKWWTP would be required to provide nitrification in the summer only for effluent discharged to the outfall. The plant would produce up to 3.5 mgd of reclaimed water. This reclaimed water production capacity corresponds to the projected amount that the Silverdale Water District is planning to obtain from the CKWWTP in the future for irrigation uses and groundwater recharge, as mentioned above. A side stream treatment system using MBR technology would be added to provide the 3.5 mgd of reclaimed water. The new MBR system would receive primary effluent and disinfection of the MBR effluent would be provided by chlorination using sodium hypochlorite. This would provide the chlorine residue needed for reclaimed water in the distribution system. Because MBRs typically require fine screening with screen opening size down to about 1 to 3 mm to prevent excessive fouling of the membranes, a new fine screening system sized for 3.5 mgd would be added to pretreat the primary effluent diverted to the side stream MBR system.

The side stream MBR system would consist of an aeration basin, membrane tanks containing the membrane cassettes or units, membrane blowers (to provide scouring air to the membranes), recirculation pumps (to provide up to 400 percent RAS flow), permeate pumps, and chemical cleaning system. The membrane tanks could be sized such that they could continue to be used if the plant converts to full MBR treatment by adding more membrane cassettes into the tanks (i.e., to convert to Alternative 4). Because of the relatively low carbon-to-nitrogen ratio measured for the primary effluent based on both historical and special sampling data, supplemental carbon addition would be required to achieve adequate denitrification. Examples of supplemental carbon include methanol, acetic acid, waste products from dairy and soft drink bottling industries, and proprietary products that contain readily biodegradable organics.

8.3.4 Alternative 4: Full MBR Conversion with TN Removal

For this alternative, the existing CAS system at the CKWWTP would be converted into an MBR system designed to achieve TN removal to produce reclaimed water quality for the full plant flow. New fine screens would be added to pretreat the primary effluent before it is routed to the MBR system. The existing aeration basins would continue to operate as the main aeration basins in the system. New, separate membrane tanks would be constructed, from which permeate is drawn before it is sent to the UV system for disinfection. Hypochlorite is then added to the effluent to provide a chlorine residual. Because solids separation is achieved via the membranes, secondary clarifiers would not be needed. For this alternative, it was assumed that the two existing clarifiers would be converted into equalization tanks. Under the 2030 flows and loading conditions, the MBR system would treat up to 18 mgd, with any excess flows sent to the equalization tanks.

Similar to the side stream MBR system for Alternative 3, the full MBR system would include new membrane blowers, permeate pumps, recirculation pumps, and chemical cleaning system. Supplemental carbon would be added to achieve the needed denitrification.

8.3.5 Alternative 5: CAS with TN Removal and Partial Flow Tertiary Filter

For this alternative, the existing CAS system would be used to achieve TN removal for reclaimed water production. Four new aeration basins would be added, thus tripling the aeration basin capacity. Just as for Alternatives 1 and 2, an IMLR pump would be added in each aeration basin to pump nitrified mixed liquor from the end of the aeration basin to the anoxic selector cell to allow denitrification. Supplemental carbon would be added to achieve the needed denitrification. One new secondary clarifier would be added to accommodate peak flows and solids loadings. This alternative would produce up to 3.5 mgd of reclaimed water to match the current plan for reuse at Silverdale. Therefore, a tertiary filtration system (either sand or cloth disc filters) sized for 3.5 mgd would be used to treat a portion of the secondary effluent. The filtered effluent is then chlorinated before it is discharged to the distribution system. This alternative can be converted to full reclaimed water production (thus converting into Alternative 6 below) by adding more filters to treat the full plant flow.

8.3.6 Alternative 6: CAS with TN Removal and Full Flow Tertiary Filter

This alternative is similar to Alternative 5, except that the tertiary filters would be sized to treat the full plant flow up to the 2030 design peak day flow (about 18 mgd). Flows beyond the peak day flow will be stored in an equalization tank and sent to the filters after the peak flow event.

8.3.7 Alternative 7: IFAS with TN Removal and Partial Flow Tertiary Filter

For this alternative, the existing CAS system would be converted into an IFAS system by placing media within the aeration basins. The media provides the surface for biofilm growth, which when combined with the suspended growth in the basins, allows the system to operate at a higher true SRT without increasing the mixed liquor suspended solids (MLSS) concentrations, and thus solids loadings to the clarifiers. Because of its benefit to reduce aerobic SRT and thus minimizing aeration basin volume requirements, the IFAS process is most commonly applied to systems that require nitrification. Two main types of media, each with different shapes and sizes, are commercially available: floating or fixed media. Floating media require coarse bubble diffused aeration and retention screens or sieves between each stage in the aeration basin. Fixed media generally have a lower specific surface area than floating media and are not mixed as well with the mixed liquor.

For the purpose of this evaluation, floating media were assumed to be added into the existing aeration basins. To achieve TN removal, two new aeration basins would be added. Each aeration basin would be divided into an anoxic zone for denitrification (same volume as the existing anaerobic selector) and two aerated zones, with media added into one or both zones. Supplemental carbon would be added to achieve adequate denitrification. In an IFAS system, solids separation would still be required in secondary clarifiers; therefore, one new secondary clarifier would be added to accommodate peak flows and solids loadings. This alternative would provide reclaimed water by routing up to 3.5 mgd of secondary effluent to a tertiary filtration system. The filtered effluent is then chlorinated before it is discharged to the distribution system. To convert to full reclaimed water production (i.e., Alternative 8), the filtration system can be expanded.

8.3.8 Alternative 8: IFAS with TN Removal and Full Flow Tertiary Filter

This alternative is similar to Alternative 7, except that the tertiary filters would be sized to treat the full plant flow up to the 2030 design peak day flow (about 18 mgd). Flows beyond the peak day flow will be stored in an equalization tank and sent to the filters after the peak flow event.

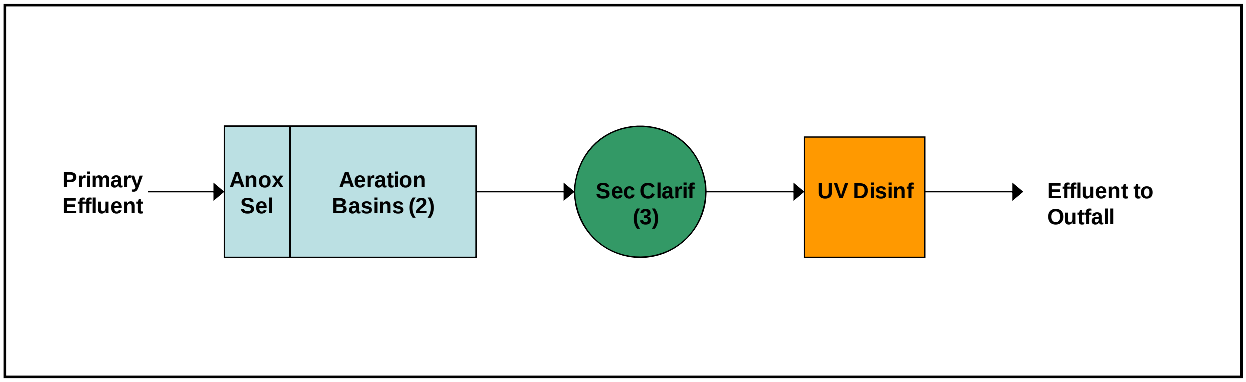

Figure 8-1. Process flow diagram for Alternative 1 (CAS with summer nitrification)

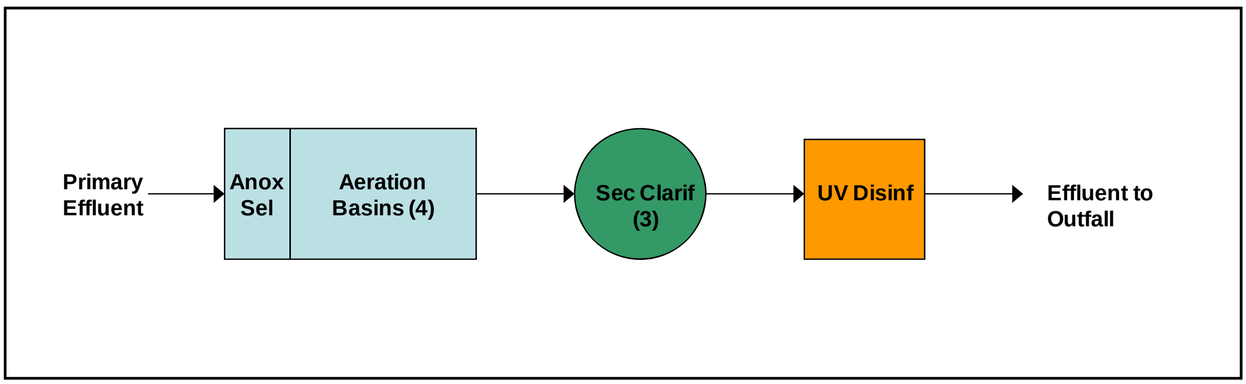

Figure 8-2. Process flow diagram for Alternative 2 (CAS with year-round nitrification)

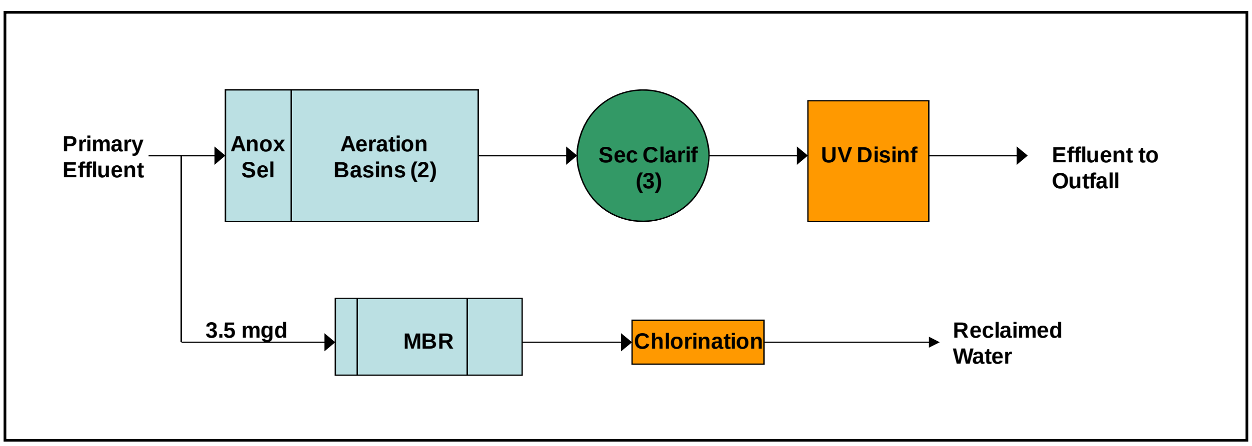

Figure 8-3. Process flow diagram for Alternative 3 (CAS with side stream MBR)

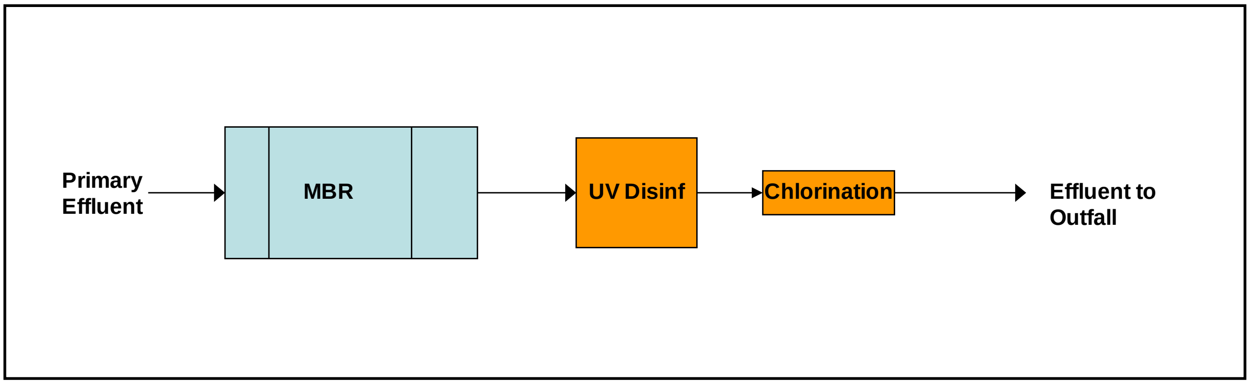

Figure 8-4. Process flow diagram for Alternative 4 (full MBR conversion with TN removal)

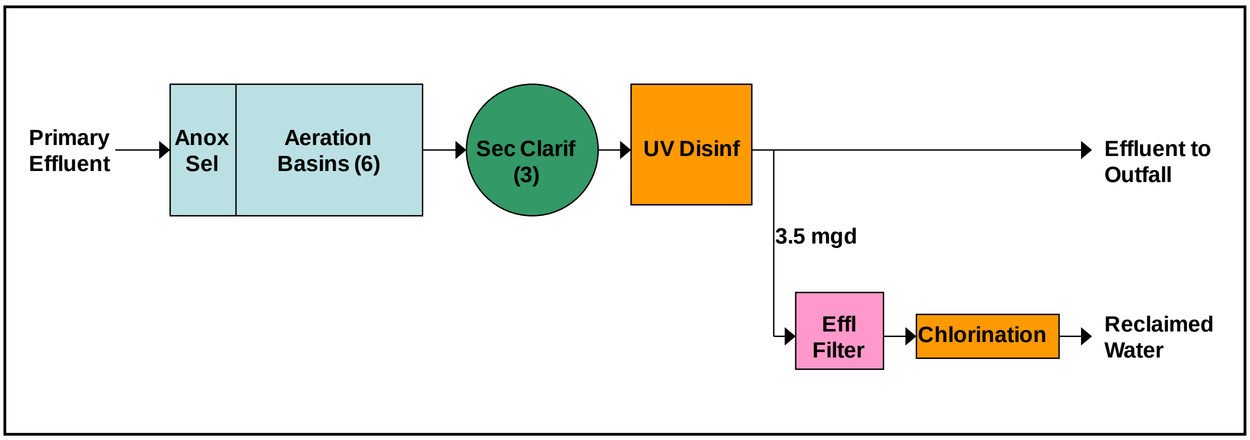

Figure 8-5. Process flow diagram for Alternative 5 (CAS with TN removal and partial flow effluent filtration)

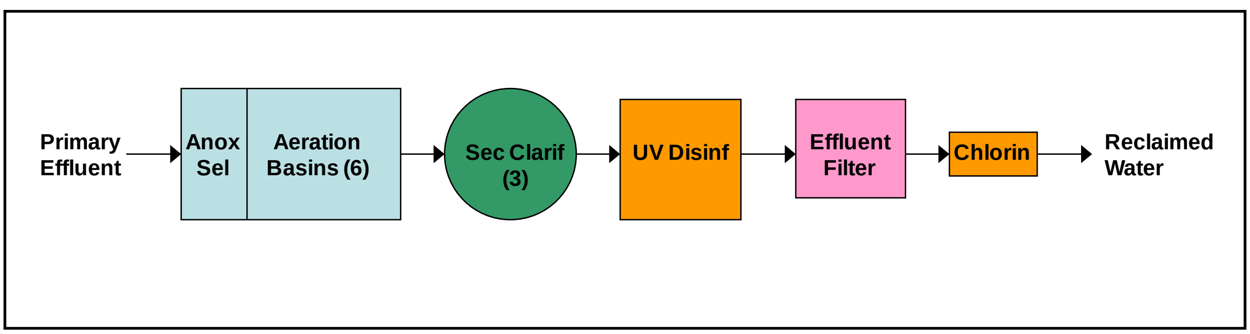

Figure 8-6. Process flow diagram for Alternative 6 (CAS with TN removal and full flow effluent filtration)

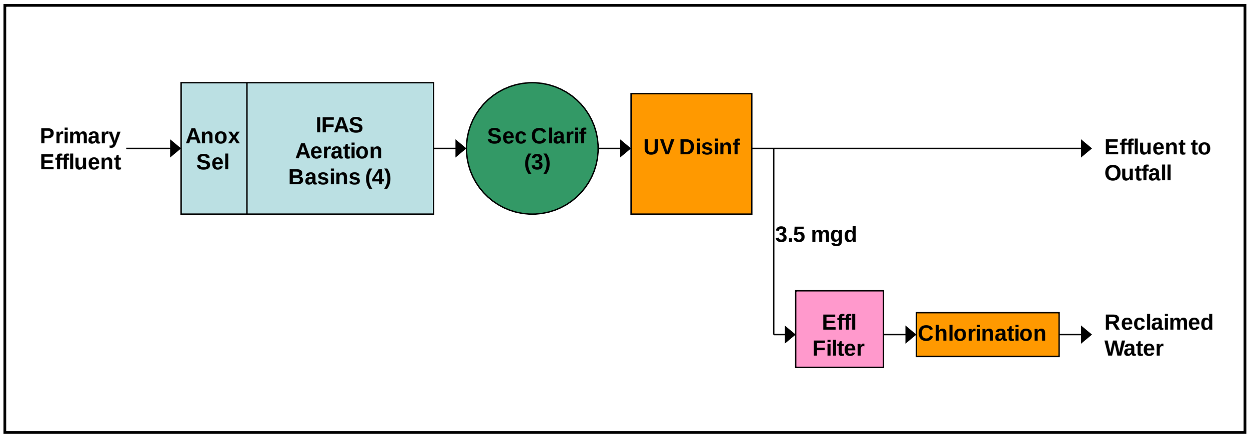

Figure 8-7. Process flow diagram for Alternative 7 (IFAS with TN removal and partial flow effluent filtration)

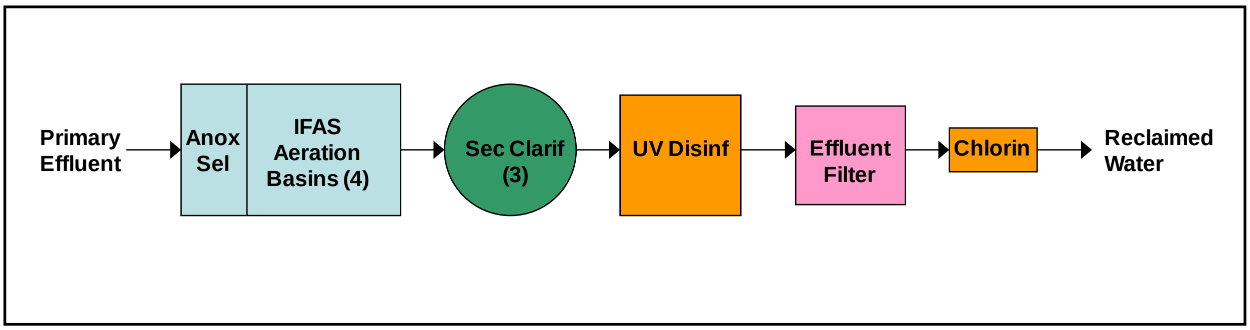

Figure 8-8. Process flow diagram for Alternative 8 (IFAS with TN removal and full flow effluent filtration)

Table 8-3. CKWWTP Liquid-Stream Treatment Alternatives Sizing and Cost Summary								
Alternative	1	2	3	4	5	6	7	8
Description	CAS w/ summer nitrification	CAS w/ year-round nitrification	CAS w/ side stream MBR	Full MBR w/ TN removal	CAS w/ TN removal and partial flow filters	CAS w/ TN removal and full flow filters	IFAS w/ TN removal and partial flow filters	IFAS w/ TN removal and full flow filters
Design criteria								
Reclaimed water flow (mgd)	0	0	3.5	8.2 (max mo.)	3.5	8.2 (max mo.)	3.5	8.2 (max mo.)
SRT (days)	5 (summer) 3 (winter)	8	3–5 (CAS) 12 (MBR)	14	6 (summer) 12 (winter)	8 (summer) 12 (winter)	5	5
RAS rate (%Q)	100	100	100 (CAS) 400 (MBR)	400	100	100	100	100
Facility sizing								
New fine screens (capacity)	None	None	3.5 mgd	8.2 (max mo.)	None	None	None	None
New process basins	None	2 @ 0.82 MG each	1 AB @ 0.82 MG 2 MTs @ 0.09 MG	5 MTs @ 0.09 MG	4 @ 0.82 MG	4 @ 0.82 MG	2 @ 0.82 MG	1 @ 0.82 MG
Modifications to existing basins	Add baffles, IMLR pump, and piping	Add baffles, IMLR pump, and piping	Add baffles, IMLR pump, and piping	Add baffles, IMLR pump, and piping; replace diffusers	Add baffles, mixers, IMLR pump, and piping	Add baffles, mixers, IMLR pump, and piping	Add media, retention screens, IMLR pump, and piping; replace diffusers	Add media, retention screens, IMLR pump, and piping; replace diffusers
New secondary clarifiers	1 @ 100 ft diam.	1 @ 100 ft diam.	1 @ 100 ft diam.	None	1 @ 100 ft diam.	1 @ 100 ft diam.	1 @ 100 ft diam.	1 @ 100 ft diam.
Modifications to existing clarifiers	None	None	None	Convert to EQ tanks	None	None	None	None
New aeration/membrane blowers	1 @ 4,400 scfm	1 @ 4,400 scfm	1 @ 4,400 scfm 3 @ 3,300 scfm	1 @ 4,400 scfm 6 @ 4,400 scfm	1 @ 4,800 scfm	1 @ 4,800 scfm	1 @ 4,800 scfm	2 @ 4.800 scfm
Tertiary filters (capacity)	None	None	None	None	3.5 mgd	8.2 mgd (max mo.)	3.5 mgd	8.2 mgd (max mo.)
Operational requirements								
2030 ann. avg. air flow (scfm)	8,060	8,750	7,270 (aeration air) 6,530 (scour air)	6,530 (aeration air) 13,060 (scour air)	8,500	8,500	11,600	11,600
2030 ann. avg. RAS flow (mgd)	6.56	6.56	3.06 (CAS) 14 (MBR)	26.2	6.56	6.56	6.56	6.56
2030 ann. avg. methanol dosing (100% soln.) (gpd)[a]	-	-	220	440	300	300	450	450
2030 energy use (MWh/yr)[b]	2,884	3,099	4,554	6,161	3,230	3,413	4,189	4,372
Total project cost (2009$)[c]	$17,000,000	$24,000,000	$57,000,000	$129,000,000	$45,000,000	$69,000,000	$75,000,000	$99,000,000

Notes for Table 8-3:

a. Assume methanol is used as supplemental carbon to achieve adequate denitrification.

b. Annual energy consumption rates calculated for aeration and membrane blowers, RAS pumps, effluent filter feed pumps, and other pumps in MBR system.

c. Total project cost including construction cost, contractor markups, sales tax, administrative costs, and engineering fees (see Chapter 6 for the costs criteria used in preparing the cost estimates). These total project costs only reflect elements (mainly in secondary and tertiary systems) that are used for comparative purposes between the eight alternatives. They do not reflect all the costs necessary for a complete project.

The eight alternatives described above were evaluated based on both economic and non-economic criteria. An evaluation matrix, which includes weighting factors for both the criteria category and the individual criteria, was applied. The complete detailed matrix for this evaluation is provided in Appendix 8O. Table 8-4 provides an abbreviated version of the final evaluation matrix.

Table 8-4. Evaluation Score Summary of CKWWTP Liquid-Stream Treatment Alternatives [a]

Alternative	1	2	3	4	5	6	7	8
Description	CAS w/ summer nitrification	CAS w/ year-round nitrification	CAS w/ side stream MBR	Full MBR w/ TN removal	CAS w/ TN removal and partial flow filters	CAS w/ TN removal and full flow filters	IFAS w/ TN removal and partial flow filters	IFAS w/ TN removal and full flow filters
Total NPV (2011 million$) [b]	$73	$80	$119	$193	$105	$129	$137	$160
Process considerations	390	375	370	395	380	380	375	375
O&M considerations	420	420	340	380	340	340	340	340
Flexibility for future expansion or enhancement	500	400	500	500	400	400	400	400
Reuse and biosolids utilization	200	200	600	1000	600	1000	600	1000
Energy usage for secondary/tertiary treatment	500	465	295	224	441	423	341	330
Environmental/ community considerations	660	640	740	860	720	750	760	790
Cost comparison	1000	789	450	312	516	417	395	353
Total score	3670	3290	3295	3671	3398	3710	3211	3588

a. Highest score is preferred.

b. NPV calculated from the period 2012–30.

From the evaluation results of Table 8-4, the ranking of treatment projects is as shown in Table 8-5.

Table 8-5. CKWWTP Liquid-Stream Treatment Alternatives Ranking			
Alternative number	Description	Total evaluation score	Rank
6	CAS w/ TN removal and full flow filters	3710	1 (most preferred)
4	Full MBR w/ TN removal	3671	2
1	CAS w/ summer nitrification	3670	3
8	IFAS w/ TN removal and full flow filters	3588	4
5	CAS w/ TN removal and partial flow filters	3398	5
3	CAS w/ side stream MBR	3295	6
2	CAS w/ year-round nitrification	3290	7
7	IFAS w/ TN removal and partial flow filters	3211	8 (least preferred)

From Tables 8-4 and 8-5, the following conclusions are developed:

- Alternative 6 has the highest total combined score; it is the recommended alternative.
- Among the alternatives that produce 3.5 mgd of reclaimed water (Alternatives 3, 5, and 7), the most favored alternative is Alternative 5 (CAS), followed by Alternative 3 (side stream MBR), and lastly Alternative 7 (IFAS). The order of the combined total score matches that of the NPVs calculated from the capital and O&M costs.
- Among the alternatives that provide full-plant water reuse (Alternatives 4, 6, and 8), the most favored alternative is similarly Alternative 6 (CAS), followed by Alternative 4 (MBR), and lastly Alternative 8 (IFAS). If considering costs only, as reflected by the NPVs or the scores for the cost comparison criterion, the IFAS alternative is more favorable than the MBR alternative. Also, costs for full plant water reuse, resulting in a zero-discharge WWTP, are nearly twice the cost of a conventional treatment plant not producing reclaimed water.
- While Alternative 2 (CAS with year-round nitrification) has a low NPV compared to other alternatives except for Alternative 1, it does not provide reclaimed water and cannot be readily converted to other treatment technology without resulting in stranded investments of the additional aeration basins and secondary clarifiers. That alternative is therefore not recommended.
- The MBR alternatives (3 and 4) have the highest energy consumption rates, mainly due to the scouring air requirements for MBR systems, followed by the IFAS alternatives (7 and 8).

Therefore, the recommended scheme for the liquid-stream treatment train at the CKWWTP is to modify and expand the existing activated sludge system to provide TN removal and add tertiary filtration. If the number of reclaimed water users in the area is still limited, the County can install only 3.5 mgd of filtration capacity initially (thus implementing Alternative 5 initially) and eventually convert to full-flow water reuse (Alternative 6).

8.4 Project Recommendations

Based on the evaluations described in this chapter, recommendations were developed for wastewater treatment, water reuse, and solids treatment in central Kitsap County. These recommendations are summarized in Table 8-6. The total project cost for these recommendations, including all of the features necessary to comprise a complete project at the CKWWTP, is provided in Chapter 9.

Table 8-6. Summary of Recommended Facilities for CKWWTP

Process train	Recommendations
Liquid-stream treatment	• Construct new headworks with Mahr screens, aerated grit tanks, and a septage receiving station (under implementation). • Replace existing primary clarifiers with new conventional primary clarifiers. • Modify existing aeration basins and channels (new diffuser membranes, baffles, mixers, pumps and piping). • Add two new aeration basins • Replace existing aeration blower with new high efficiency blowers and add one blower. • Add one new secondary clarifier.
Water reuse	• Provide reclaimed water at the CKWWTP instead of construction of satellite plants. • Construct effluent filtration facility
Solids treatment/ biosolids disposal	• Add GBT for WAS thickening and keep gravity thickeners for primary sludge thickening only. • Stay with conventional mesophilic anaerobic digestion until regulations and/or market for biosolids disposal drive the need for Class A biosolids. Add additional digester. • Provide existing digester improvements to upgrade sludge withdrawal, heating and mixing systems. • The existing system will be modified to provide the flexibility to produce Class A biosolids in the future. • Continue to send Class B biosolids to Fire Mountain Farm or similar facility for disposal.
Biogas utilization/energy usage	• Provide combined heat and power generation (cogeneration) to eliminate flaring of the biogas. • Upgrade the biogas management system to convert from the existing fuel-oil-based digester heating to biogas based heating (via cogeneration).

CHAPTER 9

RECOMMENDED WASTEWATER SYSTEM CAPITAL IMPROVEMENTS

9.1 Overview of Chapter Contents

Alternatives for upgrading the Central Kitsap wastewater collection system are presented and evaluated in Chapter 7, along with a brief description of the recommended capital improvement projects and their costs. Likewise, alternatives for upgrades to the CKWWTP wastewater treatment system are presented in Chapter 8. This chapter summarizes the key elements of these specific wastewater system capital improvement recommendations and provides a schedule for suggested project implementation. This information is subdivided into 6- and 20-year CIPs. Rate impacts associated with these recommended projects are described in Chapter 10.

Funding needs are generally set for 6-year planning windows. Beyond that time, it is understood that the CIP will be reevaluated periodically to reflect changes in growth patterns, regulations affecting wastewater infrastructure construction and treatment, alternative means of funding, changes in project costs, and advances in wastewater technology and treatment priorities. The projects identified in the 6-year CIP form a subset of the 20-year CIP project list.

For this reason, the project list beyond the upcoming 6-year period should be viewed as the most likely scenario, given the parameters currently known. The 6-year CIP projects will be designed in a manner to provide the most flexibility to accommodate changing future conditions. Similarly, the rate structure is designed to cover the near-term projects; the rates identified for future planning periods are approximations only. Adoption of the 6-year CIP does not commit the County to projects or associated rates beyond that period.

As mentioned in Chapter 5, adoption of this Facility Plan requires SEPA review by Kitsap County. A non-project SEPA checklist was prepared and is included in Appendix 9. Project-specific SEPA review will be prepared for each of the individual capital improvement projects summarized below at the time they are designed and permitted.

9.2 Collection System Improvements

The following section presents recommendations for the 6- and 20-year CIPs for the Central Kitsap collection system improvements.

9.2.1 6-Year CIP: Collection System

The 2011–16 capital improvements for the collection and conveyance system consist of five lift station projects and eight pipeline projects as described in Table 9-1.

All of the lift stations are major facilities in the conveyance system (Figure 9-1). The projects address the necessary rehabilitation of aging pumps and control equipment. Replacement equipment will be sized to accommodate future growth to avoid having to replicate work at the stations within the design life of the new equipment.

The pipeline projects consist of four projects in the Central Kitsap UGA. The Central Kitsap pipeline projects involve replacement of pipes that are subject to failure or have significant capacity and maintenance issues.

Table 9-1. 6-Year Collection System Projects

Service area	Project name	Project scope	Justification	Benefit
CK	LS-1	Lift Station 1 improvements	Age and poor condition of controls and pump motors	Improve efficiency of pump, motor, and controls; reduce possibility of failure in downtown Silverdale, reduce maintenance costs
CK	LS-6	Lift Station 6 improvements	Near FPC and original 30-year equipment that has outlived its lifespan and is inefficient	Improve efficiency of pump, motor, and controls; reduce possibility of failure in central Silverdale, reduce maintenance costs
CK	LS-8	Lift Station 8 improvements	Near FPC and original 30-year equipment that has outlived its life span and is inefficient	Improve efficiency of pump, motor, and controls; reduce possibility of failure in central Silverdale, reduce maintenance costs
CK	LS-16	Lift Station 16 improvements	Near FPC and original 30-year equipment that has outlived its life span and is inefficient	Improve efficiency of pump, motor, and controls; reduce possibility of failure at marina in Keyport and impact on Puget Sound, reduce maintenance costs
CK	LS-67	Lift Station 67 improvements	To simplify collection system and more effectively take the flow from Poulsbo and Keyport to the plant	Improve effectiveness of system, reduce maintenance costs
CK	Techite Pipe Replacement	Replace the 30" Techite force main into CKWWTP, which carries all the sewage from Silverdale and east Bremerton	The pipe installed under the original construction in the mid-1970s is made of Techite, a fiberglass spun pipe; this type of pipe is no longer used as it has been shown to lose its structural integrity with age	Avoid the possibility of a catastrophic environmental spill since this pipe carries the sewage from south Central Kitsap
CK	Bayshore Pipe Replacement	Replace 1,865 lf of pipe to 10" pipe	Capacity and maintenance	Reduce the possibility of a spill in Dyes Inlet due to overcapacity
CK	NE Bentley Drive Pipe Replacement	Replace 1,380 lf of 12-inch-dia. pipe and 485 lf of 18-inch-dia. pipe	Surcharging and velocity issues	Reduce odors, improve system function, and eliminate surcharging
CK	Silverdale Way Pipe Replacement	Replace 2,880 lf of pipe north of Waaga Way	Potential for surcharging	Reduce the possibility of a spill due to pipe surcharging
CK	LS-6 Force Main Replacement	Replace 1,150 lf of 12-inch dia. Force main from intersection of Old Military Rd NE and NE Fairgrounds Rd.	Excessive velocity issues	Reduce odors and improve system function
CK	Mickelberry Road Pipe Replacement	70 lf of 12" and 1,350 lf of 18" pipe; begin project in 2017	Surcharging problems worsen when LS-8 is upgraded	Improves hydraulic efficiency of conveyance system

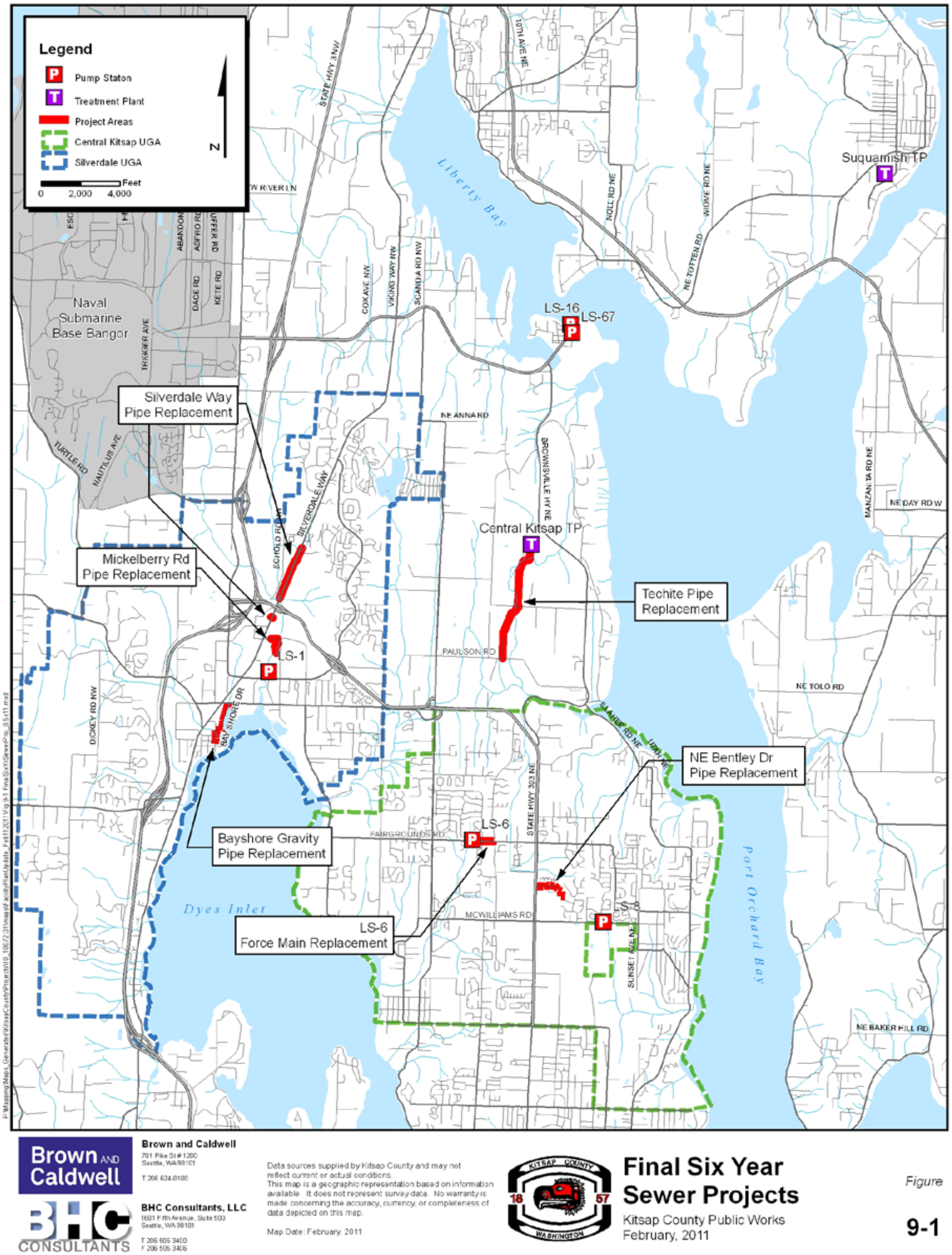

Figure 9-1. 6-year CIP: collection system projects (2011–16)

9.2.1.1 Project Costs for the 6-Year CIP

Table 9-2 summarizes the collection system project costs for the 6-year plan.

Table 9-2. Summary of Collection System 6-Year CIP Improvement Project Costs

Project	Project costs (2010$)
Lift stations	
LS-1	$3,630,000
LS-6	$3,880,000
LS-8	$1,280,000
LS-16	$4,380,000
LS-67	$10,800,000
Lift stations subtotal	$23,970,000
Collection	
Techite Pipe Replacement	$8,710,000
Bayshore Pipe Replacement	$1,340,000
NE Bentley Drive Pipe Replacement	$1,060,000
Silverdale Way Pipe Replacement	$2,080,000
LS-6 Force Main Replacement	$1,440,000
Mickelberry Road Pipe Replacement	$1,260,000
Collection subtotal	$15,890,000
Total	$39,860,000

9.2.2 20-Year CIP (Design Year 2030): Collection System

Capital improvements for the collection and conveyance system for the period from 2017 through 2030 include projects for the existing collection and conveyance system and for new facilities to serve the five areas that currently have onsite sewer systems and have been designated by the Health District as areas of concern for connection to the public sewer system.

9.2.2.1 Existing Collection and Conveyance System

The improvements to the existing system involve both lift station projects and pipeline projects. Ten lift stations located throughout the Silverdale and Central Kitsap UGAs (Figure 9-2) must have pumping capacity increases to accommodate increased flows due to population growth. All of the lift stations are located adjacent to surface waters so the lift station improvements will mitigate the potential for overflows. These lift stations also have aging pumps and control systems that should be replaced. The total project cost for the 10 lift stations is $34.5 million, with the largest individual project being LS-4 in Silverdale (Table 9-3).

Table 9-3. Summary of Existing Lift Station Improvements for 2017–30				
Lift station	Ex. firm capacity, QF.C. (gpm)	2030 future flow, Qfut (gpm)	Project costs (2010$)	Year to begin upgrade project
3	1,800	2,550	$3,760,000	2017
4	3,000	5,250	9,700,000	2017
10	270	350	2,342,000	2017
12	850	1,100	3,760,000	2017
13	400	500	2,342,000	2017
21	246	375	2,342,000	2017
22	450	550	2,092,000	2017
32	165	295	2,342,000	2017
34	900	1,250	3,760,000	2017
65	300	675	2,092,000	2017
Total			$34,532,000	

Twelve pipeline projects have also been identified to address existing and future surcharging and scouring issues with a total project cost of $37.1 million. Nine of the projects are shown in Table 9-4 as required to address existing surcharging and scouring problems. Although the magnitude of these problems is currently less than that of those identified for the 6-year CIP projects, O&M issues will worsen with time as flows increase. The timing for implementation of several pipeline projects is linked to upstream lift station improvements; that is, when a lift station capacity is increased, the downstream force main and gravity sewers must be increased in size to accommodate the higher pumped flows. Three additional projects are identified to correct future problems of surcharging and high scouring velocities in the pipes as flows increase due to population growth.

Table 9-4. Summary of Existing Collection System Pipeline Projects for 2017–30			
Existing problem area	Description of project	Project cost (2010$)	Implementation date
2	Levin Road: replace 2,100 lf of gravity pipe	$1,470,000	2017
3	Fredrickson Road: replace 970 lf of gravity pipe	$750,000	2017
4	Old Downtown Silverdale west of LS-3: replace 2,140 lf of gravity pipe	$2,000,000	2018
5	John Carlson Road east of LS-7: replace 4,375 lf of gravity pipe	$3,190,000	2018
7	Fusion Road to Franklin Avenue: replace 890 lf of gravity pipe	$600,000	2020
8	Southern Old Military Road: replace 2,710 lf of force main	$5,160,000	2020
9	Auklet Place NE south of LS-6: replace 675 lf of force main from LS-36	$780,000	2017
10	Lemolo Peninsula pipeline replacement: replace 4,450 lf of force main	$7,920,000	2017
Existing projects subtotal		$21,870,000	

Table 9-4. Summary of Existing Collection System Pipeline Projects for 2017–30			
Future problem area	Description of project	Project cost (2010$)	Implementation date
4	Anderson Hill Road: replace 3,750 lf of gravity pipe	$2,210,000	2020
11	LS-7 to State Highway 303 to LS-7: replace 3,500 lf of gravity pipe	$2,750,000	2017
12	Northern Old Military Road force main replacement: replace 345 lf of gravity pipe and 7,940 lf of force main	$7,710,000	2020
13	LS-22 force main replacement: replace 1,050 lf of pipe	$1,260,000	2017
Future projects subtotal		$13,930,000	
Grand total		$35,800,000	

9.2.2.2 Future Collection and Conveyance Systems

Future collection and conveyance systems are required to serve the areas of concern identified by the Health District (Figure 9-2). These areas would be served by a series of local lift stations, smaller force mains, and gravity pipes that would connect to the existing Kitsap County system. A summary of these future lift station and future pipeline projects is shown in Table 9-5. This information is taken from Tables 7-4 and 7-5, respectively.

Table 9-5. Summary of Future Sewer Systems Project Costs (2010$)	
Future collection system facility	Total project cost
Lift stations	$13,065,000
Gravity sewers and force mains	$23,900,000
Total project cost	$36,965,000

9.2.2.3 Summary of Collection and Conveyance System 20-Year CIP

The total cost for collection and conveyance system improvements for 2010–30 is more than $147 million (Table 9-6).

Table 9-6. Summary of Collection and Conveyance System 20-Year CIP		
Project category	6-year CIP project costs: design year 2030 (2010$)	20-year CIP project costs: design year 2030 (2010$)
Existing piping improvements for existing flows	$15,890,000	$21,870,000
Existing piping improvements for future flows	-	$13,930,000
Existing lift stations	$23,970,000	$34,532,000
Future lift stations	-	$13,065,000
Future piping	-	$23,900,000
Subtotal	$39,860,000	$107,297,000
Grand total		$147,157,000

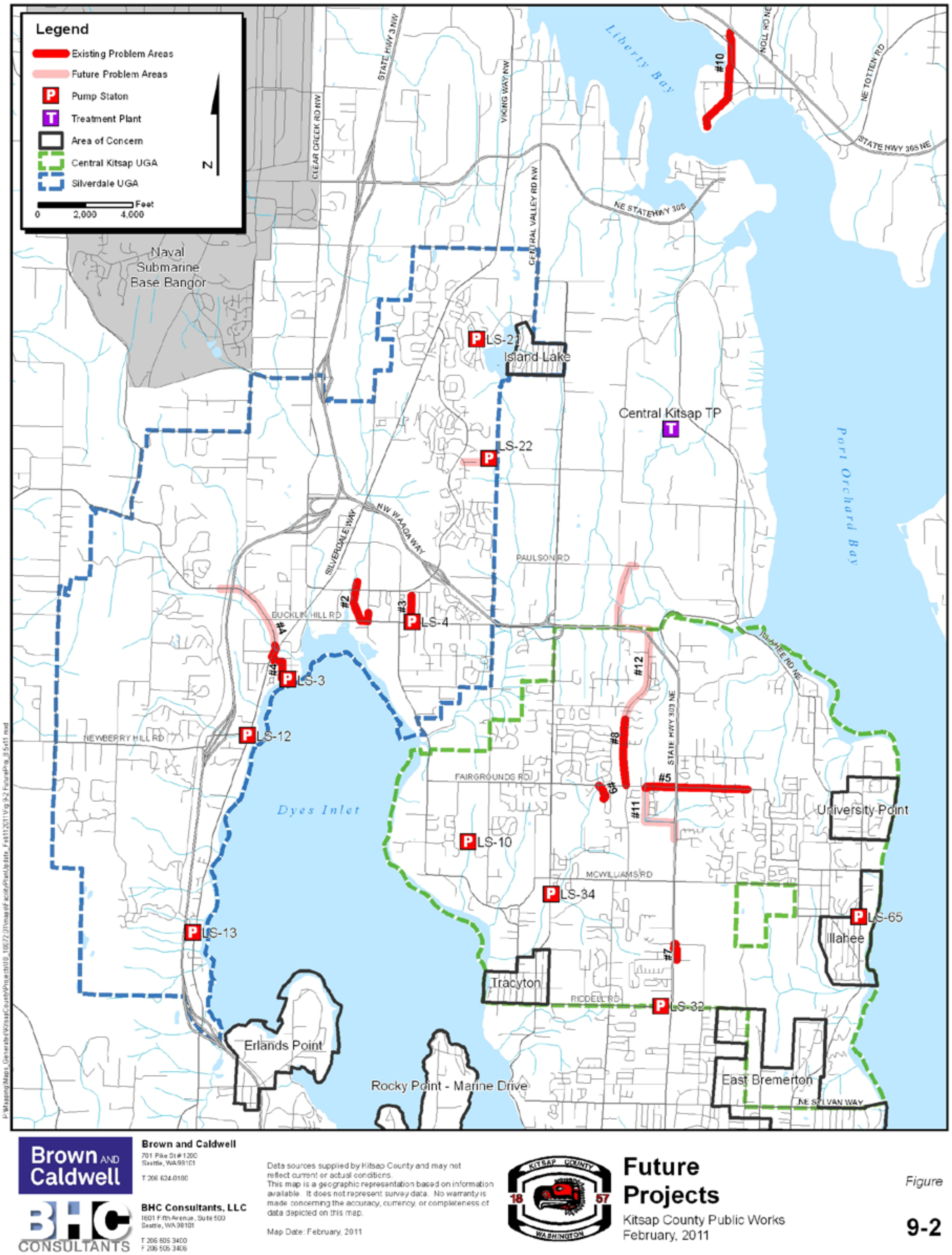

Figure 9-2. 20-year CIP: collection system projects (2017–30)

9.3 CKWWTP Improvements and Kingston WWTP Wastewater Reclamation and Reuse

The following section presents recommendations for the 6- and 20-year CIPs for the CKWWTP improvements.

9.3.1 6-Year Plan: CKWWTP

For the 6-year CIP, the following improvements are recommended at the CKWWTP and are divided into two general categories based on the project's primary drivers: (1) need for additional treatment capacity, and (2) enhanced functionality for resource reclamation:

- additional treatment capacity:
  - new headworks (currently under construction)
  - GBT
  - plant water system upgrade
- resource reclamation and reuse:
  - reclaimed water production
  - aeration basin addition/modifications (nitrogen removal)
  - blower replacement with high-efficiency blowers
  - aeration diffuser upgrade
  - digester gas cogeneration system.

In addition, some follow-up work is being proposed for the Kingston WWTP.

The following sections provide a brief description of each of these improvements. Additional information on these improvements is provided in Chapter 8. The suggested layout of these proposed facilities is shown in Figure 9-3.

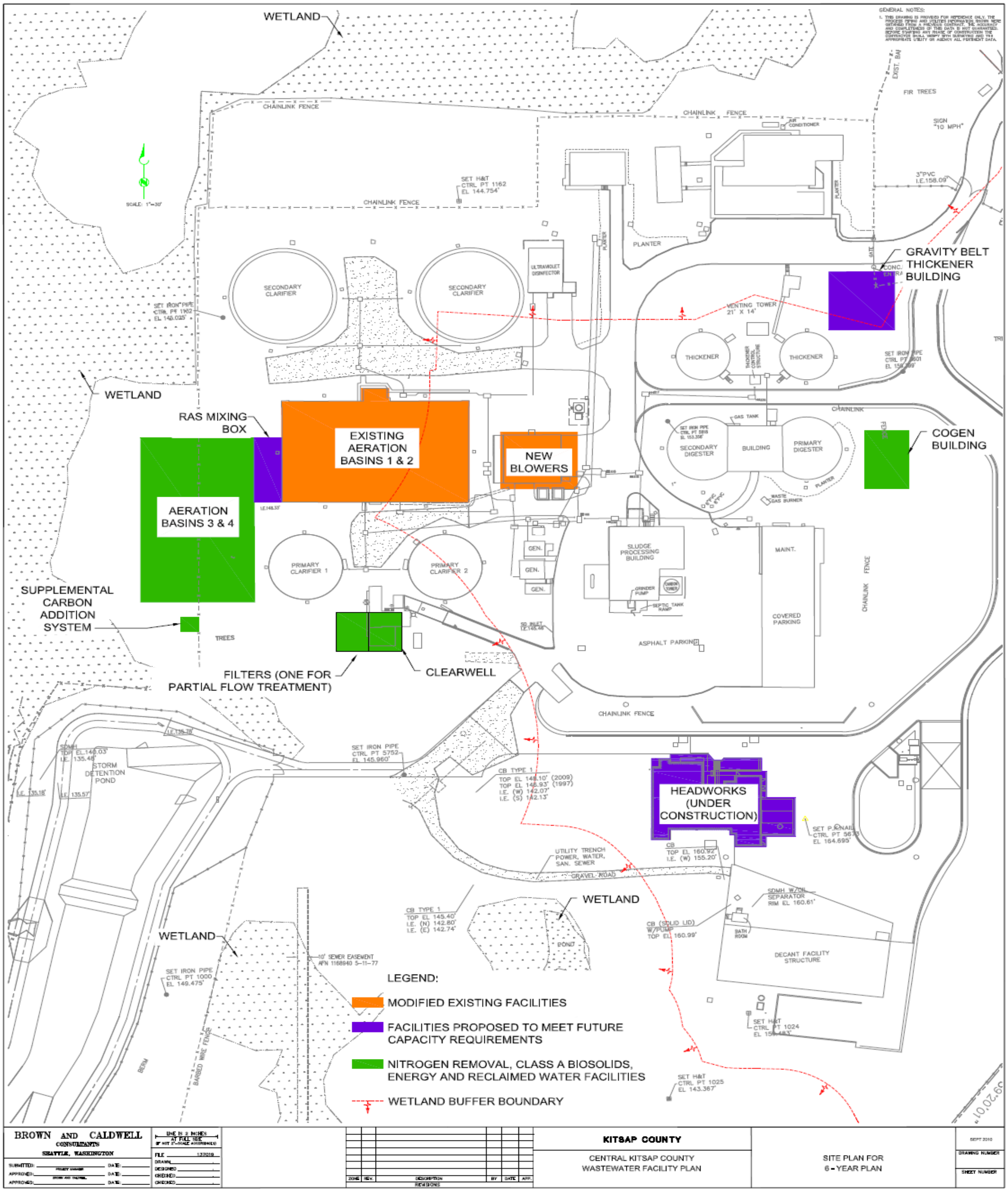

Figure 9-3. 6-year CIP: CKWWTP improvement projects (2011–16)

9.3.1.1 Headworks

This project includes construction of new headworks with mechanical bar screens and aerated grit channels. The headworks of the CKWWTP are the primary mechanism for protecting the downstream liquid and solids treatment systems from grit and debris accumulation. The new headworks will have screens with 1/4-inch openings to meet new Ecology regulations concerning inerts in biosolids, such as plastic, that are contained in the debris entering a WWTP. The aerated grit channels will provide liquid-stream grit removal to minimize grit from entering the downstream facilities. The new headworks will also include foul air collection and treatment. This will reduce odors released at the plant.

The headworks project is currently under construction; design of the project began in 2008. The new headworks is scheduled to be online in 2011.

9.3.1.2 Gravity Belt Thickener

The CKWWTP is approaching the hydraulic retention time (HRT) capacity in the existing digestion system to meet Class B biosolids production requirements. The minimum HRT criterion for mesophilic anaerobic digestion is 15 days. The CKWWTP currently operates two gravity thickeners, which co-thicken primary sludge, secondary sludge, and hauled septage and sludges from Kingston, Manchester, and Suquamish prior to digestion. Because of the relatively thin sludge produced by the gravity thickeners when operated to co-digest primary and secondary sludges, both digesters will need to be in service at all times to meet the 15-day HRT requirement for Class B sludge production. Consequently, the plant cannot take one of the digesters offline for maintenance. By improving the sludge thickening performance, which increases the thickened sludge concentrations, the corresponding HRT can be increased and the available existing digester capacity can be extended. This will allow the County to delay the construction of a third digester.

The sludge thickening system will be upgraded by adding a GBT for WAS thickening and a thickened sludge blend tank, while retaining the existing gravity thickeners for primary sludge thickening. Only one GBT unit will be installed, but the new GBT building will be sized to house a total of two GBT units to provide room for future expansion. Septage will continue to be thickened in the gravity thickeners, while the thickened WAS from the other plants will be sent directly to the blend tank.

9.3.1.3 Plant Water System Upgrade

A portion of the disinfected secondary effluent is used as process water for the screenings compactor, scum sprays in the primary and secondary clarifiers, grit classifiers, centrifuge flushing and polymer usage, biofilter irrigation, and in the seal water and utility maintenance systems throughout the plant. In the existing system, process water pumping is provided by three pumps located in the existing utilidor. The existing pumps do not have adequate capacity for the future process water requirements. This project will include removal of those pumps and installation of three new pumps at the UV disinfection effluent channel. The existing process water piping network will be expanded to service the new facilities. The new process water system will be designed to optimize energy efficiency.

9.3.1.4 Reclaimed Water Production

At the CKWWTP, water reuse is currently limited to in-plant process uses. In order to produce reclaimed water for applications outside of the treatment plant, the liquid-stream treatment will need to be enhanced to meet specific criteria for Class A reclaimed water, plus additional criteria related to applications involving indirect groundwater recharge and stream flow augmentation. These criteria include limits on turbidity, TN, total coliform, BOD, and TSS.

To produce Class A reclaimed water at the CKWWTP, a tertiary effluent filtration system will be installed to treat secondary effluent. Initially, the system will be sized to treat 3.5 mgd, the annual average plant flow. The system would consist of rapid sand filters, chemical coagulation equipment, and chlorination. During peak flow events, secondary effluent exceeding 3.5 mgd will be disinfected in the existing UV system and discharged through the plant outfall.

9.3.1.5 Aeration Basin Addition/Modifications

The existing activated sludge secondary treatment system will be expanded and modified to provide the TN removal required for reclaimed water production. The target effluent TN level is typically 10 mg/L for groundwater recharge and stream flow augmentation. In order to achieve this level of nitrogen removal, two new aeration basins (basins 3 and 4) will be added initially, doubling the aeration basin capacity. A supplemental carbon addition system will also be added to achieve the required level of denitrification.

Besides the two new basins and other modifications described above to achieve nitrogen removal, new DO sensors and air flow control valves will be installed in each basin to facilitate automatic DO control, which in conjunction with the new blowers described below will provide a more energy-efficient aeration system. The existing activated sludge system occasionally experiences excessive biological foaming that negatively impacts effluent quality. A classifying selector, consisting of a surface skimming system designed for foam and scum removal, will be installed. Other improvements include a new RAS mixing box, new WAS pumps, and new coarse-bubble diffusers in the aeration basin inlet and mixed liquor channels for channel air mixing.

9.3.1.6 High-Efficiency Blowers

The three existing aeration blowers used to supply air to the aeration basins in the activated sludge system are multistage centrifugal blowers installed in 1996 as part of the Contract I upgrade. Although the three existing blowers still function relatively well from a mechanical perspective, they operate with variable volume inlet valve control, which results in low efficiencies at reduced air flow rate operating scenarios. One new blower will be needed to meet the higher aeration requirements associated with year-round TN removal described above.

This project will consist of replacing the three existing blowers with high-efficiency turbo blowers and adding a new additional high-efficiency turbo blower as the fourth blower. The new turbo blowers and control system will result in reduction in the energy requirements associated with the aeration air blowers.

9.3.1.7 Aeration Diffuser Upgrade

The existing aeration diffusers were installed in 1996. Over the years, the oxygen transfer efficiency has deteriorated significantly due to the fouled, aging membranes on the diffusers such that the system has at times not been able to maintain adequate DO concentrations in the aeration basins. The system back-pressure requirement has also increased, exceeding the original design operating pressures for the aeration blowers. Because the existing air piping system still appears to be in good condition, it is recommended that the existing diffuser system be upgraded by replacing the membranes with new membranes, but retaining the existing diffuser grids and piping. With the new membranes, the plant will be able to maintain the DO concentration at higher overall oxygen transfer efficiencies and thus decrease energy requirements associated with the blowers.

9.3.1.8 Digester Gas Cogeneration System

Digester gas, generated in the plant's anaerobic digesters, is a by-product of the biological processes taking place in the anaerobic digester. Most of the digester gas produced is methane, which has a high heating value and is a significant GHG. Currently, all of the biogas is burned and wasted through an existing flare, and fuel oil must be purchased to heat the tanks.

This project would furnish the plant with an engine-generator that would use digester gas as its fuel source. The engine-generator, which would be housed in a manufacturer's enclosure, would generate electricity to either be used throughout the plant or supplied to the local electrical power grid. The waste heat from the engine-generator would be used to heat the digesters and the CKWWTP buildings. In this manner, the engine-generator would perform two functions (hence the term cogeneration): generate electricity from the digester gas and generate waste heat to be used to heat the digesters and the plant buildings. By using biogas to generate heat, process and space heating demands can be met by the engine-generator, potentially reducing or eliminating the need for expensive fuel oil.

9.3.1.9 Kingston Reclaimed Water (Kingston WWTP)

Although this is not part of the CKWWTP facility, a reclamation project is being proposed as part of the 6-year CIP at the Kingston WWTP. An Ecology-funded 2010 feasibility study indicates a beneficial use for reclaimed water from the Kingston WWTP for stream flow enhancement and fisheries operation. In order to further explore this option, funding has been included for predesign of a facility at the WWTP.

9.3.1.10 Project Costs for the 6-Year CIP

Table 9-7 below summarizes the project costs for the 6-year CIP.

Table 9-7. Summary of CKWWTP 6-Year CIP Improvement Project Costs

Project	Project costs (2010$)
Headworks[a]	$10,689,000
Reclaimed water filters	$14,711,000
Aeration basin addition/modifications	$13,806,000
High-efficiency blowers	$1,251,000
Aeration diffuser upgrade	$94,000
GBT	$7,637,000
Digester gas cogeneration system	$1,300,000
Plant water system upgrade	$186,000
Kingston reclaimed water[b]	$500,000
Total	$50,174,000

a. Project is under construction with an April 2011 estimated completion date.

b. Project is for reclamation at the Kingston WWTP and is not part of the Central Kitsap CIP.

9.3.2 20-Year CIP (Design Year 2030): CKWWTP

For the 20-year CIP, besides the projects implemented under the 6-year CIP, the following additional improvements are recommended at the CKWWTP:

- new primary sedimentation tanks
- new aeration basin addition
- new secondary clarifier
- expansion of reclaimed water filtration system
- existing digester improvements
- TPAD digester conversion (optional)
- FOG receiving facility (optional)
- new administration building
- laboratory expansion
- new storage and maintenance building

The following sections provide a brief description of each of these improvements. The suggested layout of these proposed facilities is shown in Figure 9-4.

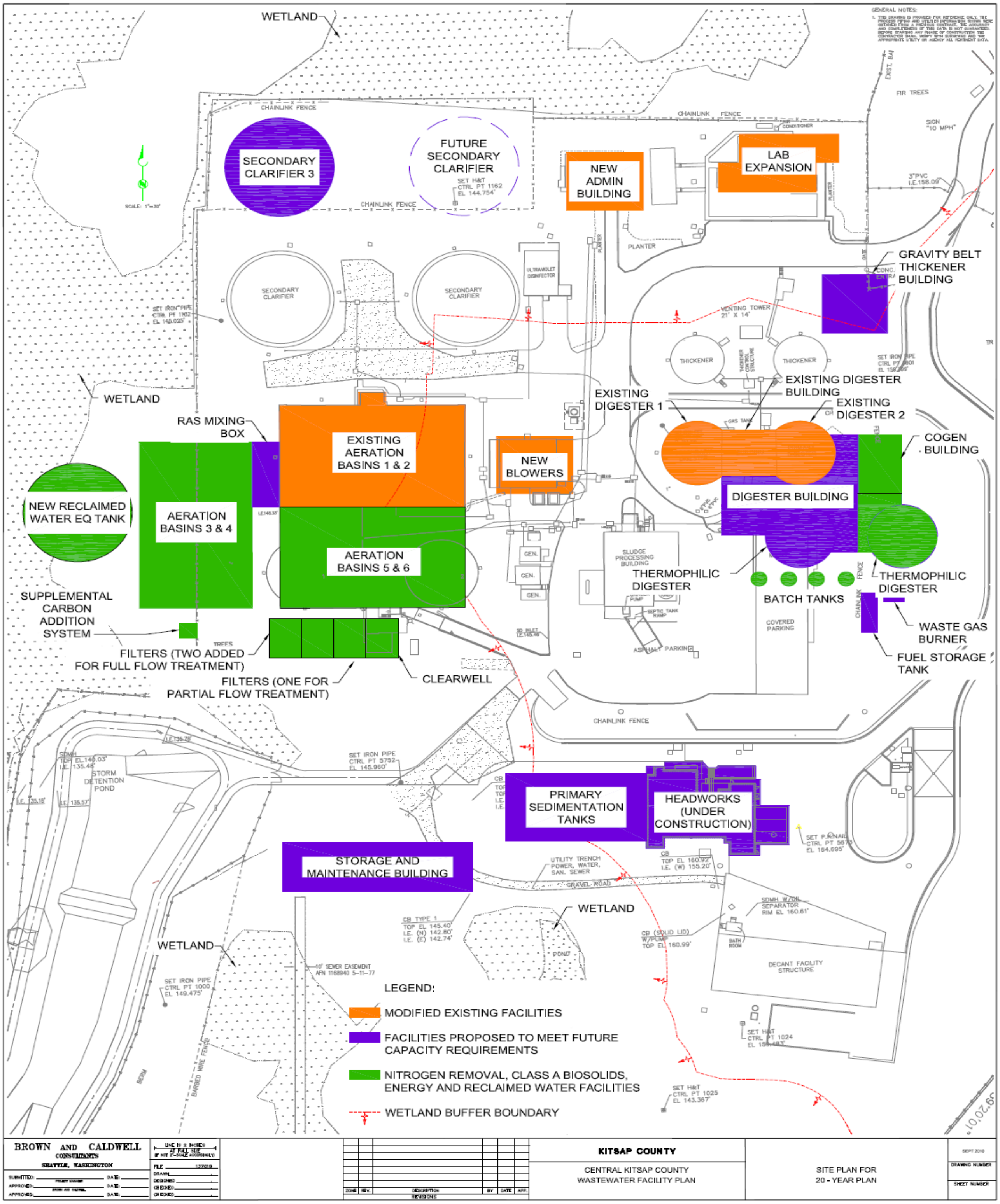

Figure 9-4. 20-year CIP: CKWWTP improvement projects (2017–30)

9.3.2.1 Primary Sedimentation Tanks

The existing primary sedimentation tanks will have adequate capacity to treat the projected flows through 2022. However, because two new aeration basins (basins 5 and 6) will be required before 2022 to provide TN removal for water reclamation, the existing primary sedimentation tanks will need to be demolished to provide the space for these aeration basins. Therefore, new primary sedimentation tanks will need to be constructed at that time. Three new tanks will be built adjacent to the new headworks. The settled primary sludge will continue to be pumped to the existing gravity thickeners.

9.3.2.2 Aeration Basin Addition

Two more aeration basins, resulting in a total of six basins, will be required to provide year-round TN removal for water reclamation by around 2017. As described above, the new basins 5 and 6 will be constructed at the site of the existing primary sedimentation tanks.

9.3.2.3 Secondary Clarifier

One new secondary clarifier will be constructed to meet the peak hydraulic and solids loading requirements associated with the projected 2030 plant flows and loadings. The new clarifier will have the same diameter as each of the two existing clarifiers. New RAS pumps will also be added to increase the total sludge recycling capacity.

9.3.2.4 Expansion of Reclaimed Water Filtration System

As described above, the plant will initially be able to produce up to 3.5 mgd of reclaimed water as part of the 6-year CIP. In order to increase the reclaimed water production capacity as plant flows increase, new filter modules can be added. To reclaim the full plant flow for up to the 2030 condition, two new filter modules must be added. In addition, a reclaimed water equalization tank will be constructed to equalize the secondary effluent flows going to the tertiary filtration system. This eliminates the need to size the filters for peak hour flow condition and thus reduces the sizing of the system.

9.3.2.5 Existing Digester Improvements

The sludge withdrawal, heating, and mixing systems for the two existing digesters will be upgraded and their respective covers will be repaired. New boilers will be added that can utilize either digester gas or heating oil as the fuel source. Other new mechanical equipment includes new pumps for digester heating and as part of the pump mix system and new heat exchangers. One of the existing digesters will be converted into a digested sludge storage tank and backup digester. A third digester will be added to provide the necessary hydraulic detention time of 15 days to produce a Class B biosolids product.

9.3.2.6 TPAD Digester Conversion (Optional)

The existing mesophilic anaerobic digestion at the CKWWTP produces Class B biosolids. In order to produce Class A biosolids, either the existing digestion process will need to be modified or a new downstream process such as sludge drying or composting will need to be added. Producing a Class A product will increase the disposal alternatives available to the County as the restrictions on disposal and human contact are less stringent. The current recommended strategy for future Class A biosolids production is to convert the existing process to TPAD. In this process, digestion would take place under two different temperature regimes, thermophilic (55°C) and mesophilic (35°C). In order to allow one digester to be taken out of service for maintenance and to meet Class A biosolids requirements, two thermophilic digesters and four batch tanks would be required.

9.3.2.7 FOG Receiving Facility (Optional)

Direct introduction of hauled liquid wastes, particularly FOG, into the digestion process, can increase biogas production for beneficial uses. It is recommended that space be set aside for FOG co-digestion in the future. A basic FOG receiving facility would consist of a dedicated receiving station, screen, transfer pumps, storage tanks, circulating pumps, and heat exchangers.

9.3.2.8 Administration Building

Placeholder estimates for all new campus buildings have been used, assuming conventional building types. Alternative building scenarios using various approaches to combining functions within existing or smaller buildings, as well as evaluating alternative building materials, will be investigated to explore means of minimizing these costs.

A new administration building will be constructed on the site of the existing chlorine building. This new building will include administrative offices and a new control room for the entire plant.

9.3.2.9 Laboratory Expansion

The existing administrative offices will be demolished and the laboratory will be extended into this area.

9.3.2.10 Storage and Maintenance Building

Because the expanded digester complex will require demolition of the existing shop and maintenance building, a new storage and maintenance building will be constructed on the south side of the plant site. The new building will include an equipment maintenance area, vehicle bay, and office.

9.3.2.11 Project Costs for the 20-Year CIP

Table 9-8 below summarizes the project costs for the current 20-year CIP. This table includes improvements that will be implemented in the current 6-year CIP. For the effluent filters, the cost associated with full flow treatment is included. Also included are the optional items of TPAD digester conversion and a FOG receiving facility for co-digestion. Note that these costs reflect projects for a design year of 2030.

Table 9-8. Summary of CKWWTP 20-Year Plan Improvement Project Costs (2010$)

Project	6-year CIP project costs: design year 2030	20-year CIP subsequent project costs: design year 2030[b]
Headworks[a]	$10,689,000	$0
Primary sedimentation tanks	$0	$15,749,000
Aeration basin addition/modifications	$13,806,000	$7,164,000
High-efficiency blowers	$1,251,000	$0
Aeration diffuser upgrade	$94,000	$0
Secondary clarifier(s)	$0	$9,782,000
Reclaimed water filters	$14,711,000	$21,439,000
GBT	$7,637,000	$0
Existing digester improvements	$0	$23,311,000
TPAD digester conversion (optional)	$0	$40,789,000
FOG receiving facility (optional)	$0	$3,500,000
Digester gas cogeneration system	$1,300,000	$0
Plant water system upgrade	$186,000	$0
New administration building	$0	$3,882,000
Laboratory expansion	$0	$2,504,000
Storage and maintenance building	$0	$2,960,000
Kingston reclaimed water[c]	$500,000	$0
Grand total	$50,174,000	$131,080,000

a. Project begun in 2008 is under construction with April 2011 estimated completion date; total project cost is $12.3 million.

b. These project costs are in addition to the 6-year CIP projects and are to be implemented before the end of the 20th year design year.

c. Project is for full reclamation at the Kingston WWTP and is not part of the Central Kitsap program.

9.4 Project Cost Summary

This section provides complete cost estimates for recommended collection and treatment system projects. The total costs for recommended wastewater infrastructure projects for the Central Kitsap planning area for the 2010–30 planning period are shown in Table 9-9.

Table 9-9. Summary of Total Infrastructure Improvement Project Costs (2010$)

Project category	6-year CIP project costs: design year 2030	20-year CIP subsequent project costs: design year 2030	Overall total
Collection system:			
Existing conveyance flows	$39,860,000	$70,332,000	$110,192,000
Future conveyance flows	$0	$36,965,000	$36,965,000
Collection system subtotal	$39,860,000	$107,297,000	$147,157,000
Treatment system:			
Additional treatment capacity	$18,512,000	$65,352,000	$83,864,000
Resource reclamation and reuse	$31,662,000[a]	$65,728,000	$97,390,000
Treatment subtotal	$50,174,000	$131,080,000	$181,254,000
Grand total	$90,034,000	$238,377,000	$328,411,000

a. Includes $500,000 project for reclamation at the Kingston WWTP and is not part of the Central Kitsap CIP.

Information on capital expenditures is shown in Figure 9-5. The data shown in this figure are factored into the financial and rate assessments in Chapter 10.

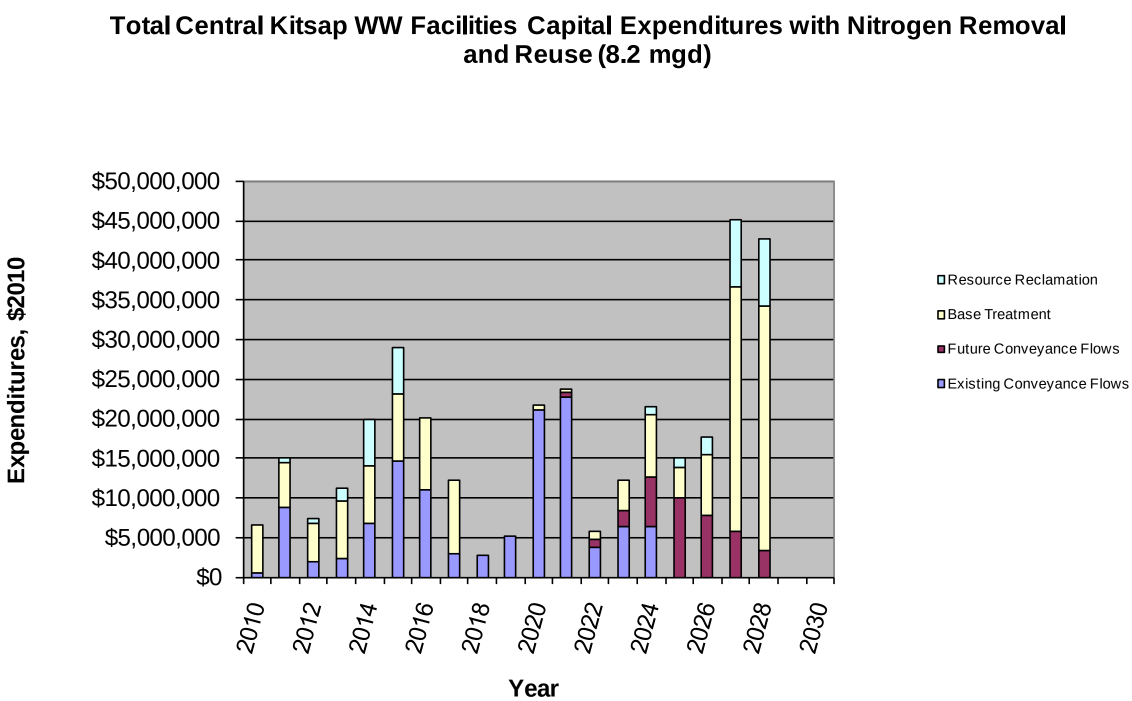

Figure 9-5. Total CKWWTP capital expenditures
(including costs for Suquamish projects)

CHAPTER 10

FINANCING EVALUATION

The impact that the central Kitsap County wastewater CIP (including both conveyance improvements and improvements to the CKWWTP) will have on wastewater utility customers is an important factor in determining an appropriate level of service to the community. Consequently, an evaluation of the CIP financing plan and subsequent customer rate impacts was necessary to support the selection of the recommended project alternatives for this Facility Plan. A revenue requirement analysis was completed to project various revenues and expenses for the utility and determine the overall need for any adjustment to the revenue (rate) levels of the utility. The results of this analysis are presented in this chapter.

In December 2010, the Kitsap Board of County Commissioners adopted a 5-year rate increase plan and issued revenue bonds to finance the near-term improvements described in this chapter. Below are some highlights of the results of the County's 6-year rate model analysis, the 20-year planning evaluation, and resulting customer rates.

10.1 Overview of Chapter Contents

The purpose of this chapter is to evaluate the financial impact of the central Kitsap County wastewater CIP on customer user rates for the near-term (6-year) and long-term (20-year) CIP improvements.

A CIP financing plan for 6- and 20-year CIPs was developed. Funding available for the CIP includes reserve funds on hand, newcomer assessment revenues from new development, and revenue bond proceeds. In addition to wastewater system capital cost estimates, projections of annual customers, other revenues, O&M expenses, current and projected debt payments, and reserve fund contributions were evaluated to determine financial obligations and rate impacts to construct, operate, and maintain the wastewater system.

Several collection system capital projects in the Suquamish service area are also included in the financial impact evaluation included in this chapter. These projects were identified by Kitsap County Operations staff as being necessary for the correction of I/I problems and are therefore also included in the 6-year rate evaluation.

10.2 Capital Costs

Projected annual capital costs to be funded were identified in order to evaluate the financing plan for the 6- and 20-year CIP alternatives. Table 10-1 shows the composite costs for the conveyance and treatment systems for the 6- and 20-year CIPs.

Table 10-1. Summary of Total Infrastructure Improvement Project Costs (2010$)			
Project category	6-year CIP project costs: design year 2030	20-year CIP subsequent project costs: design year 2030	Overall total
Collection system subtotal	$39,860,000	$107,297,000	$147,157,000
Treatment subtotal	$50,174,000	$131,080,000	$181,254,000
Grand total	$90,034,000	$238,377,000	$328,411,000

10.3 Projected 6-Year Revenue Requirement

An evaluation of the annual cost to finance the County's 6-year CIP and ongoing operations was conducted for the County's consideration and approval. Historical and budgeted revenues, expenses, customer information, and plant asset records were used as a basis for determining the annual revenue requirement, rate base, and customer usage data to determine monthly sewer rates by year for each class of customer. The 6- and 20-year CIPs, project schedule, and costs estimates, which were used to develop the CIP financing plan, were provided by County staff and their consultants. Historical expenses and plant asset records were broken down by costs associated with pumping, treatment, collection, sludge management, administration, and general, to determine functional categories by which to classify costs. Customer account information and water use data were used to allocate functional costs to customer classes. Below are some highlights of the results of the County's 6-year rate model analysis and adopted and proposed customer rates.

Annual revenues required to fund the 6-year CIP and ongoing operations are projected to increase from $14.4 million in 2011 to $20.1 million in 2016, as shown on Table 10-2.

Table 10-2. Annual Revenue Requirement

	2011	2012	2013	2014	2015	2016
Equivalent Residential Units	18,300	18,500	18,700	18,900	19,100	19,300
Revenues						
Revenues from Current Rates	$11,908,000	$12,027,000	$12,148,000	$12,269,000	$12,392,000	$12,516,000
Contract Revenues	$1,357,000	$1,367,000	$1,391,000	$1,414,000	$1,438,000	$1,461,000
Other Revenues	$1,672,000	$1,681,000	$1,690,000	$1,700,000	$1,708,000	$1,718,000
Total Annual Revenues at Present Rates	$14,937,000	$15,075,000	$15,229,000	$15,383,000	$15,538,000	$15,695,000
Expenses						
Annual Operation and Maintenance (O&M) Expenses	$8,245,000	$8,344,000	$8,575,000	$8,806,000	$9,036,000	$9,267,000
Taxes and Other Expenses	$1,062,000	$1,095,000	$1,123,000	$1,158,000	$1,283,000	$1,310,000
Current Bond Payments	$2,561,000	$2,557,000	$2,555,000	$2,560,000	$2,563,000	$2,563,000
Current LT GO Bonds and Loan Payments	$919,000	$918,000	$918,000	$917,000	$917,000	$914,000
Additional Bond Payment for 2010 Issue	$1,636,066	$1,636,066	$1,636,066	$1,636,066	$1,636,066	$1,636,066
Additional Bond Payment for 2014 Issue					$2,718,438	$2,718,438
Additional Debt Service Coverage Reserves				$350,000	$1,700,000	$1,700,000
Capital Projects Funded From Rates						
Total Annual Expenses	$14,423,066	$14,550,066	$14,807,066	$15,427,066	$19,853,504	$20,108,504
Debt Service Coverage Ratio	1.54	1.54	1.52	1.50	1.50	1.50
Additional Revenues Required	-$513,934	-$524,934	-$421,934	$44,066	$4,315,504	$4,413,504
% Increase in Rates Over Present Rates Required	-4%	-4%	-3%	0%	35%	35%
Projected Annual Rate Increase	6%	7%	7%	7%	7%	6%

10.4 Cost of Service Analysis and Rate Increases Required

Based on the customer usage and plant information developed in the 6-year cost of service rate model, the annual revenue requirement shown on Table 10-2 was allocated to each class of customer based on their use of the system. A summary comparison of the cost of service analysis (COSA) based rate increases, adjusted proposed annual rate increases, and resulting annual revenues by customer class are shown on Table 10-3.

Table 10-3. Annual Cost of Service Rates, Adopted or Proposed Rates and Revenues

	Total Revenues	Residential	Multifamily	Commercial & Bangor	Restaurants	Revenue Requirement	Difference
Present Rates		$51.72	$43.28	$0.058	$0.074		
Forecast Year: 2011							
COSA % Increase (Decrease) Over Present Rates	-4%	-7%	-18%	0%	20%		
Proposed % Increase (Decrease) Over Present Rates	6%	5%	4%	10%	15%		
Estimated Number of ERU's		10,577	5,527				
Estimated Annual Ccf				320,433	65,933		
Monthly Charge, $/ERU		$54.30	$45.00				
Volume Charge, $/cf				$0.064	$0.085		
Total Revenues	$12,482,226	$6,892,245	$2,984,527	$2,044,365	$561,088	$11,394,414	9%
Forecast Year: 2012							
COSA % Increase (Decrease) Over Previous Year	0%	0%	0%	0%	0%		
Proposed % Increase (Decrease) Over Proposed Rates	7%	5%	4%	10%	15%		
Estimated Number of ERU's		10,683	5,582				
Estimated Annual Ccf				323,638	66,592		
Monthly Charge, $/ERU		$57.00	$46.80				
Volume Charge, $/cf				$0.070	$0.098		
Total Revenues	$13,365,244	$7,307,303	$3,134,947	$2,271,290	$651,704	$11,501,983	14%
Forecast Year: 2013							
Proposed % Increase (Decrease) Over 2012 Proposed Rates	7%	5%	4%	10%	15%		
Estimated Number of ERU's		10,790	5,638				
Estimated Annual Ccf				326,874	67,258		
Monthly Charge, $/ERU		$59.90	$48.70				
Volume Charge, $/cf				$0.077	$0.113		
Total Revenues	$14,331,069	$7,755,869	$3,294,843	$2,523,403	$756,954	$11,725,923	18%
Forecast Year: 2014							
Proposed % Increase (Decrease) Over 2013 Proposed Rates	7%	5%	4%	10%	15%		
Estimated Number of ERU's		10,898	5,694				
Estimated Annual Ccf				330,143	67,931		
Monthly Charge, $/ERU		$62.90	$50.60				
Volume Charge, $/cf				$0.085	$0.129		
Total Revenues	$15,366,079	$8,225,752	$3,457,623	$2,803,501	$879,202	$12,312,911	20%
Forecast Year: 2015							
Proposed % Increase (Decrease) Over 2014 Proposed Rates	7%	5%	4%	10%	15%		
Estimated Number of ERU's		11,007	5,751				
Estimated Annual Ccf				333,444	68,610		
Monthly Charge, $/ERU		$66.00	$52.60				
Volume Charge, $/cf				$0.093	$0.149		
Total Revenues	$16,483,581	$8,717,467	$3,630,231	$3,114,690	$1,021,194	$16,707,491	-1%
Forecast Year: 2016							
Proposed % Increase (Decrease) Over 2015 Proposed Rates	6%	6%	6%	6%	6%		
Estimated Number of ERU's		11,117	5,809				
Estimated Annual Ccf				336,779	69,296		
Monthly Charge, $/ERU		$70.00	$55.80				
Volume Charge, $/cf				$0.099	$0.158		
Total Revenues	$17,655,725	$9,338,256	$3,889,592	$3,334,587	$1,093,290	$16,929,748	4%

A summary of the 5-year adopted annual rate increases to fund the 6-year CIP are shown on Table 10-4. Rates are required to increase in 2011 to accommodate the revenue bonds issued in 2010 and the associated financing assumptions described at the end of this chapter. The adopted rates are designed to levelize annual rate increases each year rather than having a significant increase each year in which bonds are issued. The rates are also designed to ramp up customer charges each year to achieve cost of service based rates by 2016.

Detailed results of the 6-year cost of service analysis rate model are included as Appendix 10A of this report.

Table 10-4. Proposed or Adopted Annual Rate Increases for the 6-Year CIP

	2011	2012	2013	2014	2015	2016
Fixed Monthly Charge, $/ERU/Mo.						
Residential	$54.30	$57.00	$59.90	$62.90	$66.00	$70.00
% Increase	5%	5%	5%	5%	5%	6%
Multifamily	$45.00	$46.80	$48.70	$50.60	$52.60	$55.80
% Increase	4%	4%	4%	4%	4%	6%
Volume Charge, $/cf						
Commercial & Bangor	$0.064	$0.070	$0.077	$0.085	$0.093	$0.099
% Increase	10%	10%	10%	10%	10%	6%
Restaurants	$0.085	$0.098	$0.113	$0.129	$0.149	$0.158
% Increase	15%	15%	15%	15%	15%	6%
System Wide Rate Increase	6%	7%	7%	7%	7%	6%

A summary of additional annual overall rate increases required to fund the remaining 20-year CIP are shown on Table 10-5. In an effort to avoid dramatic rate increases, the County evaluated a level annual increase required to fund the CIP and ongoing operations, which balances the use of cash and debt financing. As shown on Table 10-5, maintaining annual rate increases of 6 percent per year between 2016 and 2030 is projected to achieve this goal.

Table 10-5. Additional Annual Rate Increases for the 20-Year CIP

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Equivalent Residential Units	19,500	19,700	19,900	20,100	20,300	20,500	20,700	20,900	21,100	21,300	21,500	21,700	21,900	22,100
Annual Rate Increase Required For Levelized Rates	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Revenues From Rates plus Growth	$18,410,537	$19,710,321	$21,101,870	$22,591,662	$24,186,633	$25,894,209	$27,722,340	$29,679,538	$31,774,913	$34,018,222	$36,419,908	$38,991,154	$41,743,929	$44,691,051
Revenues From Rate Increase	$1,104,632	$1,182,619	$1,266,112	$1,355,500	$1,451,198	$1,553,653	$1,663,340	$1,780,772	$1,906,495	$2,041,093	$2,185,195	$2,339,469	$2,504,636	$2,681,463
Total Rate Revenues	$19,515,169	$20,892,940	$22,367,982	$23,947,161	$25,637,831	$27,447,862	$29,385,681	$31,460,310	$33,681,408	$36,059,315	$38,605,103	$41,330,623	$44,248,565	$47,372,514
Contract and Other Revenues	$3,194,000	$3,209,000	$3,224,000	$3,239,000	$3,254,000	$3,269,000	$3,284,000	$3,299,000	$3,314,000	$3,329,000	$3,344,000	$3,359,000	$3,374,000	$3,389,000
Total Revenues	$22,709,169	$24,101,940	$25,591,982	$27,186,161	$28,891,831	$30,716,862	$32,669,681	$34,759,310	$36,995,408	$39,388,315	$41,949,103	$44,689,623	$47,622,565	$50,761,514
Expenses	$11,482,483	$12,144,000	$12,812,000	$13,487,000	$14,170,000	$14,861,000	$15,561,000	$16,269,000	$16,986,000	$17,710,000	$18,065,000	$18,428,000	$18,800,000	$19,183,000
Annual Debt Payment	$7,573,504	$7,573,504	$7,574,004	$7,575,504	$7,475,254	$7,321,754	$7,409,554	$7,408,754	$7,242,354	$7,245,241	$9,309,691	$11,417,754	$11,417,835	$11,419,052
Total Expenses	$19,055,987	$19,717,504	$20,386,004	$21,062,504	$21,645,254	$22,182,754	$22,970,554	$23,677,754	$24,228,354	$24,955,241	$27,374,691	$29,845,754	$30,217,835	$30,602,052
Net Revenues for CIP	$3,653,182	$4,384,437	$5,205,978	$6,123,658	$7,246,577	$8,534,108	$9,699,127	$11,081,556	$12,767,054	$14,433,074	$14,574,412	$14,843,869	$17,404,730	$20,159,462
Debt Service Coverage Ratio	1.79	1.90	2.02	2.16	2.35	2.53	2.68	2.89	3.06	3.16	2.71	2.43	2.65	2.89
Cumulative Reserves	$17,017,529	$21,401,965	$26,607,943	$32,731,601	$29,524,178	$15,444,286	$20,493,413	$21,574,969	$14,041,024	$16,474,097	$18,548,509	$15,392,378	$17,797,108	$37,956,570
Reserve Used For CIP				$10,454,000	$22,614,000	$4,650,000	$10,000,000	$20,301,000	$12,000,000	$12,500,000	$18,000,000	$15,000,000		
Reserve Balance	$17,017,529	$21,401,965	$26,607,943	$22,277,601	$6,910,178	$10,794,286	$10,493,413	$1,273,969	$2,041,024	$3,974,097	$548,509	$392,378	$17,797,108	$37,956,570

10.5 Affordability

Ecology determines that monthly single family sewer rates that represent a cost above 2 percent of the annual median household income (MHI) of an area present a financial hardship on customers. The proposed rate increases compared to the projected Silverdale area MHI are shown on Table 10-6. As shown, the adopted or projected rate increases would not result in a financial hardship for customers based on the Ecology standard.

Table 10-6. Ecology Financial Hardship Evaluation

2030 Forecast Year	Projected Median Household Income (MHI)	Adopted and Projected Monthly Residential Rate	Ecology Hardship Rate as % of MHI	County Adopted or Projected Rate as a % of MHI	Hardship
2011	$63,216	$54	2.0%	1.0%	No
2012	$65,112	$57	2.0%	1.1%	No
2013	$67,066	$60	2.0%	1.1%	No
2014	$69,078	$66	2.0%	1.1%	No
2015	$71,150	$70	2.0%	1.2%	No
2016	$73,285	$74	2.0%	1.2%	No
2017	$75,483	$79	2.0%	1.3%	No
2018	$77,748	$83	2.0%	1.3%	No
2019	$80,080	$88	2.0%	1.3%	No
2020	$82,483	$94	2.0%	1.4%	No
2021	$84,957	$99	2.0%	1.4%	No
2022	$87,506	$105	2.0%	1.4%	No
2023	$90,131	$112	2.0%	1.5%	No
2024	$92,835	$118	2.0%	1.5%	No
2025	$95,620	$125	2.0%	1.6%	No
2026	$98,488	$133	2.0%	1.6%	No
2027	$101,443	$141	2.0%	1.7%	No
2028	$104,486	$149	2.0%	1.7%	No
2029	$104,486	$158	2.0%	1.8%	No
2030	$104,486	$168	2.0%	1.9%	No

As part of the bond issuance effort, SDM Financial Advisors conducted a survey of local monthly sewer rates and compared those to the County sewer rates. Figure 10-1 shows the results of that survey. The County's current rates are below average and the adopted 5-year rates, shown on Table 10-6, are consistent with other local area rates.

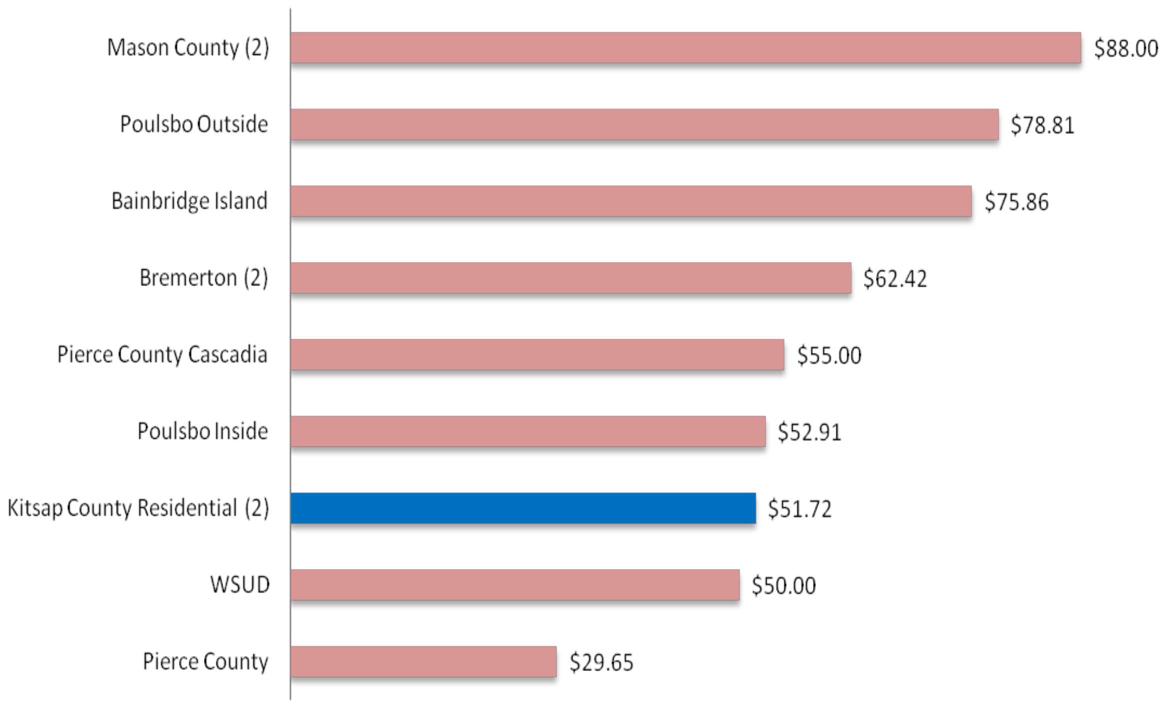

Figure 10-1. Comparison of local monthly single-family sewer rates

A summary of rate impacts required to fund the capital improvements discussed in this Facility Plan is shown in Figure 10-2. Future collection systems required to serve growth have a higher impact on rates, whereas the comparative rate impact of wastewater treatment improvements is much less.

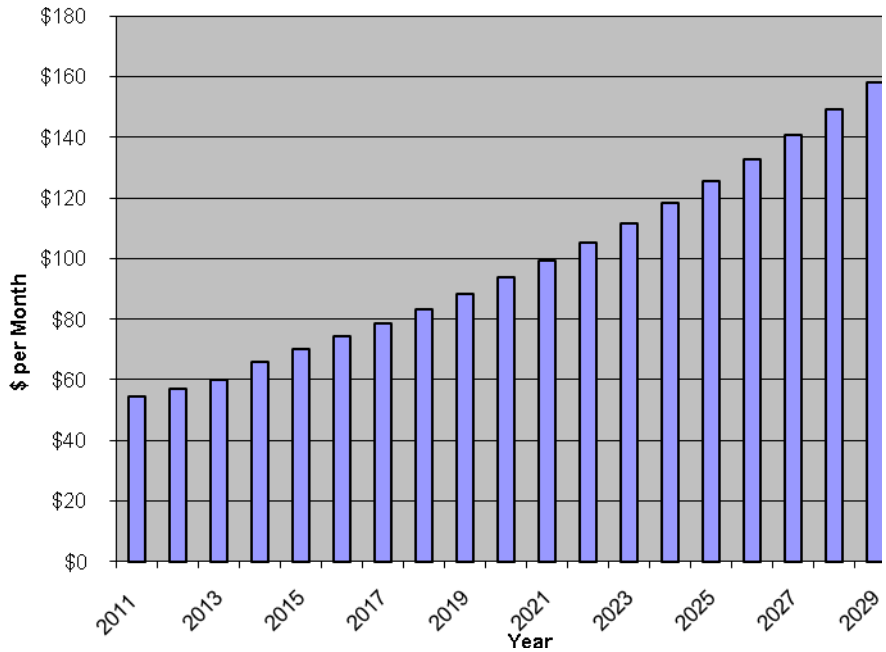

Figure 10-2. Adopted and projected monthly residential sewer rate

10.6 Alternative Funding Resources Available

A summary of government grants and loans potentially available to finance capital costs and reduce the need for future rate increases is provided in Appendix 10B. The County will take advantage of every opportunity to obtain grants and subsidized loan funding to minimize the cost of these capital projects to the ratepayers.

10.7 Conclusions

To fund the CIP and ongoing operations, the projected wastewater system revenues would need to be increased over current rates by 224 percent, or approximately 6 percent per year, by 2030. In assessing the implications of these projected rate increases, it is important to note that several of the underlying assumptions are conservative and that deviations from these assumed conditions will likely lessen future rate increases. These assumptions are as follows:

- No revenue is assumed to accrue to the Wastewater Division for reclaimed water production and sale.
- Grant funding has not been included to offset projected required capital costs.
- The potential for private/public or interlocal partnerships has not been assessed.

Based on the evaluation provided herein, the County's CIP presented in this Facility Plan could be affordably implemented.

10.8 Major Funding Assumptions

The major funding assumptions upon which annual revenue requirements and proposed rates are based are provided below:

- Maintain a minimum debt service coverage (DSC) ratio of 1.50.
- Excess revenues for DSC in the 6-year CIP example are to be deposited into the repair and replacement (R&R) reserves and not used for CIP. Excess revenues are projected to be used in the 20-year CIP example starting in 2020 to offset CIP costs.
- The 6- and 20-year annual CIP costs are as provided by the Consulting Engineer.
- $41 million bond issue in 2010 and a $55 million bond issue in 2014. Annual debt service represents level debt payments as provided by SDM Advisors.
- The near-term CIP will be primarily bond-financed without reserves used or debt financed from government loans or grants. Reserves will be used to fund the long-term CIP.
- Customer growth is 1 percent per year.
- O&M expenses and other revenues are based on 2009 actual data and 2010 and 2011 budgeted information.
- O&M inflation is 3 percent in 2010, 1 percent in 2011, and 3 percent per year thereafter based on information provided by the County.
- The 20-year evaluation includes additional treatment costs of 4.5 percent of current treatment costs and 0.5 percent of current collection costs per year for new facilities.
- Poulsbo and Navy contributions will be based on previous revenues plus inflation.
- Poulsbo capital facility charges for new facilities are anticipated to be $200,000 in 2010 and $400,000 per year thereafter, based on previous information provided by the City.
- Investment interest is 2 percent of funds held in reserves.
- The growth-related component of the adjusted newcomer assessment fee is based on a capital cost allocation of 60 percent of the treatment costs and 11 percent of the pumping and conveyance costs assumed to be related to expanding facilities.
- For the 20-year CIP, all current capital reserve funds (405, 410, and 411) are projected to be spent directly on capital projects; $5 million in operating reserve funds (402) are projected to be used to fund the CIP with $3.5 million anticipated to remain in reserves.

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