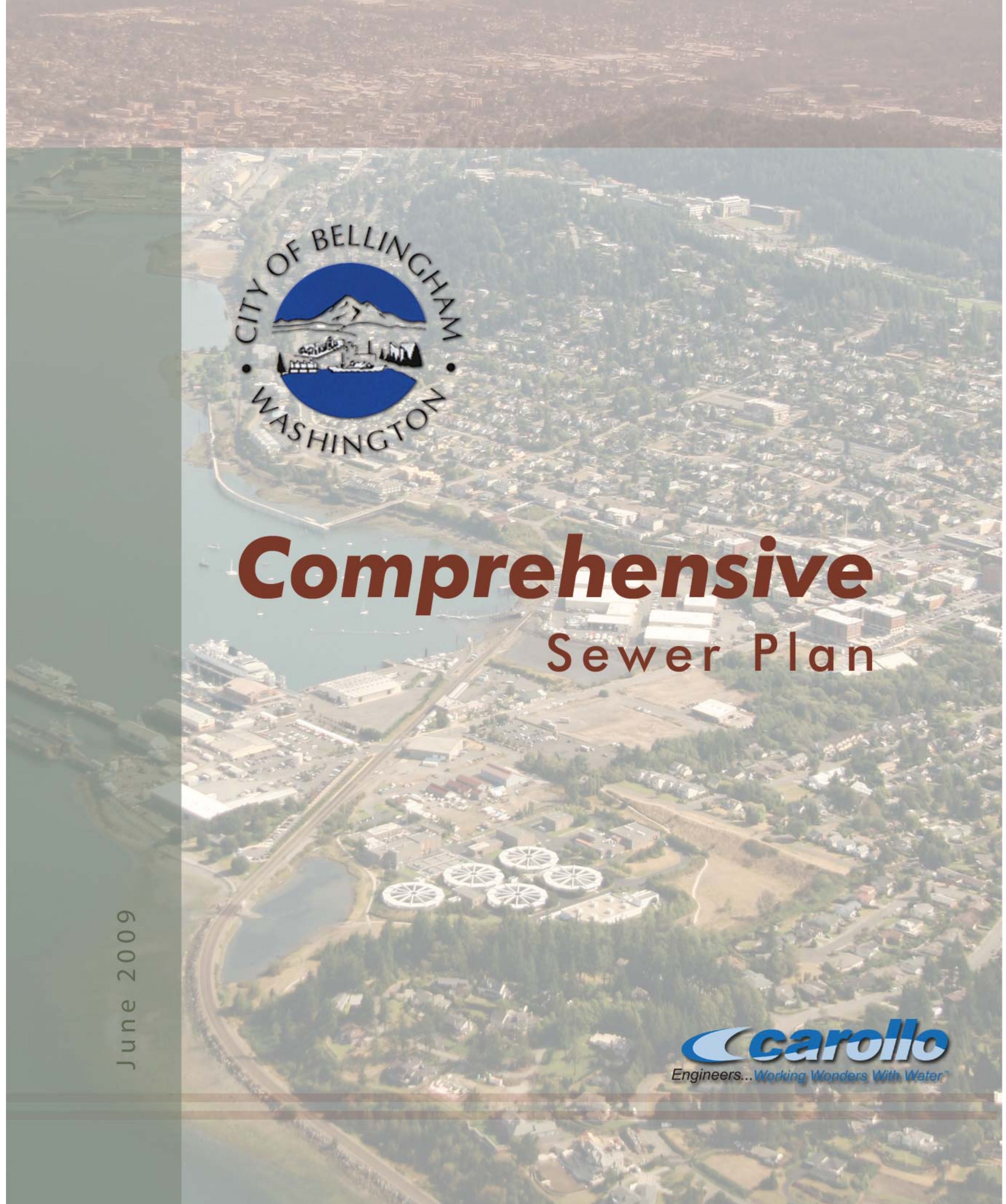

CITY OF BELLINGHAM
WASHINGTON

Comprehensive
Sewer Plan

June 2009

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City of Bellingham

COMPREHENSIVE SEWER PLAN

June 2009

JAMES P. HAGSTROM
STATE OF WASHINGTON
37252
REGISTERED
PROFESSIONAL ENGINEER

BRIAN R. MATSON
STATE OF WASHINGTON
43443
REGISTERED
PROFESSIONAL ENGINEER

carollo
Engineers...Working Wonders With Water™

1218 THIRD AVENUE • SUITE 1600 • SEATTLE, WASHINGTON 98101-3032 • (206) 684-6532 • FAX (206) 903-0419

City of Bellingham

Comprehensive Sewer Plan

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DEFINITIONS

μg/L	micrograms per liter
AA	average annual
AAF	average annual flow. The average yearly flow.
ADW	average dry weather
ADWF	average dry weather flow. Flow least impacted by I/I during the months of July through September.
AS	activated sludge
BI	Base Infiltration
BNR	biological nutrient removal
BOD	biochemical oxygen demand
BOD_5	Five day biochemical oxygen demand
CAO	Whatcom County Critical Areas Ordinance
CDBG	Community Development Block Grant
CEPT	chemically enhanced primary treatment
CF	cubic feet
CFP	Capital Facilities Plan
CFR	Code of Federal Regulation
CIP	Capital Improvement Plan
City	City of Bellingham
CSO	combined sewer overflow
CSS	combined sewer system
Ct	product of residual chlorine concentration multiplied by contact time
d/D	peak flow depth to pipe diameter ratio
DCIA	directly connected impervious areas
District	Lake Whatcom Water & Sewer District (formerly Water District No. 10)
DO	dissolved oxygen
DOE	Washington State Department of Ecology
DOH	Washington State Department of Health
DWF	dry weather flow
EIS	Environmental Impact Statement
ELA	Engineering, Legal, and Administration
ERU	equivalent residential unit

FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Act
GO	General Obligation
gal/acre-d	gallons per acre per day
GBT	gravity belt thickeners
GC	General Conditions
GIS	Geographic Information System
GMA	Growth Management Act
gpcd	gallons per capita per day
gpd/sf	gallons per day per square foot
gpm	gallons per minute
gpm/sf	gallon per minute per square foot
HGL	hydraulic grade line
hp	horsepower
HPO	high purity oxygen
hr	hour
HRT	high rate treatment
I/I	Infiltration and Inflow
in	inches
infiltration	groundwater leaking into the collection system
inflow	contribution from connected impervious areas such as roof drains and catch basins
lbs/day	pounds per day
LOX	liquid oxygen
LTS	Long-Term Simulation
LWWSD	Lake Whatcom Water & Sewer District
MBR	membrane bioreactor
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
mL	milliliters
MLLW	mean lower low water
MLSS	mixed liquor suspended solids
MM	maximum month

MMF	maximum month flow. The maximum average monthly flow, determined by maximum of the 30-day running average of the daily average effluent flows.
NES	National Ecological Services
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NWAPA	Northwest Air Pollution Authority
NWI	northwest inventory
O&M	operations and maintenance
Oak Street	Oak Street Pump Station
OH&P	overhead and profit
PD	peak day
PDF	peak day flow. The maximum average daily flow.
PE	primary effluent
PH	peak hour
PHF	peak hour flow. The maximum hourly flow.
Plan	Comprehensive Sewer Plan
POTWs	publicly owned treatment works
ppcd	pound per capita day
ppd/kcf	pounds per day per thousand cubic feet
pph	pounds per hour
pph/m	pounds per hour per meter
PSA	Pressure Swing Adsorption
PUD	Public Utility District No. 1
PVC	polyvinyl chloride
PWF	peak weekly flow
PWTF	Public Works Trust Fund
R2	intermediate fraction of rainfall that enters sewer
RAS	return activated sludge
RAS/WAS	return activated sludge/waste activated sludge
RCP	reinforced concrete pipe
RCW	Revised Code of Washington
RDII	Rainfall Dependent Infiltration and Inflow
RG	rain gauges
Roeder PS	Roeder Avenue Pump Station
RTC	Real Time Control

RTK	R = fraction of rainfall volume; T = time to peak; K = recession constant
SCADA	supervisory control and data acquisition
SCS, NRCS	Soil Conservation Service, now the National Resource Conservation Service
SDC	system development charges
SEPA	State Environmental Policy Act
SLR	surface loading rates
SOR	surface overflow rate
SRF	State Revolving Fund
SRT	solids residence time
SSO	sanitary sewer overflow
SVI	sludge volume index
SWMM	Long Term Simulation modeling with EPA modeling software SWMM 5.0.011
TAZ	traffic analysis zones
TM	technical memorandum
TSS	total suspended solids
UFSP	urban fringe subarea plan
UGA	urban growth area
USEPA	United States Environmental Protection Agency
UV	ultraviolet
VFD	variable frequency drive
WAC	Washington Administrative Code
WAS	waste activated sludge
WCWD#2	Whatcom County Water District No. 2
WCWD#7	Whatcom County Water District No. 7
WRIA 1	Water Resource Inventory Area 1
WWF	wet weather flow
WWTP	wastewater treatment plant

REFERENCES

Brown and Caldwell. 2001. *Hydraulic Evaluation.*

Brown and Caldwell. 2002. *Post Point Wastewater Treatment Plant Hydraulic Evaluation.*

Carollo Engineers. 2004. *Re-Rating of the Post Point WWTP Amendment to the Engineering Report.*

Carollo Engineers. 2006. *Addendum to the Post Point WWTP Re-Rating Study.*

Carollo Engineers. 2006. *Evaluation Of Potential Uses For The Homeport Properties Site.*

CH2M Hill. 1989. *City of Bellingham Post Point Wastewater Treatment Plant Upgrade.*

Christensen Design Management. 2006. *New Whatcom Draft Framework Plan 2026.*

City of Bellingham and Water District No. 10 of Whatcom County. 1974. Amended 1977. *Agreement for Sewer Service.*

City of Bellingham Planning and Community Development Department, Planning Division. 2005 and 2006. *Comprehensive Plan*, http://www.cob.org.pcd/planning/grwoth/comp-update.htm (accessed April 2006).

City of Bellingham. 2004. *Final Environmental Impact Statement (FEIS) for the City of Bellingham; Bellingham Urban Growth Area; Five-year Review Areas; and Whatcom County Urban Fringe Subarea.*

City of Bellingham. 2005. *Draft Comprehensive Plan.*

DOE (Department of Environment). 1997. *Criteria for Sewage Works Design.*

Earth Tech, Inc. 1998. *City of Bellingham Wastewater Conveyance Plan.*

Earth Tech, Inc. 2005. *City of Bellingham 2005 Comprehensive Water Plan.*

Ecology. 2006. *Criteria for Sewage Works Design.*

EPA (Environmental Protection Agency). 1974. *Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability.*

Hart Crowser. 2004. *Post Point Wastewater Treatment Plant and Alternative Outfall Investigation and Alternatives Analysis*. Bellingham, Washington.

Lake Whatcom Water & Sewer District (LWWSD). 2004. *Comprehensive Plan Update - Exhibit C. Sudden Valley - Geneva I&I Analysis, and Exhibit D. North Shore I&I Analysis*.

Revised Code of Washington (RCW).

U.S. Department of Agriculture, Soil Conservation Service. 1992. *Soil Survey of Whatcom County Area, Washington.*

Washington Administrative Code (WAC).

Whatcom County Planning and Development Services Department, Planning Division. 1997, revised 2005. *Whatcom County Comprehensive Plan.* http://www.co.whatcom.wa.us/pds/planning/comp_plan/comp_plan.jsp (accessed June 2006).

Whatcom County. 2005. *Whatcom County Comprehensive Plan, Urban Growth Areas*.

Wilson Engineering. 1991. *Water and Sewer Comprehensive Plan*, Lake Whatcom Water District 10.

Wright, D. 2004. *Draft Comprehensive Water Plan.* Public Utility District No. 1 of Whatcom County.

ES.1 INTRODUCTION

This executive summary presents a brief background of the City of Bellingham (City) sewer system, the need for this Comprehensive Sewer Plan (Plan), proposed improvements to mitigate existing collection system and treatment plant capacity deficiencies, and proposed improvements for anticipated future growth. The City initiated this Plan recognizing the importance of planning, developing, and financing sewer system facilities to provide reliable and enhanced service for existing customers and to serve anticipated growth. The Plan is required to meet state, county, and local requirements. It complies with the requirements of the Washington State Department of Ecology (DOE) as set forth in the Washington Administrative Code (WAC) 173-240.

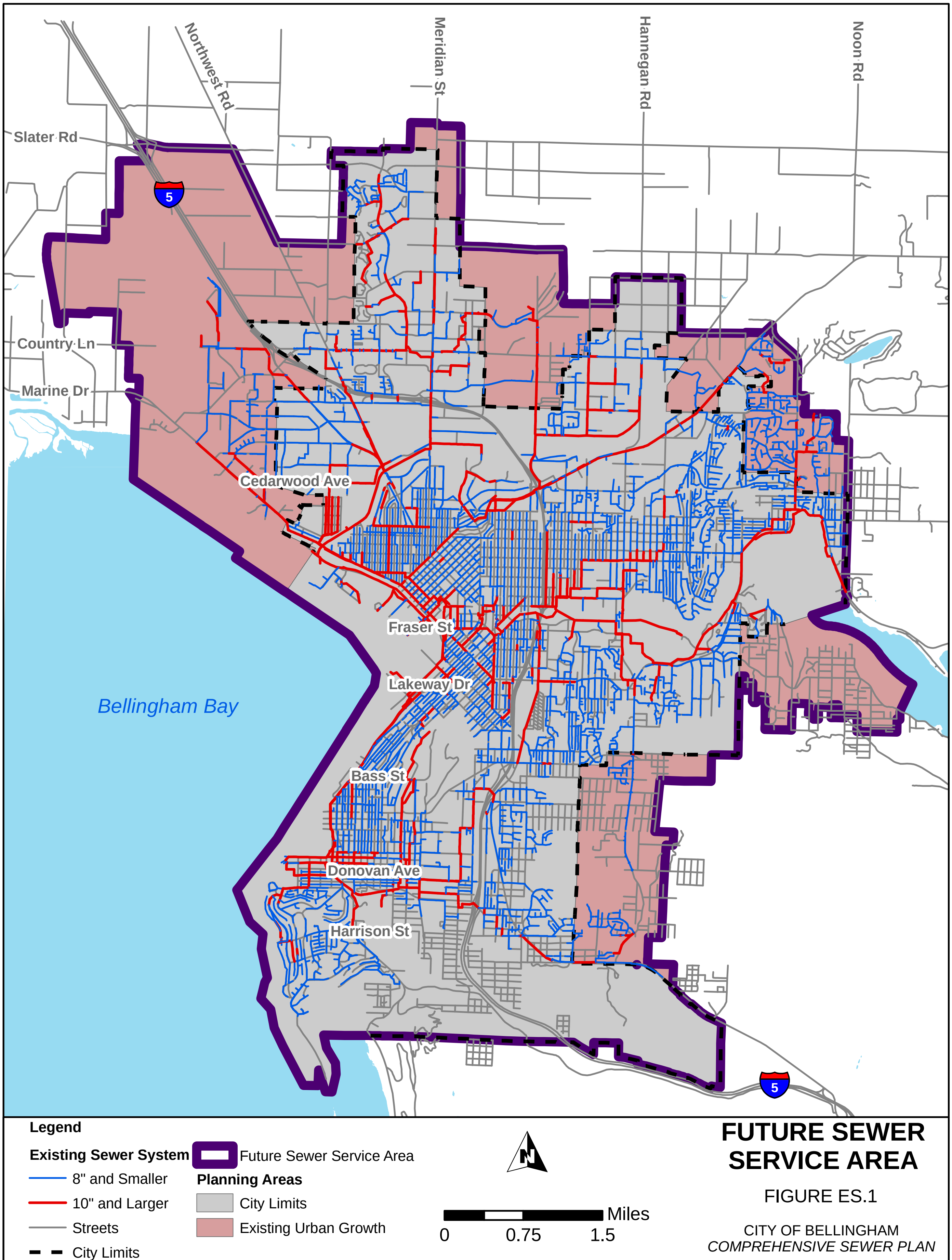
The City provides wastewater collection and treatment services within the City of Bellingham. The City currently operates 324 miles of wastewater collection system, and the Post Point Wastewater Treatment Plant (WWTP), which has a peak capacity of 72 million gallons per day (mgd). The Lake Whatcom Water & Sewer District (formerly Water District No. 10, (LWWSD) provides sewer service to the east of the City's service area near Lake Whatcom and contracts with the City to provide sewage treatment.

ES.2 BASIS FOR PLANNING

The City's sewer service area covers approximately 30 square miles serving approximately 83,000 customers. The City currently provides sewer service to areas within the City limits and sewer service zones within the Urban Growth Areas (UGAs) of Whatcom County. The sewer system currently extends as far as Kelly Road to the north, Lake Samish Road to the south, Lake Whatcom to the east and Bellingham Bay to the west. The elevation ranges from sea level to approximately 800 feet. The topography is mostly rolling hills, crossed by a few major streams and creeks.

The City is planning around a service area that includes the City limits and UGAs as identified in this study. The future sewer service area is shown in Figure ES.1. The future service area does not include any area outside the urban growth boundary.

It is the City's intent to provide appropriate, safe, reliable sewer service at a fair and reasonable price to customers while protecting and preserving the integrity of the environment. It is the goal of the City sewer utility to minimize degradation of water quality and to maintain compliance with the effluent standards for discharged waste. An ongoing goal of the City's infiltration and inflow (I/I) removal program is to perform the necessary maintenance and replacement to help keep combined sewer overflows from occurring more



FUTURE SEWER SERVICE AREA

FIGURE ES.1

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than once per year and to further reduce peak flow response to rainfall through targeted collection system rehabilitation.

ES.3 DEMOGRAPHIC ANALYSIS

A demographic analysis was completed to determine the projected population in the service area, and where this growth is expected to occur. The future sewer service area demographic analysis utilized the City's current population and employment data, and the Traffic Analysis Zones (TAZ) from the City's Geographic Information System (GIS). This platform made it possible to overlay TAZ, City/UGA zoning and land use, and Whatcom County land use layers in an effort to generate population and employment projection data.

Many factors influence population growth in the Greater Bellingham region. The state of the economy, interest rates, demands for annexation by neighboring cities, and up-zoning all influence new development and population growth. Rapid growth experienced during the mid-1990s prompted the City to join Whatcom County and the other local cities in updating their state mandated Comprehensive Plans. The City's land use regulations established in the Comprehensive Plan provide a guideline for implementing the community's vision. Currently, approximately 58 percent of the land within the City limits is zoned for residential use, while the remaining land is classified for non-residential or mixed-use. Much of the remaining residential land within the City limits is zoned multi-family. Therefore, the planning data provided by the City used in the demographic analysis assumes 67 percent of the housing needs will be met by multi-family development.

Historically, the City has accounted for approximately 50 percent of the population of Whatcom County. A notable acceleration in population growth was observed beginning in 1980, and this trend is forecasted through 2020. The City experienced a population increase of approximately 22 percent in the 1990s alone.

Employment in the Greater Bellingham area has grown steadily with the population over the past 20 years. During this period, service and retail sector jobs have outpaced the growth experienced in other sectors (government, manufacturing, etc.) and now make up over 60 percent (2002 estimate) of employment in the region. This trend is expected to continue over the next 20 years with the service sector growing at a more rapid pace than other sectors. Proportional to the rest of the county, it is estimated that Bellingham will employ 68 percent of the county's workforce by 2022, up from 62 percent in 2002.

Two forecasting scenarios were developed from the City's current and project planning data. The first scenario assumes a constant growth rate based on the 2002 and 2022 population and employment data. The 2026 total population is estimated to be 119,375 based on a linear extrapolation from the 2022 projection of 113,055.

Scenario 2 was developed to more accurately present the current expectation of the timing and location of growth and development within the City. In early 2007, City Planning Staff proposed anticipated development trends by area within the City at the 2016, 2022, and 2026 planning scenarios. The majority of the modified planning values occurred in the UGA, Downtown, Waterfront, and Fairhaven areas. The resulting total population projections for Scenario 2 can be seen in Table ES.1.

Table ES.1 Population Distribution by Planning Area Scenario 2 – Custom Variable Growth Rate
Comprehensive Sewer Plan
City of Bellingham

Area	2002	2006	2012	2016	2022(1)	2026
City Limits(1)	69,260	72,597	78,948	82,660	88,577	95,072
UGA	12,194	14,651	17,158	20,557	24,478	26,935
Total	81,454	87,248	96,107	103,217	113,055	122,007

Notes:
1. Based on available TAZ data.

Overall, Scenario 2 predicts growth from 2006 to 2012 to be slightly slower (3,526 people) than Scenario 1 and then increase in the middle of the planning period from 2012 to 2016. The total population in 2026 is slightly greater by 2,632 people in Scenario 2 than in Scenario 1 due to the proposed waterfront redevelopment.

ES.4 FLOW AND LOAD PROJECTIONS

Flows currently tributary to the WWTP were compiled from analysis of effluent flow records from 1998 though present. Daily effluent flow from 1998 though 2006 were analyzed to determine the current average dry weather flow (ADWF), maximum month flow (MMF), peak day flow (PDF), and peak hour flow (PHF). Peaking factors were established using ADWF as a basis. Per capita flow values were determined by dividing the current flow values by the population within the existing sewer service area. The per capita flow rates and peaking factors were then used to estimate future flows.

Future flows to the WWTP were estimated using the population projections from the Scenario 2 demographic analysis. Assumptions were made to reflect the impact of the growing fraction of sewered population within the City limits and UGA. Table ES.2 summarizes current flow values, and projected flows for the years 2016 and 2026.

Table ES.2 Flow Projections Comprehensive Sewer Plan City of Bellingham			
Flow	**2005 Flows, mgd(1)**	**2016 Flows, mgd**	**2026 Flows, mgd**
ADWF	10.2	14.0	17.7
AAF	12.5	17.2	21.7
MMF	19.8	27.3	34.3
PDF	52.9	58.8	64.2
PHF(2)	67.3	72.0	72.0

Notes:

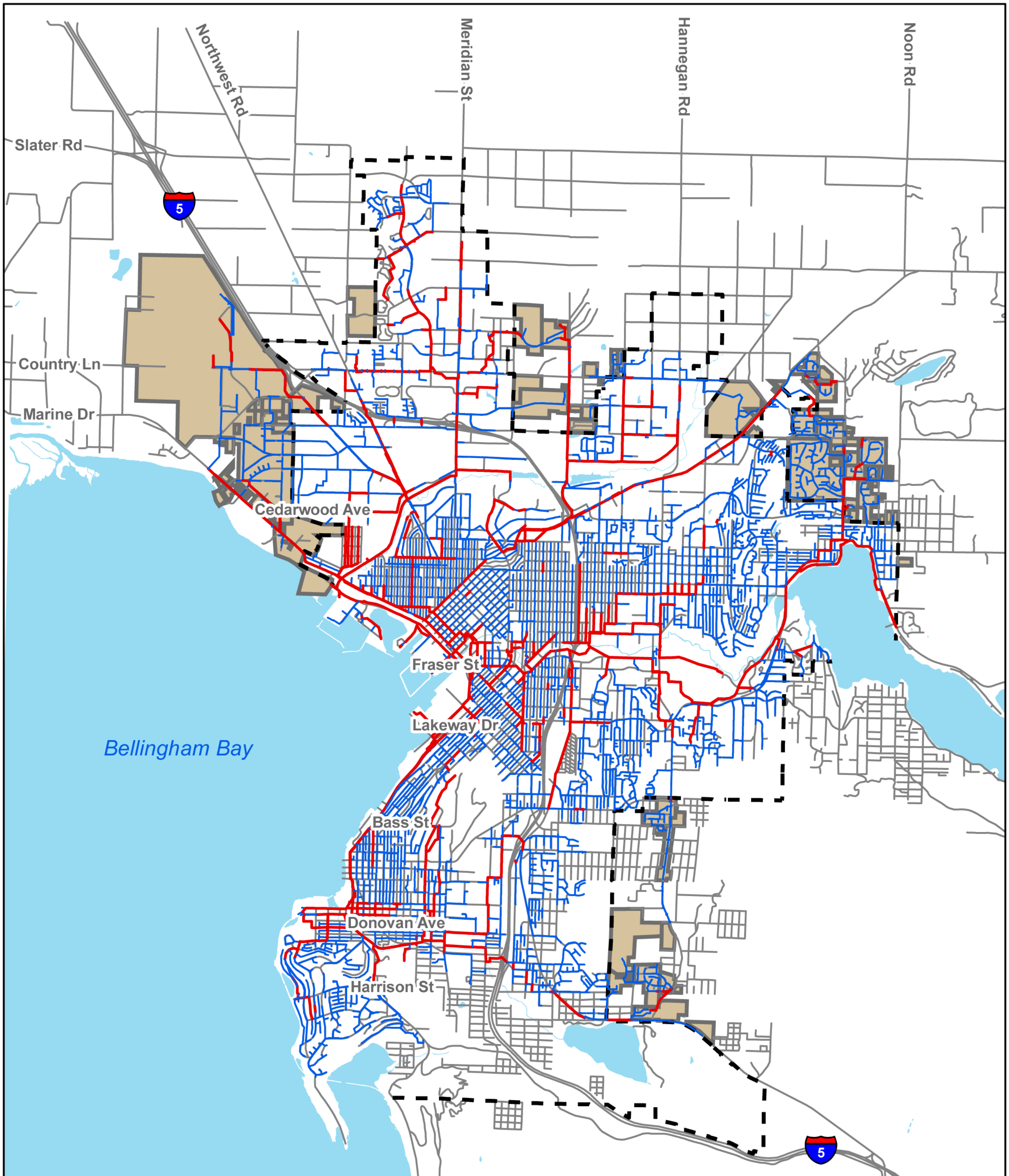
1. Flows reflect the projected 2005 flows based on the applied growth rate from the base flow calculated from the 2003 data, and are slightly higher than recorded flows in 2005.
2. Use of remote storage caps peak flow to the WWTP at 72 mgd.

A similar analysis was completed for wastewater loads. The loading parameters of principal interest for evaluating WWTP capacity are biochemical oxygen demand (BOD) and total suspended solids (TSS). These parameters were evaluated and projected in a manner consistent with the flow projections. The majority of the BOD currently treated at the WWTP comes from domestic sources (including residential and commercial) and is approximately 80 percent of the maximum month load. The industrial load comprises approximately 17 percent, with the remainder coming from septage haulers. Both domestic and industrial BOD loads may be reduced by implementing conservation measures and/or more restrictive limits on industrial sources. Table ES.3 summarizes existing loading values, and projected loads for the years 2016 and 2026, showing average annual (AA), maximum month (MM) and peak day (PD) loads.

Table ES.3 BOD and TSS Load Projections Comprehensive Sewer Plan City of Bellingham						
Load	**2005 BOD, ppd**	**2016 BOD, ppd**	**2026 BOD, ppd**	**2005 TSS, ppd**	**2016 TSS, ppd**	**2026 TSS, ppd**
AA	20,200	27,800	35,000	22,600	30,900	39,000
MM	23,000	31,700	39,900	26,300	36,100	45,500
PD	42,100	57,900	73,000	64,700	88,700	111,900

ES.5 EXISTING COLLECTION SYSTEM

The City operates and maintains approximately 318 miles of sewer mains and 6 miles of force mains, serving an estimated 26,100 residential service connections over an area of approximately 30 square miles. The system is divided into eight sewage drainage basins: Birchwood, Broadway, Central, Cordata/Meridian, Lake Whatcom, Northwest, South Side, and Sunset Beach/Mt. Baker. Figure ES.2 shows the extent of the existing system.



Legend

Existing Sewer System

- 8" and Smaller
- 10" and Larger
- Streets
- City Limits
- Extended Sewer Service Zone

0 0.8 1.6 Miles

EXISTING SEWER SYSTEM

FIGURE ES.2

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Sewer pipes range in diameter from 4 inches to 60 inches, with the majority of pipes between 4 and 8 inches in diameter. Smaller pipes in the collection system feed four main trunks, which convey the sewage to two interceptors leading to the WWTP. There are 27 pumps stations in the system, the largest being the Oak Street Pump Station (Oak Street) with a peak operating capacity of approximately 76 mgd, but is limited by downstream conveyance capacity to 60 mgd.

A portion of the system is a Combined Sewer System (CSS), meaning that it was designed to convey sewage as well as storm water. In most combined systems untreated overflows occur during peak rainfall events when conveyance capacity is exceeded due to the high volume of storm water entering the system. Between 1974 and 1987 numerous storm water separation projects were completed, reducing four Combined Sewer Overflow (CSO) points to one, at the C Street overflow structure. This CSO is still active, and used infrequently to relieve capacity during extreme wet weather events. The City's existing National Pollution Discharge Elimination System (NPDES) Permit allows continued CSO events, but limits their frequency and volume to less than or equal to current "baseline" conditions.

ES.6 COLLECTION SYSTEM ANALYSIS

In order to determine existing capacity and future deficiencies as flows increase over time, the City's conveyance system was evaluated using two modeling approaches. First, peak flows generated in response to rainfall were simulated using a calibrated model of the City's collection system, H2OMAP Sewer. Next, the statistical frequency of CSO discharges at the existing C Street CSO point were evaluated using Long Term Simulation (LTS) modeling with EPA modeling software (SWMM).

The H2OMAP Sewer model was calibrated to a variety of dry season and wet weather conditions at the onset of the modeling effort. Once the model was calibrated, current and future peak flows were simulated using several design storm events. The analysis concluded that two design storms, an actual event that was measured in November 2004, and a 10-year, 24-hour synthetic event, were appropriate for determining peak flows and associated capacity improvements.

Current and future (year 2026) peak flows for both the November 2004 and 10-year storm events exceed the conveyance capacity of the existing system. Specifically, piping near the existing CSO, Oak Street, and the interceptor between Oak Street and the WWTP were determined to have insufficient capacity under the modeled peak flow conditions. Improvements to these components of the system are needed to increase the capacity the conveyance system, and reduce the number of CSO events in a given year.

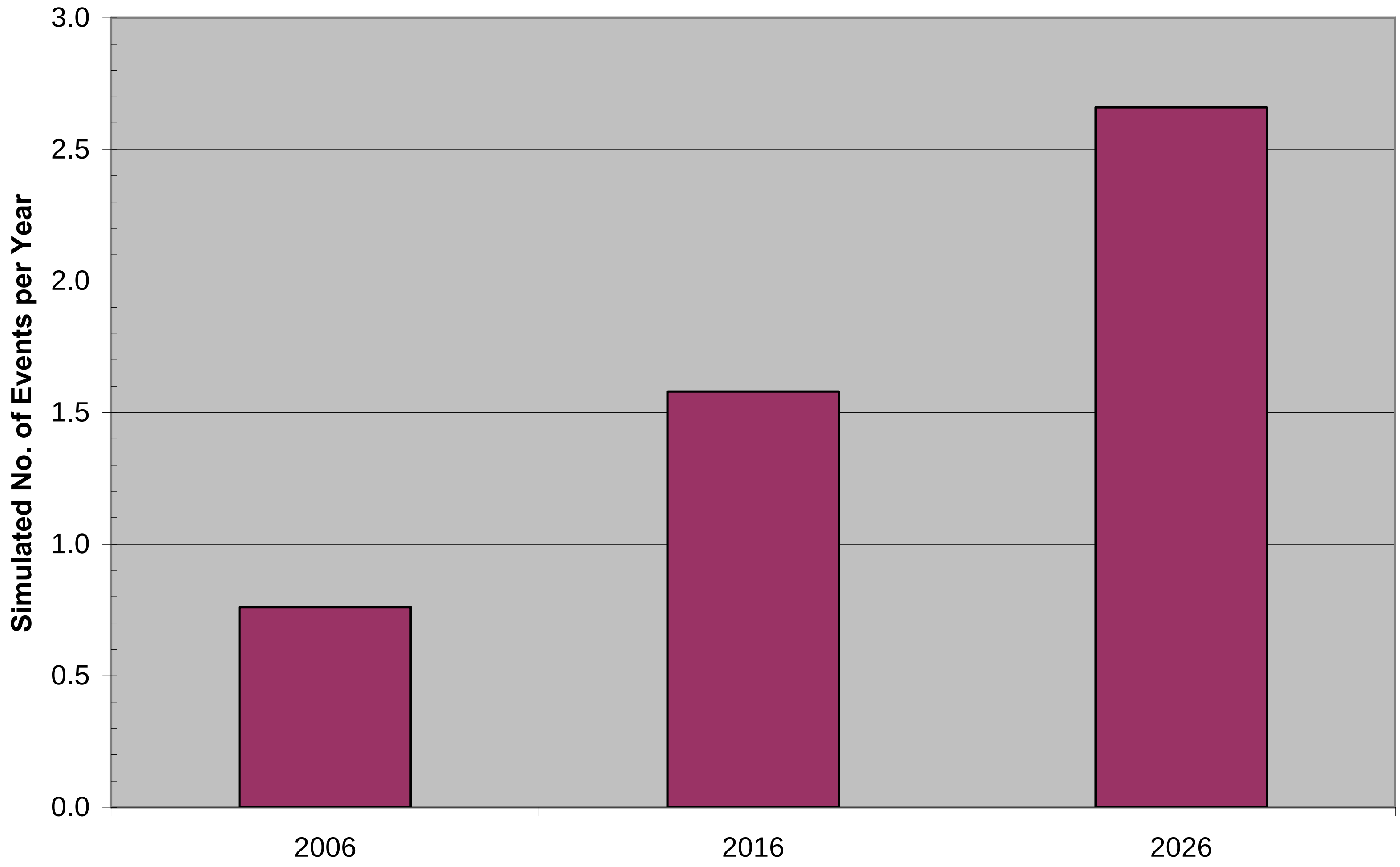
LTS modeling was completed to better define the improvements needed to meet NPDES requirements. The model was constructed to represent the flow input and hydraulics constraints of the CSS in a simplified manner, while still maintaining accurate simulation of flow into Oak Street, overflows at the C Street CSO, and influent to the WWTP. Hourly rainfall records for a 59 year period were processed through the model in order to simulate current and future flow responses to actual rainfall duration and intensity experienced in the Bellingham area.

The model running under current conditions predicted a total of 45 CSO events over the 59-year period, or an average of 0.76 events per year and established the average "baseline" CSO volume at 1.2 MG per year. This result is consistent with the City's historical CSO records, and indicates that the current system has adequate capacity to meet the NPDES requirement of one event per year. As growth occurs in the collection system, the model predicted an increased risk of exceeding the one event per year limit. By 2016, the model predicted an average of 1.57 CSO events per year and established the average annual CSO volume of 2.8 MG. The 2026 model run predicted a total of 157 CSO events, or 2.66 events per year and established the average annual CSO volume of 5.2 MG. Figure ES.3 shows how the LTS model predicts number of CSO events per year to increase over time. LTS analysis refined the H2OSewer Map modeling results, and confirmed that the capacity of the existing conveyance and treatment systems, currently 72 mgd, would need to be increased in the future to meet NPDES limits.

Approximately 20 % of the existing sewer service area consists of a CSS and based on the calibrated model, this section of the collection system contributes approximately 50% of the peak flow. The City of Bellingham has an ongoing program to reduce peak flows through collection system improvements that dates back to the early 1970s around the time of passage of the Clean Water Act. Between 1974 and 1987 numerous storm water separation projects were completed, reducing four overflow points to one at the C Street overflow structure, and significantly reducing the "baseline" CSO frequency and volume. Historical collection system improvement projects represent over $40 million (escalated to 2007 dollars) in capital investments to reduce CSO frequency and volume. The City continues to proactively manage peak flows through regulation and annual repair/replacement projects and budgets one percent of the collection system value (estimated at over $1 million per year) with the goal of further reducing I/I.

Additional improvements (i.e., beyond the City's historic and ongoing programs to reduce peak flows) will be required to comply with CSO control regulations. Management of excess peak flows can be achieved two ways:

Peak flows can be managed within the collection system at a remote wet weather facility (usually a high rate treatment plant or storage tank). Constructing a wet weather facility near the existing C Street CSO would eliminate the majority of the most costly conveyance system improvements, as well as the need to increase the peak capacity at the WWTP.



SUMMARY OF EXPECTED CSO EVENTS PER YEAR

FIGURE ES.3

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- Peak flows can be managed at the WWTP, which requires an increase in conveyance and downstream treatment capacity.

The LTS modeling indicated that a 10 mgd high rate treatment (HRT) facility or approximately 1.7 million gallons (MG) of peak flow storage would be needed to limit CSOs to one event per year in 2026. Additional improvements, i.e. more storage, greater treatment capacity, and/or low peak flow reduction are required to maintain CSO volumes at their current "baseline" levels. Alternately, 82 mgd of peak conveyance and treatment capacity would be needed if peak flows were managed at the WWTP.

Regardless of which peak flow management option is selected, the City is committed to finding ways to reduce the response to rainfall in its combined and separated sewer systems. Several programs have been identified for early implementation, with the goal of continued peak flow reduction. Table ES.4 summarizes these programs and their anticipated implementation date.

Table ES.4 Peak Flow Reduction Program Summary
Comprehensive Sewer Plan
City of Bellingham

Program	Benefit	Implementation Date
Targeted downspout disconnection	Reduce known sources of inflow	2010
Side sewer rehabilitation incentives	Motivate home owners to reduce infiltration	2010
Field verification analysis (GIS, geotech, etc.)	Confirm site-specific conditions allow I/I reduction	2011
Green Stormwater Infrastructure (GSI) Campaign	Reduce rainfall response using GSI on residential, commercial sites	2011

ES.7 RECOMMENDED COLLECTION SYSTEM IMPROVEMENTS

The approach to identifying collection system improvements needed by year 2026 was developed in three parts. First, improvements throughout the existing collection system that are needed to accommodate future flows were identified. The November 2004 storm was selected as the trigger event for collection system improvements based on its recurrence interval and peak flow impact on the system. Next, an estimate of sewer extension to provide service for projected areas of growth within the UGA was developed. These improvements will be required regardless of which strategy for peak flow management is selected.

The third component of the analysis involved alternatives for peak flow management. As described in Section ES.6, several programs have been identified for early implementation, with the goal of continued peak flow reduction in response to rainfall, in addition to the development of two alternatives for peak flow management. Alternative 1 assumed that peak flows would be managed in the collection system, by constructing a wet weather facility near the CSO location. As previously mentioned, this alternative would eliminate the need for increasing the capacity of the conveyance system between the C Street CSO and the WWTP. Costs for remote storage (Alternative 1A), and remote HRT (Alternative 1B) were developed for a comparative cost analysis.

Alternative 2 assumed that peak flows would be conveyed to the WWTP. The necessary collection system piping and pump station improvements were identified and used to estimate the conveyance cost component of this alternative. Options for increasing peak flow capacity at the WWTP were evaluated as a part of the WWTP analysis described in the following sections. The conveyance cost component plus the cost associated with increasing peak capacity at the WWTP was totaled and compared to the cost of remote storage and HRT in order to determine the most effective means of managing excess peak flow.

ES.8 EXISTING TREATMENT FACILITY

The City's existing WWTP provides secondary treatment of wastewater prior to marine discharge in Bellingham Bay. The original primary treatment plant at Post Point was built in 1974 to replace an aging treatment plant near the mouth of Whatcom Creek. The facility was upgraded in 1990 to provide full secondary treatment. Figure ES.4 shows the existing plant layout.

The headworks at the WWTP provides preliminary treatment (screening and grit removal). Primary treatment is provided downstream of the headworks by two 120-foot diameter primary clarifiers. Primary effluent pumps lift effluent from the clarifiers to the secondary process.

The secondary process includes three main components: two high purity oxygen (HPO) aeration basins; an oxygen generation/dissolution system; and three 120-foot diameter secondary clarifiers. The plant currently treats up to 40 mgd through the secondary train. Bypass of secondary treatment occurs at an automatic overflow weir when flows exceed 40 mgd. Bypass flow is directed to the chlorine contact basin, blended with secondary effluent, and disinfected prior to discharge.

The WWTP uses gas/liquid chlorine for disinfection of wastewater effluent prior to discharge to Bellingham Bay. The chlorine system was upgraded during the 1990 expansion. The system has the capability for prechlorination, post chlorination, and intermittent chlorination of return activated sludge for sludge bulking control.

The WWTP has two outfalls. The main 60-inch diameter effluent outfall discharges to a multi-port diffuser and a 54-inch outfall that begins upstream of the effluent Parshall flume and is used only when flows exceed the capacity of the multiport diffuser. A replacement for this outfall is currently under construction.

Mixed primary and waste activated sludges from the secondary treatment system are pumped to gravity belt thickeners for initial thickening prior to storage and subsequent centrifuge dewatering. Two multiple hearth incinerators thermally convert dewatered solids from the WWTP to ash, which is disposed of at a landfill.

ES.9 TREATMENT PLANT ANALYSIS

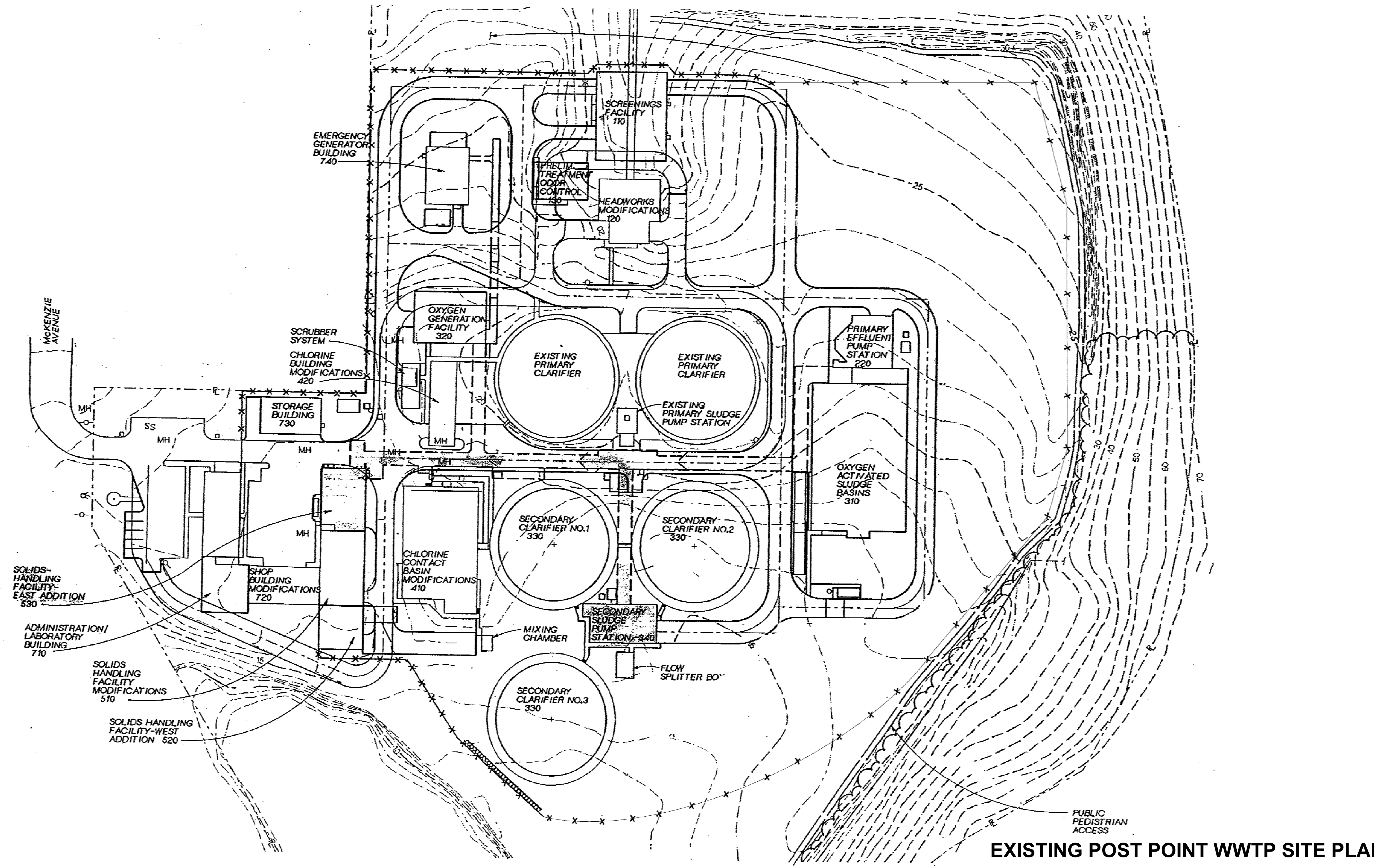
The WWTP produces secondary effluent that is typically well below current NPDES limits. The recent plant performance data compared to the NPDES effluent limits for coliform, pH, BOD and TSS indicate that from 1998 through 2006, the WWTP did not exceed permit conditions.

Overall WWTP capacity was evaluated to identify improvements that would be needed to accommodate increased flows and loads over the planning period. The analysis considered liquid stream process upgrades needed to meet the requirements of the NPDES permit, and hydraulic upgrades needed to convey peak flows through the plant. The capacity of the solids handling system was also determined.

Process capacities for each liquid and solids treatment system were evaluated using a combination of computer modeling and historical design criteria. Process modeling was calibrated to consider the impact of recent modifications to the HPO process, including conversion of a portion of the existing aeration basins to an anaerobic selector.

A hydraulic model of the existing WWTP was not developed for the analysis. The most recent hydraulic analysis of the plant was conducted in 2002 (Brown and Caldwell 2002). This evaluation determined the potential for the WWTP to convey a peak hour flow of 72 mgd, which is 18 percent greater than the rated design capacity of 60 mgd.

The capacity of the existing WWTP based on critical capacity parameters is summarized in Table ES.5.



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EXISTING POST POINT WWTP SITE PLAN

FIGURE ES.4

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Table ES.5 Existing WWTP Capacity Summary Comprehensive Sewer Plan City of Bellingham		
Capacity Parameter	**Value**	**Limiting Process**
Max Month Flow	20 mgd	Primary/Secondary System
Max Day Flow	62 mgd	Disinfection System
Peak Hour Flow	72 mgd	Overall Hydraulic Capacity
Max Month BOD	25,000 lb/d	Primary/Secondary System
Max Month TSS	47,000 lb/d	Sludge Thickening

ES.10 RECOMMENDED TREATMENT PLANT IMPROVEMENTS

Projected flows and loads were compared to the WWTP capacity to determine upgrades needed for future growth in the service area. Table ES.6 compares the current WWTP capacity to projected (year 2026) flows and loads. As shown in the table, the max month flow and BOD capacity of the existing WWTP will be exceeded during the planning period. Plant hydraulic capacity will also be exceeded if peak flows over 72 mgd are conveyed to the WWTP.

Table ES.6 WWTP Capacity Limitations Comprehensive Sewer Plan City of Bellingham		
Capacity Parameter	**Existing Capacity**	**Future Flow/Load**
Max Month Flow	20 mgd	34.3 mgd
Max Day Flow	62 mgd	64.2 mgd
Peak Hour Flow	72 mgd	72 mgd (1) 82 mgd (2)
Max Month BOD	25,000 lb/d	39,900 lb/d
Max Month TSS	47,000 lb/d	45,500 lb/d

Notes:

1. Peak hour flow assuming that 10 mgd of the peak flow is treated in the collection system.
2. Peak hour flow assuming that the entire peak is conveyed to the treatment plant.

The capacity of the existing primary and secondary processes must be increased in order to provide effective treatment of future flows and loads at the WWTP. A third 120-foot primary clarifier is required, along with expansion of the secondary treatment system.

Three options for secondary expansion were evaluated, including expanded HPO, conversion to air activated sludge (AS), and conversion to membrane bioreactor (MBR).

The expanded HPO option is recommended based on its lower relative cost and other operational and site factors. Preliminary analysis indicates the need for a new anaerobic selector, two new aeration basins, and a new 120-foot secondary clarifier. A new 20-ton pressure swing adsorption (PSA) system will also be needed to replace the existing system.

A comparative cost analysis concluded that remote storage and peak flow reduction (Alternative 1A) is the preferred peak flow management alternative based on its cost effectiveness, and non-cost considerations including operation and maintenance (O&M) impacts, reliability, and NPDES permitting issues. With peak flows stored remotely in the system, no hydraulic improvements are required at the WWTP. Figure ES.5 shows the site layout for the WWTP improvements that are recommended to provide future flow and BOD capacity.

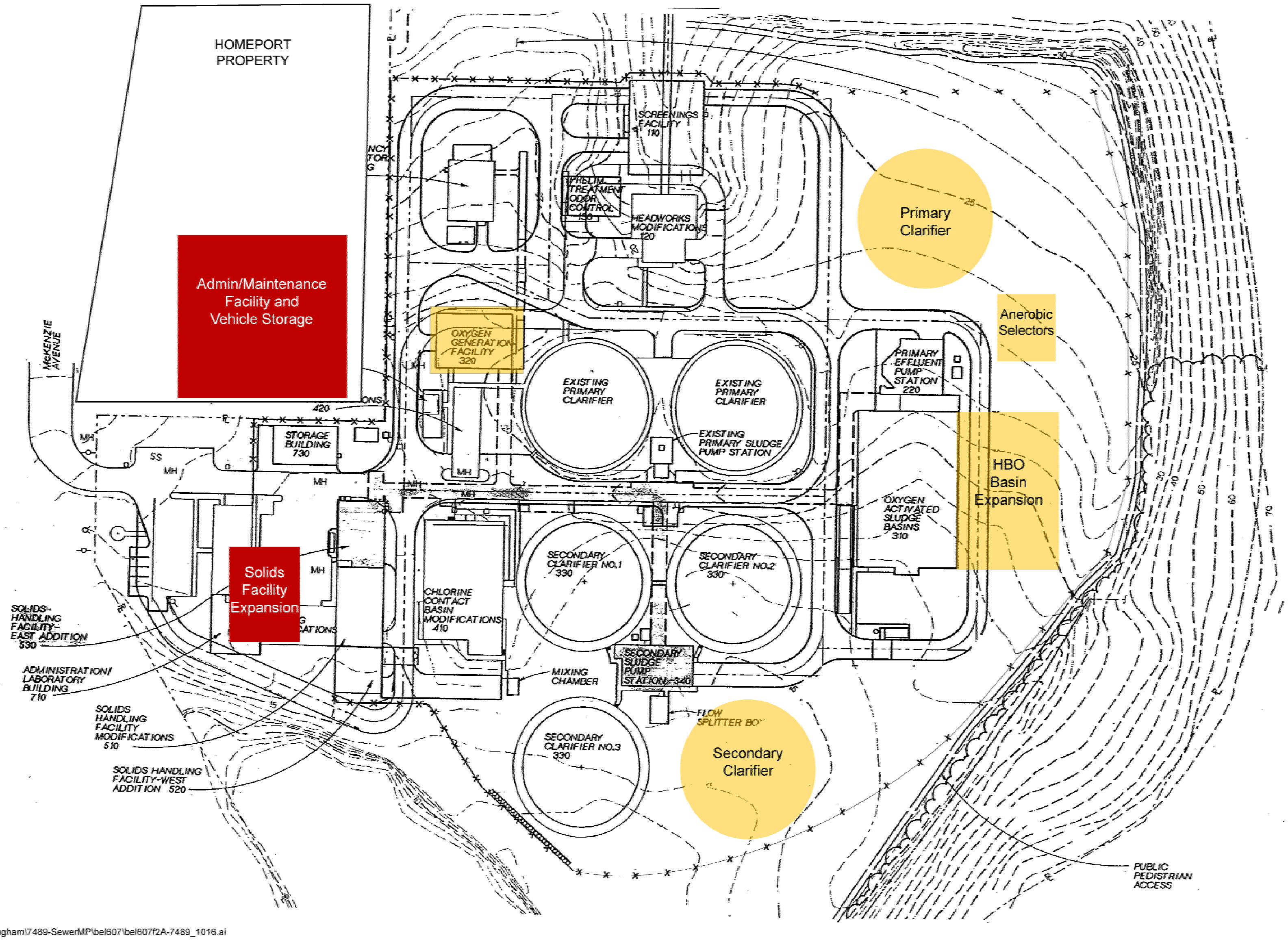
Three scenarios were developed to reduce the amount of BOD entering the City's collection system. The scenarios were evaluated to determine the potential impacts on the existing and future capacity needs at the WWTP. The preliminary evaluation highlights the potential effectiveness of reducing BOD loads from industrial and domestic sources, thereby deferring the future expansion at the WWTP. The effectiveness of the programs could provide an equivalent of up to three years of population growth for Scenario 1 - Moderate Reduction and a maximum of eight years of equivalent population growth for Scenario 3 - Very Aggressive Reduction. As programs are implemented, influent BOD loads should be monitored to validate performance and quantify impacts on future WWTP expansion plans.

ES.11 CAPITAL IMPROVEMENT PLAN

Phasing plans for the recommended collection system and WWTP improvement projects were developed to provide capacity to match projected growth in the City and UGA. The trigger for collection system improvements is driven by future growth and expansion of the sewer system, as well as the need to meet NPDES permit limits for CSOs.

Collection system piping improvements to correct capacity limited segments of the system are presented in the CIP in three priority categories. Priority 1 projects are required in the near term to address current capacity limitations. Priority 2 and 3 projects are triggered by future growth in the existing sewer service area, and expansion of the system into currently unsewered areas of the UGA.

The CIP includes an I/I study to better target and improve the cost effectiveness and performance of future peak flow reduction projects. The regulatory trigger that drives peak flow storage is the need to limit CSOs. LTS modeling indicates that this trigger will occur prior to year 2016. The preferred location for the peak flow management facility is in the vicinity of the existing CSO outfall, near C Street. A phased approach is recommended. The timing of this facility is driven by the regulatory trigger as well as future development plans in the surrounding waterfront area. Coordination with planned development requires that the first phase of the storage tank construction project be completed by the end of 2011.



WWTP SITE PLAN, RECOMMENDED HPO EXPANSION OPTION

FIGURE ES.5

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Completing the storage facility on this schedule will also provide peak flow capacity on a schedule that matches predicted growth in the system.

Additional refinement of the storage volume size is recommended during subsequent design phases, to maximize the effect of storage on CSO control and identify the most cost effective volume and storage configure to fit on the remote site. Table ES.7 summarizes the elements and costs of the recommended collection system and peak flow storage improvements.

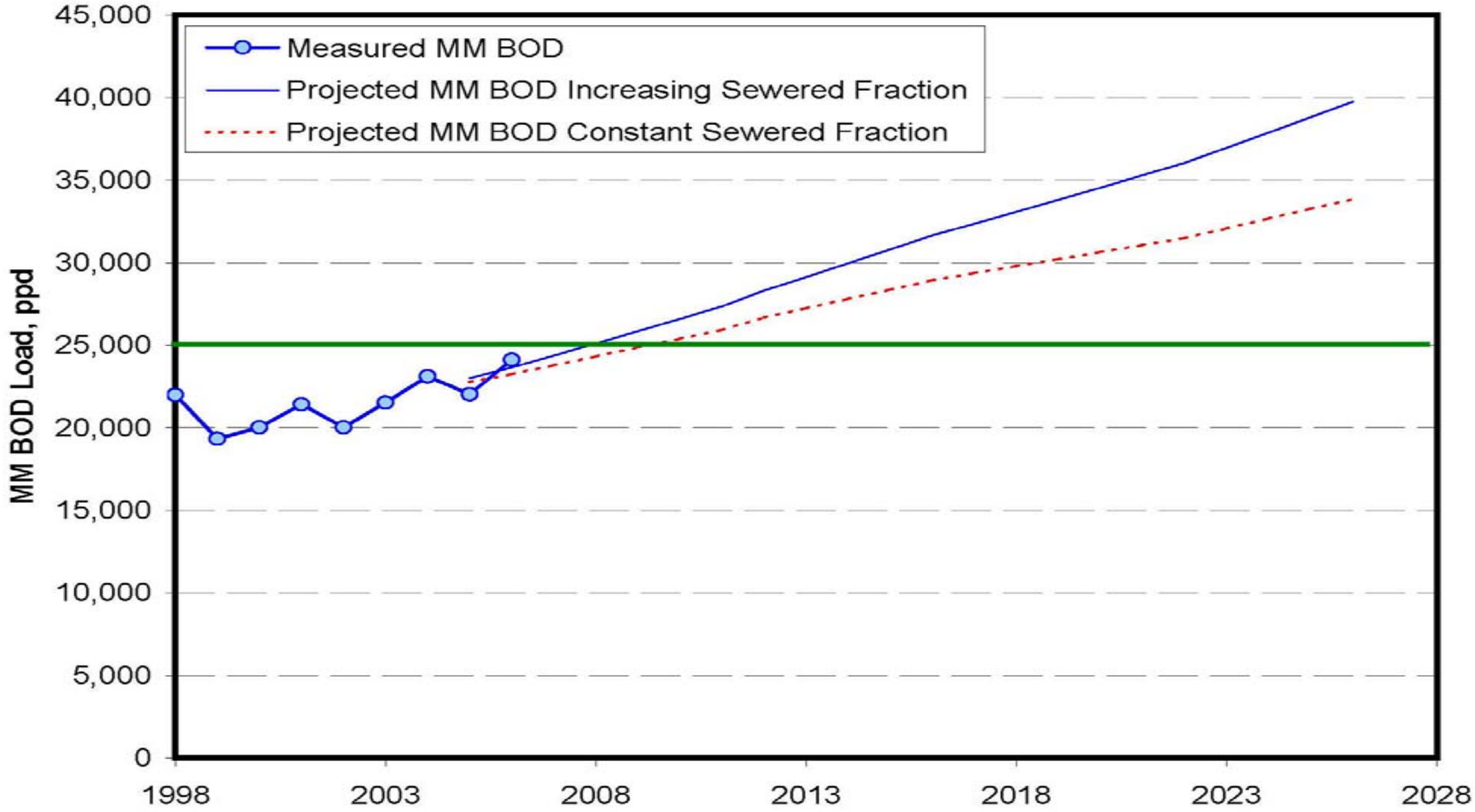
Table ES.7 Recommended Collection System and Peak Flow Storage Improvements Comprehensive Sewer Plan City of Bellingham

Collection System Project	Estimated Total Project Cost
Priority 1 Improvements	$ 12,660,000
Priority 2 Improvements	$ 980,000
Priority 3 Improvements	$ 15,530,000
Total Collection System Costs	**$ 29,170,000**
I/I Study	**$ 2,000,000**
Peak Flow Facility	$ 28,240,000
Total Estimated Project Costs	**$ 59,410,000**

Figure ES.6 shows the existing maximum month BOD capacity of the WWTP compared to projected increases in this loading parameter. As shown in the figure, WWTP expansion is required within the first five years of the CIP to provide capacity for future flow and BOD increases. A second phase of WWTP improvements will be needed before the end of the planning period. Based on the population projections in this Plan, the trigger for Phase 2 is beyond the year 2020. Table ES.8 summarizes the elements and costs of the Phase 1 and Phase 2 WWTP improvements. Figure ES.7 shows the anticipated cash expenditure over the 20 year CIP period.

Table ES.8 WWTP Improvements Comprehensive Sewer Plan City of Bellingham

WWTP Project	Estimated Total Project Cost
Phase 1 Improvements	$ 44,610,000
Phase 2 Improvements	$ 7,930,000
Total Estimated Cost	**$ 52,540,000**



PROJECTED MAXIMUM MONTH BOD LOADS

FIGURE ES.6

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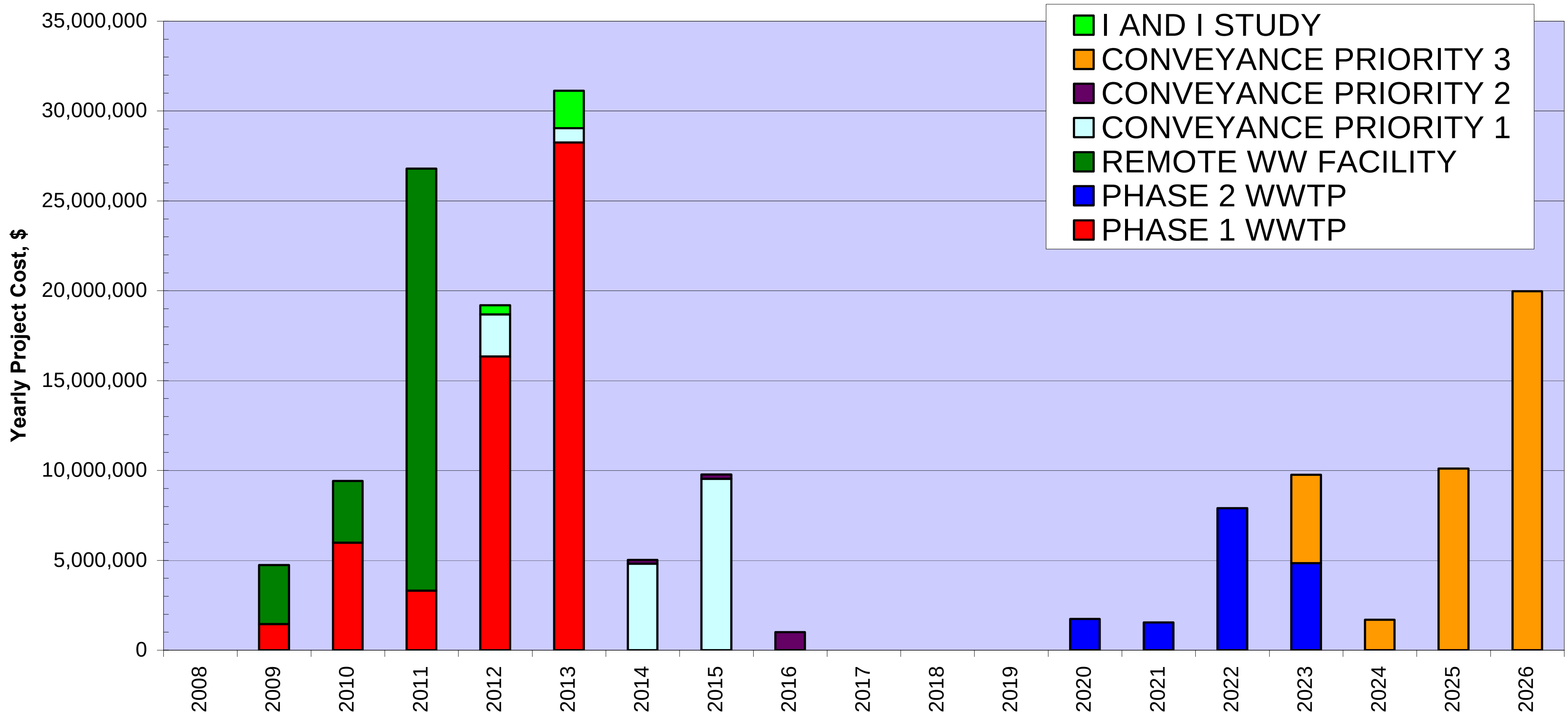

ANNUAL CAPITAL EXPENDITURES

FIGURE ES.7

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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ES.12 FINANCIAL PLAN

The financial plan provides reasonable assurance that the City has and will have the financial ability to maintain and operate the utility on an ongoing basis, and have the capacity to fund the wastewater system improvements in the CIP. It defines a financial strategy that is projected to fully fund the six to twenty year CIPs while sustaining system infrastructure and satisfying City fiscal policies related to the sewer utility. The financial plan also calculates the overall level of impact on monthly rates and System Development Charges (SDCs). Following Plan adoption, it is recommended that the City explore alternative rate and charge implementation plans to smooth rate transitions while meeting the financial management objectives of the utility and minimizing customer impacts.

A review of the Statement of Revenues and Expenses and Changes in Fund Net Assets from 2001 through 2006 shows that operating revenues, and specifically rates, have not increased as quickly as operating expenses. Thus, operating income and net earnings have declined, although they remain positive. Capital assets have increased during this period, while cash and investments have declined as projects are funded.

The 2007 SDC was $3,436 per equivalent residential unit (ERU). SDCs are imposed on new customers connecting to the system as a condition of service, in addition to any other costs incurred to connect the customer such as meter installation charges. The underlying premise of the SDC is that new growth (i.e., future customers) will pay an equitable share of system costs through an upfront charge for system capacity. The capital improvement program has been allocated between existing and future customers based on engineering and planning criteria. The updated analysis, based on the current system and capital improvement plan, results in a charge of $7,637 per ERU. In December 2007, the City Council approved the SDC update in a two year phased approach. The increase in the charge is primarily attributable to an increase in the future facilities portion of the charge.

The City’s existing wastewater rates are comprised of a single fixed bi-monthly rate for single-family residential customers, and non-single family customers pay a fixed charge including 800 cubic feet (CF) monthly and a volume rate for each 100 unit above the 800 CF per month. There are both bi-monthly and monthly billed non-single family customers. In December 2007, the City approved a 6.5% annual rate increase through 2012. The rate increase has been applied equally to each customer class and each rate component (fixed and variable).

The recommended capital improvement program totals nearly $160 million over 20 years, with roughly $102 million concentrated in the first six years of the program. Based on analysis of available and projected resources, and City implementation of the recommended SDC of $7,637, additional funding of $56 million is needed for the 6-year capital-financing forecast. The City may fund the wastewater capital improvement program from a variety of sources. In general, these sources can be summarized as:

1) governmental grant and loan programs; 2) publicly issued debt (tax-exempt or taxable); and 3) cash resources and revenues. The 20-year forecast projects that the majority of subsequent project costs can be cash funded. As a result, roughly 32 percent of the total $193.1 million projected capital spending may be debt-funded, with the balance funded from capital reserves (including SDCs), as shown on Table ES.9.

Table ES.9 20-Year Capital Financing Plan 2008-2026 (Inflated $)
Comprehensive Sewer Plan
City of Bellingham

Capital Financing 2008 through 2026	Total
Capital Projects	**$ 193,109,401**
Funding Sources	
Capital Fund Balance	$ 131,369,718
Revenue Bond Proceeds	$ 61,739,683
Total funding Sources	**$ 193,109,401**

The financial analysis indicates that the City of Bellingham will maintain reasonable wastewater rate levels while financing the capital projects identified in this plan. The City has in place fiscal policies, such as annual system reinvestment reserve funding that will allow the City to continue to maintain strong fiscal and financial health of the wastewater utility.

INTRODUCTION

1.1 PURPOSE

The City of Bellingham (City) prepared this Comprehensive Sewer Plan (Plan) to document the status and analyze the future needs of the wastewater utility system. The Plan will be used as a guide to plan for maintenance and improvements to the system in the next 20 years in order to provide the City with an effective, safe and reliable sewer system. This Plan is inspired by the need to provide constant evaluation of the City's sewer system and operating policies in order to meet the needs of the customers and to ensure compatibility with the City and County's comprehensive plans. This updated plan is prepared in conformance with Chapter 173-240 WAC.

The City needed an updated Plan for several reasons, but fundamentally, the need for the Plan was driven by growth and the necessity to plan for its impact. Development pressures along the I-5 corridor will stress existing infrastructure and the City will benefit from an updated roadmap that allows it to plan for and guide its response to these stresses. A well-developed Plan will be a living document and tool that the City staff can use to anticipate the capacity, the timing, and the cost of improvements necessary to accommodate growth. An integrated plan will provide staff with the tools to quickly and knowledgeably answer questions from the Council and the public about the costs of growth and how to pay for it.

The City's sanitary sewer system is large, and because of the topography, complex in its operation. The condition of the current system, as well as the need for improvements, has been documented in this report. Due to the complexity of this system and the number of issues that must be addressed, this report is organized so that a reader may review a summary of it and its recommendations in this chapter without reading the background or detailed information that led to those results.

The Plan results from an evaluation of the existing sanitary sewer system and recommendations to resolve existing deficiencies and concerns, and to accommodate growth. The improvements identified in this Plan are based on the requirements of the Washington State Department of Ecology (DOE), Washington State Department of Health (DOH), Whatcom County Comprehensive Plan, and City Comprehensive Plan.

1.2 SCOPE AND AUTHORIZATION

Recognizing the importance of planning, developing, and financing sewer system facilities to provide reliable and enhanced service for the existing customers and to serve anticipated growth, the City initiated the preparation of this Plan.

In 2005, the City solicited for qualified consultants, conducted interviews, and selected Carollo Engineers to prepare the updated Plan in accordance with applicable rules and regulations governing planning for wastewater utility systems.

The objectives of the Comprehensive Sewer Plan include:

- Develop a basis for planning for the overall system plan by establishing the service area goals and policies and by identifying the existing and future study area boundaries.
- Develop a demographic analysis summarizing the population, employment, and land use projections for the City.
- Develop accurate demand projections (flows and loadings) for the sanitary system to forecast future expansion needs.
- Describe and inventory the City's wastewater collection system.
- Assess the existing system's ability to meet the needs of the existing and forecasted population in the City's sewer service area.
- Summarize the system improvements identified in the City of Bellingham Wastewater Conveyance Plan (Earth Tech 1998) and to develop conceptual level mitigation measures for future conveyance system improvements.
- Assess the existing treatment plant's ability to meet the needs of the existing and forecasted population in the City's sewer service area.
- Develop conceptual level alternatives and recommendations for future treatment plant improvements.
- Develop the recommended Capital Improvement Plan (CIP) for the City, including separate schedules for collection system and treatment plant improvements.
- Develop a funding strategy that will provide financial strength and viability of the City to implement the schedule of capital improvements.
- Support the City with the State Environmental Protection Act (SEPA) process.

1.3 PLAN ORGANIZATION

The Plan includes an analysis of the existing service areas and boundaries, physical features of the service area, demographic analysis, flow projection analysis, collection system inventory and analysis, recommended collection system improvements, analysis of the existing treatment facilities, recommended treatment facilities improvements, and a recommended Capital Improvement Plan.

The Plan contains 12 chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters of the Plan are organized as follows:

Chapter 2 provides a general overview of the existing sewer system and summarizes planning considerations pertinent to the City's sewer service area such as service goals/policies and rules/regulations.

Chapter 3 summarizes the existing and future land use, population, employment, and school demographic data, based on the most recent projections provided by City Planning Staff.

Chapter 4 evaluates the historical wastewater flows and loads entering the City's Post Point Wastewater Treatment Plant (WWTP) and established flow and load projections for the future planning scenarios.

Chapter 5 provides an inventory of the City's current physical assets of the collection system basins, including pipelines, manholes, pump stations, and the Combined Sewer Overflow (CSO) structure.

Chapter 6 summarizes the results of calibrated model of the City's collection system and the Long Term Simulation (LTS) modeling used to evaluate the CSO discharges. Results from both approaches were used in determining existing and future capacity limitations in the collection and conveyance system. Peak flows that must be managed as future growth occurs are presented.

Chapter 7 identifies improvements to the collection system that are needed to accommodate future flows, and to provide service to currently unsewered portions of the Urban Growth Area (UGA). Alternatives for managing peak wet weather flow are also developed.

Chapter 9 summarizes the existing WWTP performance and results of the capacity analysis of the City's Post Point WWTP.

Chapter 10 evaluates expansion alternatives at the WWTP to meet future flow and loading conditions improvements. Several options for increasing the capacity of the WWTP to meet future flows and loads, and alternatives for managing peak wet weather flow are evaluated.

Chapter 11 summarizes the CIP including the estimated capital costs and phasing plans that are required to meet current and future capacity limitations at the WWTP and in the wastewater collection system.

Chapter 12 presents a summary of the financing requirements that are necessary to implement the CIP.

1.4 LOCATION

The City of Bellingham, the county seat of Whatcom County, is located in the northeast corner of Washington State, 90 miles north of Seattle, Washington and 50 miles south of Vancouver British Columbia. The City encompasses 25.6 square miles and is generally bordered between the Bellingham Bay to the west and Lake Whatcom to the east. The cities closest to Bellingham include Ferndale and Burlington. Figure 1.1 shows the vicinity map for the City of Bellingham.

1.5 HISTORY OF THE CITY

Europeans first settled the Bellingham area in the 1850s while searching for gold and coal. The first sewers were installed in 1892, which transported both sewage and rainwater to Whatcom Creek and Bellingham Bay. In 1903, several smaller cities were incorporated into the City and by 1908, the first dedicated storm sewers were installed.

In 1974, the City began providing primary treatment at the Post Point WWTP. The plant treated flows up to 55 mgd and discharged the primary effluent into the Bellingham Bay. In 1993, the treatment plant was upgraded for secondary treatment. Peak flows in recent years have reached 70 mgd.

Currently, the City provides wastewater collection and treatment services within the city of Bellingham and several adjacent districts. The City currently operates 324 miles of wastewater collection system, 27 pump stations, a CSO structure, and a wastewater treatment plant with a capacity of 72 million gallons per day (mgd).

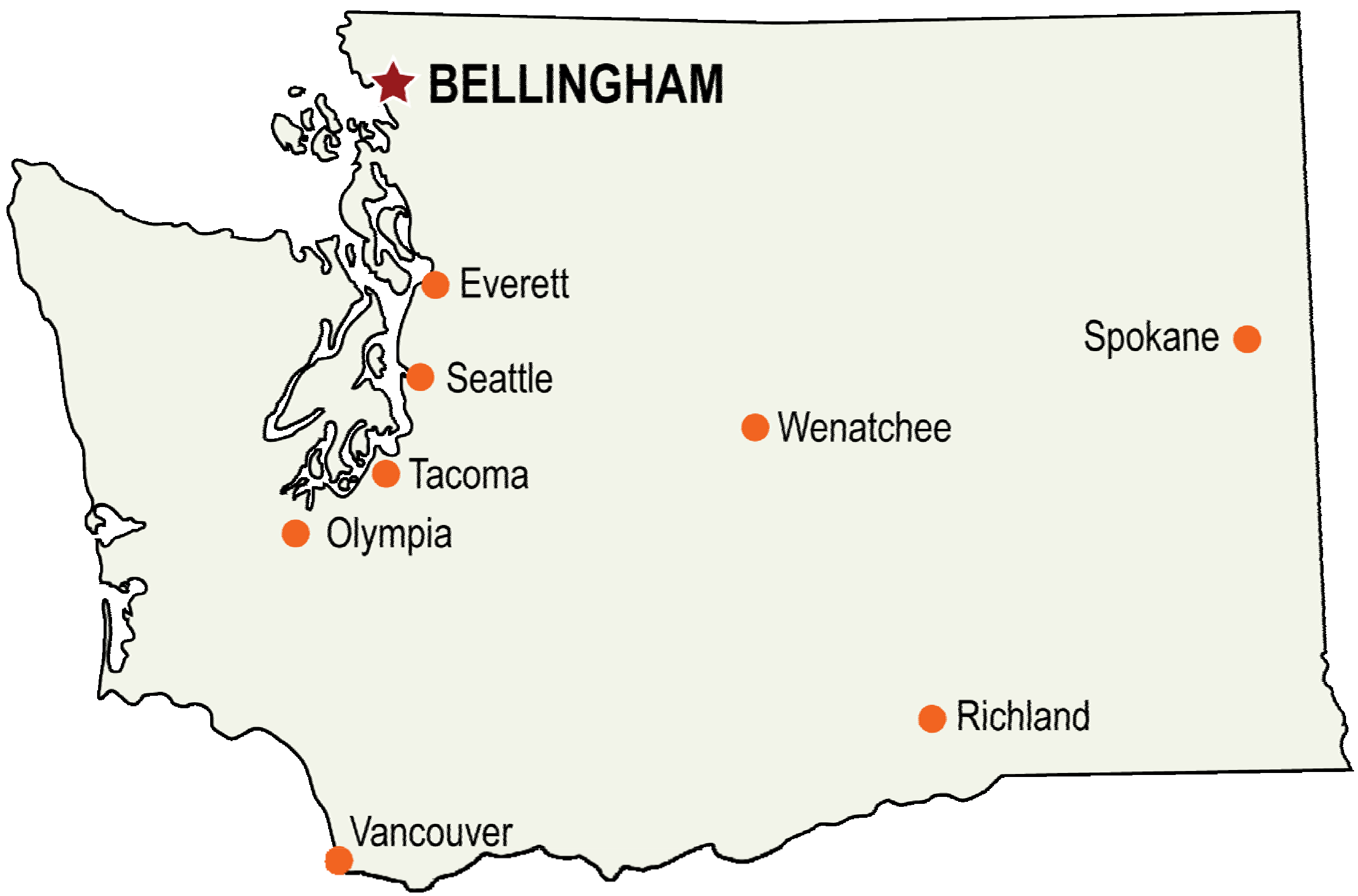
1.6 AUTHORITY AND MANAGEMENT

The City owns their sewer system and WWTP. Additionally, the City receives sewage from the Lake Whatcom Water & Sewer District (LWWSD). Operations of the WWTP are overseen by the plant superintendent, and operations and maintenance (O&M) supervisors. The Plant has extensive automation and state certified plant operators who are on duty at all times. Additionally the WWTP runs its own state certified laboratory that is overseen by the laboratory supervisor.

1.7 RELATED PLANNING STUDIES

Various previously conducted planning and engineering studies conducted by the City have been reviewed while developing this Plan. A summary of the relevant planning and engineering studies is presented below.

- City of Bellingham Facility Plan Wastewater Collection Volume I - Infiltration/Inflow Analysis, 1977



CITY OF BELLINGHAM VICINITY MAP

FIGURE 1.1

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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- City of Bellingham Wastewater Collection Volume II-Wastewater Transport System, 1979
- (Engineering Report) City of Bellingham Post Point Wastewater Treatment Plant Upgrade, 1989
- Whatcom County Water District 10 Water and Sewer Comprehensive Plan, 1991
- Post Point Wastewater Treatment Facility Site Improvement and Landscape Buffer Master Plan Design Report, 1993
- City of Bellingham Wastewater Conveyance Plan, 1998
- Water District No. 7 Water System Plan, 1999
- Water System Plan Whatcom County Water District No. 7, Second Draft, 1999
- Whatcom County Water District 10 Water System Comprehensive Plan, 2001
- Whatcom County Population and Economic Forecasts, 2002
- Comprehensive Water Plan - Public Utility District No.1 of Whatcom County, Draft, 2004
- Post Point Wastewater Treatment Plant Alternative Outfall Investigation and Alternatives Analysis, 2004
- Re-rating of the Post Point Wastewater Treatment Plant, Amendment to the Engineering Report, 2004
- City of Bellingham Comprehensive Water Plan - Electronic Format (PDF), 2005

1.8 APPROVAL PROCESS

This Plan is required to meet state, county, and local requirements. It complies with the requirements of the DOE as set forth in the Washington Administrative Code (WAC) 173-270-050, the DOH as set forth in WAC 246-271-040, and the Revised Code of Washington (RCW) as set forth in RCW 90.48.110. The City will submit this plan to DOH, DOE, Whatcom County, adjacent utilities, and local governments during the Environmental Assessment. See Appendix A for the SEPA Checklist and Determination, and Appendix B for Comment Letters. The Adopting Resolution will be included in Appendix C, upon Plan approval by the City Council.

1.9 ENVIRONMENTAL ASSESSMENT

A SEPA Checklist has been prepared for this Plan. The City has determined this Plan does not have probable significant adverse impacts on the environment and has issued a Determination of Non Significance under WAC 197-11-340(2). The decision was made after review of the completed SEPA Checklist and other information on file with the City. It is anticipated that this proposed plan will not have a probable significant adverse impact on the environment and that an Environmental Impact Statement (EIS) will not be required. However, many of the projects proposed within the Plan will require subsequent project specific environmental review and SEPA checklists as part of their preliminary and final design process. The SEPA Checklist and Determination are included in Appendix A.

1.10 ACKNOWLEDGEMENTS

Carollo Engineers and their team members, FCS Group and Roth Hill Engineering Partners wish to acknowledge and thank the following individuals for their efforts and assistance in completing this Plan.

- Larry Bateman, WWTP Operations Supervisor
- Dick McKinley, Public Works Director
- Tom Rosenberg, Assistant Public Works Director, Operations
- Rory Routhe, Assistant Public Works Director, Engineering
- Sam Shipp, Project Manager
- Geoff Smyth, Public Works Superintendent, Operations
- Ravyn Whitewolf, Engineering Manager
- Post Point WWTP O&M Staff

BASIS FOR PLANNING

2.1 INTRODUCTION

This Chapter provides an overview of the sewer service area characteristics for the City of Bellingham (City). The service area description provided includes information regarding neighborhood providers, the physical environment, service goals and policies and rules and regulations associated with the sewer system. These considerations establish the basis of the planning for the demographic and system analysis used to evaluate the potential for development within the established service area and the adequacy of the system to serve anticipated development.

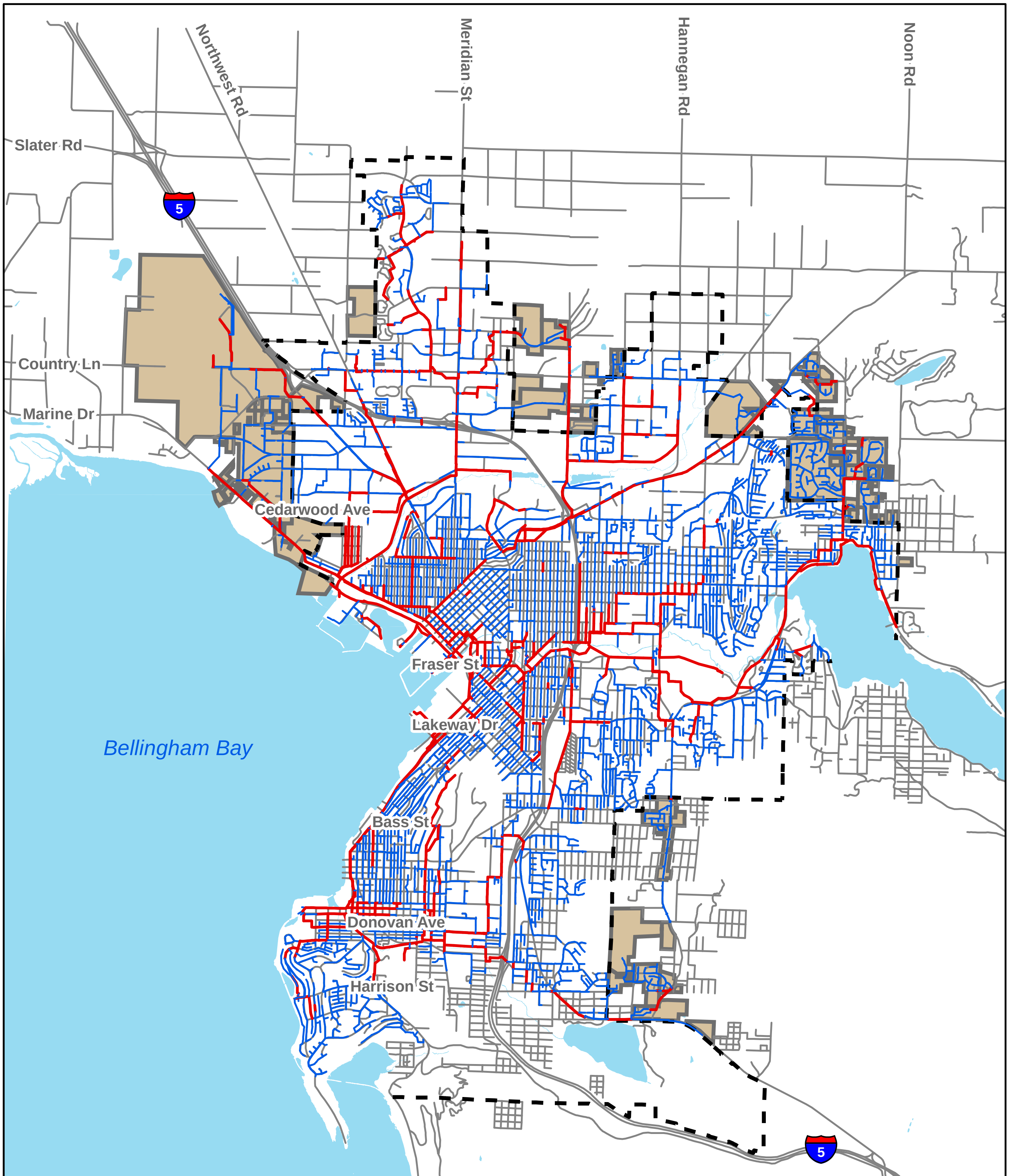
2.2 SERVICE AREA CHARACTERISTICS

2.2.1 Existing

The City's sewer service area covers approximately 30 square miles serving approximately 83,000 customers. The City provides sewer service to areas within the City limits and sewer service zones within the Urban Growth Areas (UGA) of Whatcom County. The sewer system currently extends as far as Kelly Road to the north, Lake Samish Road to the south, Lake Whatcom to the east and Bellingham Bay to the west. Figure 2.1 shows the existing sewer system. The elevation ranges from sea level to approximately 800 feet. The topography is mostly rolling hills, crossed by a few major streams and creeks.

A sewer service zone, outside the corporate limits but within the UGA of the City, is established by the City Council. These zones will not be provided sewer service without an adopted program for annexation and adopted Capital Facilities Plan. Exceptions may be made by the City Council in certain cases, as discussed in the policy section of the City's Draft 2005 Comprehensive Plan. There are several of these sewer service zones that are currently provided sewer service.

Lake Whatcom Water & Sewer District (formerly Water District No. 10) (District) provides sewer service to the east of the City's service area near Lake Whatcom. The District does not provide treatment of its sewage but rather connects to the City's Silver Beach trunk sewer in Whatcom Falls Park. The District contracts with the City to provide treatment of its sewage at a maximum flow rate of 3,200 gallons per minute. A copy of the contract can be found in Appendix D.



EXISTING SEWER SYSTEM

FIGURE 2.1

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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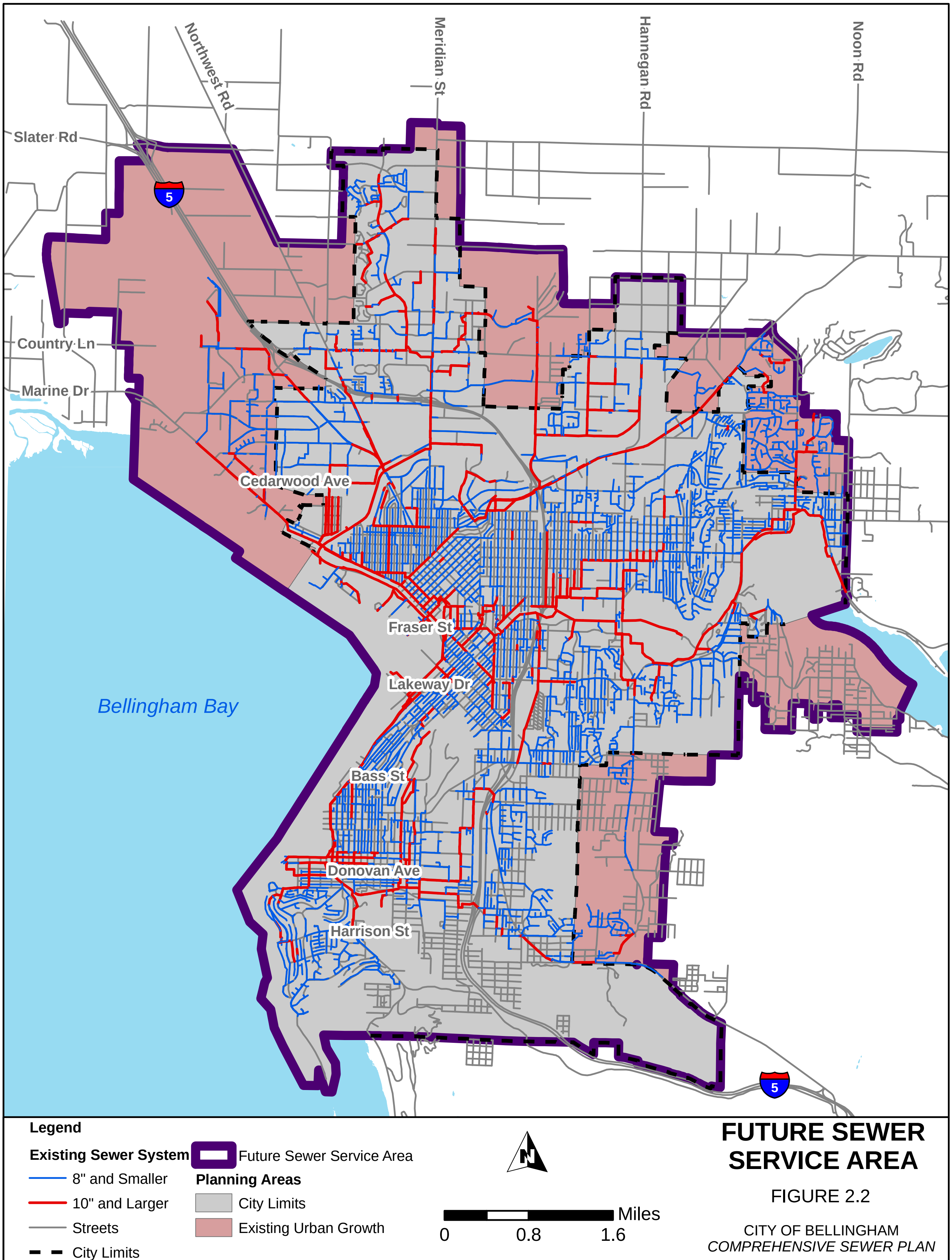
2.2.2 Future

The potential sewer service area is much larger than the area proposed within this Comprehensive Sewer Plan (Plan). The existing potential sewer service area is shown on Map CF.4 of the City's Draft 2005 Comprehensive Plan. It was established in the Engineering Report (CH2M HILL 1989) for the Post Point Wastewater Treatment Plant upgrade. The potential sewer service area currently includes Bellingham's incorporated City limits, Urban Growth Areas and other rural areas within Whatcom County in the Urban Fringe Subarea. The potential serviceable area is bounded by Smith Road to the north, Old Samish Highway to the south, Lake Whatcom to the east, and Bellingham Bay to the west. Unincorporated Whatcom County bounds the service areas on the north, east, and south.

The City's Urban Fringe Subarea includes the rural analysis area, and urban growth areas adjacent to the City limits. The Urban Fringe Subarea lies east, north, and west of the City and generally extends to Mission Road on the east, Slater and Smith Roads on the north, and the Lummi Indian Reservation on the west, and measures approximately 19,700 acres (30.8 square miles) in size. The City developed the Urban Fringe Subarea Plan, in coordination with Whatcom County for the northern portion of the UGA. There are two other subarea plans that fall within the UGA: the Lake Whatcom subarea, near Geneva, and the Chuckanut-Lake Samish subarea, near Yew Street. In the Urban Fringe Subarea, outside the City limits but within the UGA, disposal of wastewater is accomplished by either a centralized sewage collection system with treatment of domestic and industrial wastewater, or by individual onsite wastewater disposal (septic) systems.

During this planning process, the Urban Growth Area boundary was revised and adopted by both City Council on February 4, 2008 by Resolution 2008-03 and Whatcom County on February 12, 2008 by Ordinance 2008-003. The future sewer service area in this plan includes the City Limits and Urban Growth Areas. The future sewer service area is shown in Figure 2.2. It does not include any area outside the urban growth boundary.It is expected that the sewer service area will provide service to approximately 113,055 persons by the year 2022. This population would include the projected 31,601 new residents in Bellingham and the UGA. Detailed information on population, household and employment projections can be found in Chapter 3.



FUTURE SEWER SERVICE AREA

FIGURE 2.2

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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2.3 NEIGHBORING JURIDICTIONS

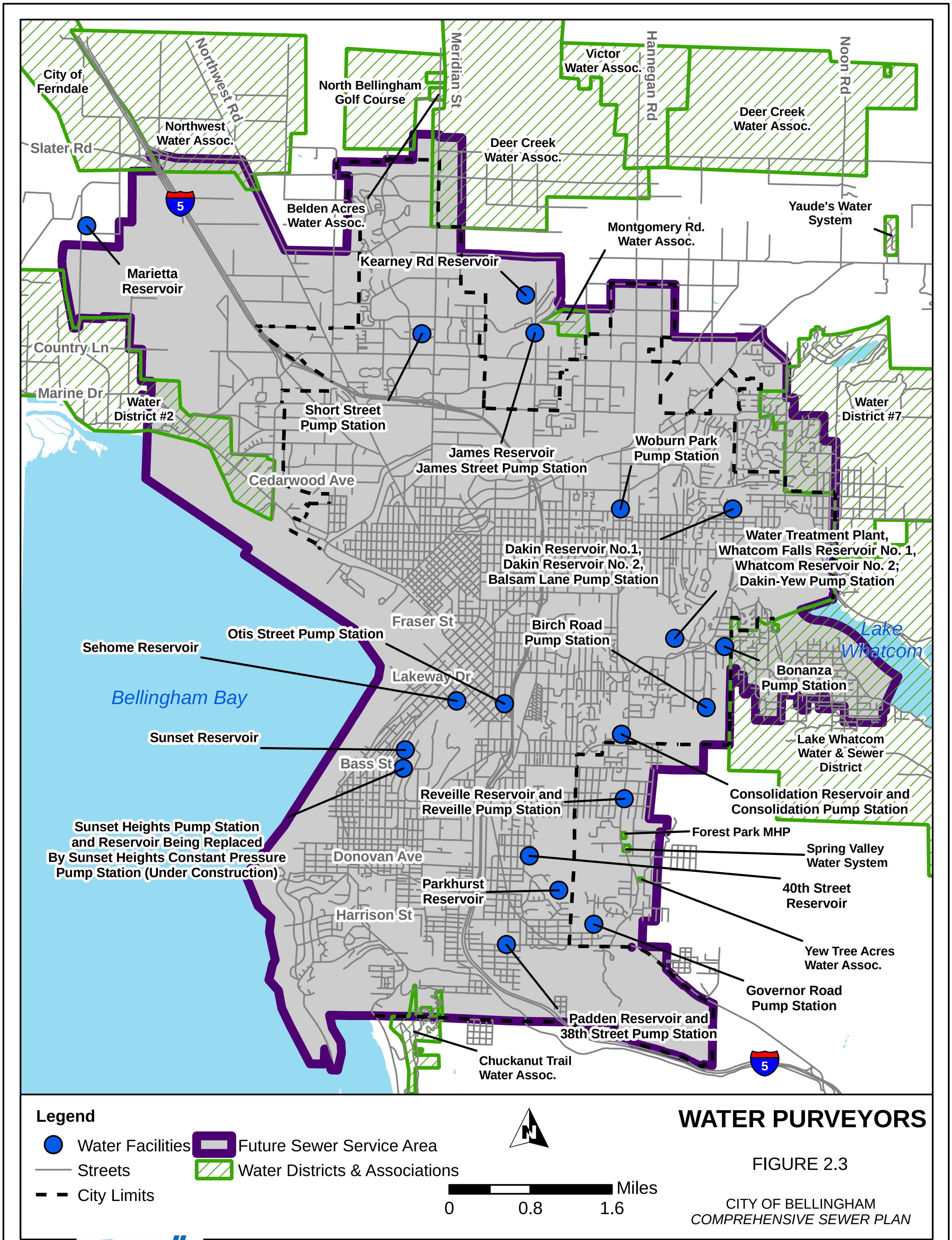
The City's water utility and several other jurisdictions, including privately owned systems, operate throughout the City's existing and future sewer service area. While the only jurisdiction that provides sewer service is Lake Whatcom Water & Sewer District, there are water purveyors within or adjacent to the sewer service area. Figure 2.3 depicts the City's Water System Facilities and the location of neighboring jurisdictions. None of these water utilities or sources of supply, including Lake Whatcom, are impacted by the City's existing or planned sewer outfalls. The City is currently preparing their Water System Plan. As the Plan is finalized, the Sewer Utility will coordinate with the Water Utility to eliminate any future infrastructure conflicts. Additionally, the sewer utility will assist with the implementation of proposed water reclamation opportunities, if identified in the Water System Plan. The following is provided as a brief overview of these jurisdictions.

2.3.1 Lake Whatcom Water & Sewer District (Formerly Water District No. 10)

Lake Whatcom Water & Sewer District (LWWSD) was formed in 1968 and provides water and sewer services to approximately 3,400 residences around Lake Whatcom. LWWSD is expected to serve an additional 1,450 residences on the South Shore and an additional 50 to 100 on the North Shore within the next 20 years. LWWSD does not have a sewage treatment plant and contracts with the City of Bellingham to transport, treat, and dispose of domestic sewage from the District at a maximum flow rate of 3,200 gallons per minute (gpm). The District operates and maintains a total of 340,000 lineal feet of gravity sewer and 72,000 lineal feet of pressure sewer, including 27 sewage pump stations.

There are three sewage interceptors that deliver wastewater from the LWWSD collection system to the City's Silver Beach Trunk sewer in Whatcom Falls Park: the North Shore interceptor, the Lake Whatcom Boulevard interceptor, and the Lake Louise Road interceptor. The Sudden Valley and Geneva areas share a joint interceptor system and are considered a "linked system," sharing the Lake Whatcom Boulevard and Lake Louise Road interceptors to some degree. In areas where properties are located below Lake Whatcom Boulevard and cannot utilize direct gravity flow, gravity collectors drain the wastewater toward the Lake, and the effluent is then pumped back to the Lake Whatcom Interceptor via one of the smaller pump stations operated by the LWWSD.

The LWWSD has approximately 900 customers in the Geneva area, within the City's UGA and Future Sewer Service Area. Currently, the contract with the City limits the LWWSD to a flow rate of 2,500 gpm from the south shore of Lake Whatcom. Total available capacity for this area would allow approximately 3,500 additional dwelling units on the South Shore. The City restricts the LWWSD to a flow of 700 gpm from the North Shore. This would allow approximately 1,300 additional hookups.



WATER PURVEYORS

FIGURE 2.3

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

2.3.2 Whatcom County

The City's UGA within the Future Sewer Service Area are subject to Whatcom County jurisdiction. The County's Comprehensive Plan establishes the County's policies for land use, infrastructure, public safety, human services, economic development, parks, and cultural resources. The plan provides policy direction for functional plans, such as a comprehensive sewer plan.

The Whatcom County Comprehensive Plan includes the following language: "Annexation should be considered prior to or concurrently with the extension of City sewer and water and prior to urban development. Annexations should be a logical extension of the City boundaries and not create unincorporated islands." (Whatcom County 2005, 2)

2.3.3 Public Utility District No. 1 of Whatcom County

The Public Utility District No. 1 (PUD) of Whatcom County provides retail water to two areas north of the City. These areas are the Cherry Point industrial area and the Grandview industrial/commercial area. The PUD's wholesale water service area is described as all of Whatcom County west of the Mt. Baker-Snoqualmie National Forest boundary, excluding the Nooksack Tribal Reservation and Trust Lands, the Lummi Tribal Reservation and Trust Lands, the City of Bellingham Service area and portions of the County east and south of the City of Bellingham. Additionally, non-potable water is provided to the City of Ferndale and others within its wholesale water service area, adjacent to the PUD's major transmission pipelines. The PUD also has an agreement to supply Birch Bay Water and Sewer District; however, water has not yet been delivered as contemplated in the agreement.

2.3.4 City of Ferndale

The City of Ferndale provides water service to the City of Ferndale and surrounding areas. Ferndale's water service area is adjacent to the City's UGA in the northwest part of the Urban Fringe Subarea, west of Interstate 5 and near Slater Road.

2.3.5 Whatcom County Water District No. 2

Whatcom County Water District No. 2 (WCWD#2) was established in 1946 as a Utility Local Improvement District and provides water service to customers generally located between Silver Creek, Curtis Road, Wynn Road, and Bennett Drive to Marine Drive, and Bellingham Bay. WCWD#2 serves within the City's rural analysis area and UGA near the Airport, residential areas of Bennett and Marine Drive, and the Shoreline Industrial area. WCWD#2 has an Interlocal Agreement with the City of Bellingham to purchase Lake Whatcom reservoir water for resale and distribution to its customers. WCWD#2 began with 64 residential connections and experienced major service expansions in 1953, 1969, 1978, and 1993. WCWD#2 has Washington State Department of Health (DOH) approval for 821 service connections, but currently serves 523 connections with an estimated population of

1,400 persons. According to the zoning currently applied to land within District boundaries, the ultimate buildout of WCWD#2 may require up to 1,322 residential service connections.

2.3.6 Whatcom County Water District No. 7

Whatcom County Water District No. 7 (WCWD#7) is located in the Lake Whatcom and Squalicum Creek watersheds and serves a small area in the Subarea around Britton and Toad Lake Roads. WCWD#2 serves within the City's rural analysis area and UGA within the residential areas of Britton Road and Hillsdale/Watershed. The WCWD#7 purchases water from the City of Bellingham, and resells and distributes it to their customers. In 2002, an additional pump station was constructed on Britton Road, which allowed WCWD#7 to expand service. In 2003, the District served 551 residential connections and had DOH approval for 1,145 connections.

2.3.7 Community Water Associations

Several community water associations currently serve the planning area. Water associations are small, rural cooperative water distribution organizations, which are not required to define a boundary of service and are not specifically required to provide service to anyone. Although the water associations in the planning area own, operate, and maintain their water system infrastructure, a primary water source and sewer service for many is the City of Bellingham. These are shown in Figure 2.3.

2.4 PHYSICAL FEATURES OF THE SERVICE AREA

There are unique physical features in the City's area including the foothills and forested backdrops; marine coastline and bluffs of Bellingham Bay; Lake Whatcom; Toad Lake; Whatcom Creek Gorge; Squalicum Creek; Padden Creek Estuary; Chuckanut Creek and other streams and wetlands; Chuckanut, King, Queen, Squalicum and Galbraith Mountains; and viewscapes of the San Juan Islands, Mount Baker, and the Canadian Coastal Mountains. Coal deposits and abandoned coal mine workings underlie parts of the City and extend past the northwest City limits in an area north of Alderwood Avenue. Abandoned coal mines are identified in the Whatcom County Critical Areas Ordinance (CAO) maps as Mine Hazard Areas.

2.5 TOPOGRAPHY

The topography of the area is generally slightly rolling except for some beaches, a high bank marine coastline, some deeply incised stream corridors, freshwater lakes, and the uplands of Sehome Hill, Squalicum, King, Queen, and Galbraith Mountains. Elevations range from sea level between Chuckanut Bay and the mouth of the Nooksack River to over 1,000 feet above sea level on the south and west slopes of Squalicum Mountain. The higher elevations provide excellent views and natural backdrops. Sehome Hill, King, Queen, and Squalicum Mountains are four significant topographic features within the area that rise over 1,000 feet above sea level.

The Whatcom County CAO identifies landslide hazard areas on slopes between 15 percent and 35 percent where adverse geologic conditions exist and on all slopes greater than 35 percent. Slopes in the 15 percent to 35 percent range occur along the bluffs of Bellingham Bay; along streams draining to Bellingham Bay (including Little Squalicum Creek); along the Spring Creek, Baker Creek and Squalicum Creek corridors; on King and Queen, Mountains; scattered throughout the Squalicum Mountain area including the Hillsdale/Toad Lake Road/Academy Road area; and on the slopes of Galbraith Mountain including part of the Geneva area, areas east of Yew Street Road and the “additional review area” east of Lake Padden adjacent to the southeast corner of the City limits.

Areas with slopes greater than 35 percent are found along the bluffs of Bellingham Bay; in the Squalicum Creek corridor; on the east slope of King and Queen Mountains; on the north slope of Squalicum Mountain; around Toad Lake; above the Yew Street and Geneva areas; and immediately above Interstate 5, in the southern part of the “additional review area” east of the southeast corner of the City limits (FEIS 2004).

2.6 GEOLOGY AND SOILS

2.6.1 Earth

The City lies within the southeast portion of the Georgia Depression (Fraser-Lowland) and northeast of the Puget Lowland, an elongated trough extending north-south between the Cascade Mountains to the east and the mountains of Vancouver Island and the Olympic Peninsula to the west. The underlying bedrock is composed of folded and faulted beds of sandstone, mudstone, and coal known as the Chuckanut and Huntingdon formations. Outcrops of the Huntingdon formation are found north of East Bakerview Road on King and Queen Mountains, and on the north slope of Squalicum Mountain north of Toad Lake. Chuckanut formation bedrock appears on Squalicum Mountain, Galbraith Mountain, in the Geneva area, and east of Lake Padden adjacent to the southeast corner of the City limits.

Coal deposits underlie a large portion of the area between Bellingham Bay and Interstate 5 and from the City limits north as far as Slater Road. Over 1,300 acres of the area's coal reserves were mined between 1918 and 1955 using the room and pillar underground mining method. Most of the abandoned workings of this mine are under Bellingham’s Birchwood neighborhood, with a small area just outside the City limits in the Alderwood area. An older, less extensive abandoned coal mine is under Railroad and State Streets in the downtown area. Exploratory coal mining has occurred in the Geneva area south of Lakeview Street. Abandoned underground mine areas present a land subsidence hazard and are considered geologically hazardous areas under the Whatcom County CAO.

Overlying the bedrock in most lowland areas are glacially derived surficial deposits of various thicknesses that were deposited by continental ice sheets. The thickness and stratigraphy of these deposits vary greatly due to the changing conditions associated with the periodic advance and retreat of glaciers over the area. These include marine terrace deposits, glaciomarine drift and glacial outwash deposits.

- *Marine terrace deposits* are composed of silt, clay and sand. These deposits lie adjacent to the alluvial deposits of the Nooksack River floodplain in the western portion of the planning area.
- *Glaciomarine drift deposits*, consisting of unsorted and unstratified pebbly and sandy silty clay, overlie most of the planning area with the exception of localized areas containing the other geologic units described in this section.
- *Glacial outwash deposits* consist of sorted, stratified pebble-sized gravel with some sand. These deposits are found in the Squalicum Creek drainage including the Dewey Valley area. In some places, recent sediments overlie the bedrock and glacial deposits. These include alluvial deposits and peat.
- *Alluvial deposits*, composed of fine textured silt and sand, are found in the floodplains of the Nooksack River and Squalicum Creek, in the western part of the planning area.
- *Peat* consists of decomposing organic matter (usually vegetation), which has accumulated in former streambeds, lakes, or ponds. The only sizable peat deposits in the planning area are in the Silver Creek drainage, east of Aldrich Road and south of Smith Road.

2.6.2 Soils

Near the ground surface (except for rock outcrops), the glacial deposits and underlying geologic units have weathered to soil. The U.S. Department of Agriculture identifies over 40 different soil types in the planning area (U.S. Dept. of Agriculture 1992). For each soil type, the survey identifies soil limitations for various types of construction and development and soil suitability for agriculture and forestry.

Soil characteristics are a function of the underlying parent material, climate, slope, drainage, depth to groundwater, vegetation, degree of disturbance and historical land use. Specific site conditions should be verified by on-site analysis and testing, due to the potential for irregular or small-scale inclusions of dissimilar soil types and the likelihood of previous disturbance such as grading, excavation and/or fill.

2.7 SURFACE WATERS

The City's surface water system consists of natural and constructed drainages that eventually discharge to the marine waters of Puget Sound. The major creeks in Bellingham are Squalicum Creek, Whatcom Creek, Padden Creek, and Chuckanut Creek. In addition, a small area of land in the northern part of the City drains to Silver Creek, a tributary of the Nooksack River, and to the river itself.

In 2001, the Washington Department of Ecology issued a new storm water manual detailing best management practices that are now required for new storm water systems in the City. The City commissioned a comprehensive drainage study in 1973 and again in 1992. The 1992 Watershed Master Plan resulted in a basin planning approach to surface water issues. The Plan details the need for additional regional detention systems, conveyance improvements, and water quality treatment systems throughout the City. The Watershed Master Plan, while being a useful document, is scheduled for update to meet new standards for storm water management. In addition, a planning process was started in 1999 to look at water management holistically. The Water Resource Inventory Area 1 (WRIA 1) planning process is a joint venture with the County, cities, the Tribes, and service providers.

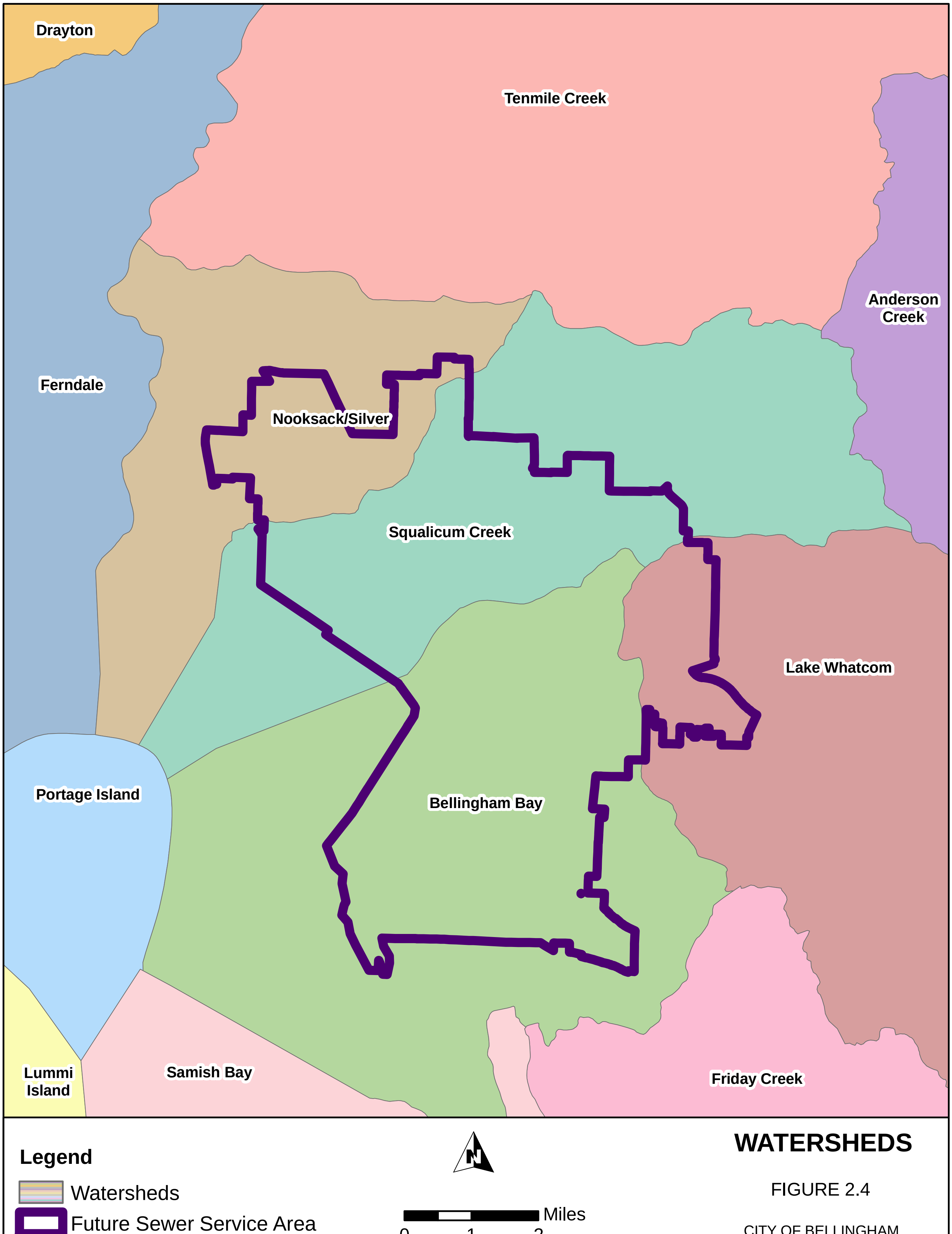
The City of Bellingham participates in Federal Emergency Management Act's (FEMA) National Flood Insurance Program. The City's Community Number is 530199. Within the City, the following water sources have defined 100-year flood plains: along Bellingham Bay, Squalicum Creek, Baker Creek, Whatcom Creek and un-named tributary, along the shoreline of Lake Whatcom, Padden Creek, Connelly Creek, and along the shore of Chuckanut Bay. A copy of the flood insurance maps can be found on the FEMA website at http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1&userType=G.

2.8 WATERSHEDS

The City Sewer Service area wholly or partially overlies four watersheds, each of which includes one or more drainage basins. The watersheds are discussed in geographic order, beginning in the northwest and moving south and east in a clockwise direction. The sensitive areas within each watershed are described herein. The watershed description includes the definition of the drainage, water quality, wetlands and flooding impacts. All drainage basins in the planning area ultimately discharge into Bellingham Bay and include one or more year-round or seasonal streams. A summary map of the Watersheds is included as Figure 2.4.

2.8.1 Nooksack Silver Watershed

The Nooksack Silver Watershed includes approximately 10,100 acres, of which approximately 1,700 acres of the Silver Creek Drainage Basin are in the northwestern portion of the City's planning area. Major streams within this basin include Silver Creek (with seven unnamed tributaries draining into it), Tennant Creek (with four unnamed tributaries draining into it), and Bear Creek (with three unnamed tributaries draining into it). The basin also includes Lost Lake, located northeast of the airport. One channelized drainage and a network of sloughs are located to the west of Silver Creek, southwest of Rural Avenue.



WATERSHEDS

FIGURE 2.4

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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Approximately 400 acres of wetlands have been identified. There are four complexes of significant size. The largest, approximately 120 acres, is located on the Bellingham International Airport property. Half of this wetland is in the Fort Bellingham drainage and half is in the Silver Creek drainage. Three additional complexes of significant size are an approximately 100 acre wetland located in the Pacific Highway/Northwest Road Area, an approximately 70 acre wetland located in the Interstate 5/Northwest Road Industrial Area and an approximately 50 acre wetland located in the URMX zone of the Northwest Road/Aldrich Residential Area.

The area between Silver Creek, Tennant Creek, and the lower Nooksack River lies within a FEMA Zone AE (100-year floodplain). There is also a narrow 100-year floodplain along Silver Creek, which extends outside the planning area north and east almost to Northwest Drive, north of Slater Road.

2.8.2 Squalicum Creek Watershed

The Squalicum Creek Watershed drains a total of 15,800 acres, of which approximately 4,700 acres are in the northern part of the City's planning area, including Baker Creek, Spring Creek, McCormick Creek, Toad Creek, Upper Squalicum Creek, Squalicum Creek and additional unnamed streams.

- Baker Creek Drainage Basin - This sub-basin drains the land area generally lying between the Spring Creek Drainage Basin, the Lower Squalicum Creek Drainage Basin, and a narrow stretch along Baker Creek between Interstate 5 and Northwest Avenue.
- Spring Creek Drainage Basin - The Spring Creek basin drains approximately 3,000 acres in the central part of the Urban Fringe Subarea and the Guide Meridian corridor in the City of Bellingham, generally north of the Bellis Faire mall.
- McCormick Creek Drainage Basin - This 3,600 acre basin drains most of the northeast part of the Urban Fringe Subarea and lies generally west of Mission Road and east of Dewey Valley between E. Smith Road on the north and Mount Baker Highway to the south.
- Toad Creek Drainage Basin - This basin is approximately 1,300 acres and drains an area generally lying between the Lake Whatcom watershed, McGrath Road, the ridge of Toad Mountain, and the eastern boundary of the planning area. Toad Lake lies within this sub-basin and forms the headwaters of Toad Creek, which flows to Squalicum Creek.
- Upper Squalicum Creek Drainage Basin - The Upper Squalicum basin is generally bounded by Squalicum Creek to the north and the crest of Toad Mountain to the south, east of the Lower Squalicum Creek Drainage Basin.

- Lower Squalicum Creek Drainage Basin - This basin drains approximately 3,000 acres generally lying southwest of Dewey Valley. Sunset Drive and Squalicum Parkway run through this basin, which contains the main stem of Squalicum Creek as it flows into Bellingham Bay.

Approximately 130 acres of wetlands have been identified in this watershed. There are three complexes of significant size in this area. The complex located in the Baker Creek drainage basin is approximately 60 acres and is located in the East Bakerview/James Street Residential Area. Two wetlands complexes are located in the McCormick Creek drainage basin. One is north of Kelly Road and west of Noon Road. The other is north of Kelly Road, west of Mission Road and east of Wahl Road. Both of these complexes are connected to fish-bearing portions of the Squalicum Creek drainage system.

The portion of Squalicum Creek extending upstream to the intersection of Dewey Road and Van Wyck Road has been designated as a FEMA Zone A (100-year floodplain).

2.8.3 Lake Whatcom Watershed

The Lake Whatcom watershed is a multi-use watershed and is the drinking water reservoir for the City of Bellingham and the Lake Whatcom Water & Sewer District, which, combined, serve approximately one-half of the population of Whatcom County. Lake Whatcom and its watershed have been studied for over 40 years. These studies recognize the impact of development on the watershed, but are inconclusive on the level of development that can occur before the Lake's water supply function is compromised.

The Bellingham City Council, Whatcom County Council and Water District 10 Commissioners (now LWWSD) continue to work together on how to protect the watershed while allowing for growth by establishing goals by resolution in 1992. The joint resolution includes goals for watershed management that extend beyond urbanization. Goals are included for storm water management, on-site waste systems, conservation, forest management, spill response, hazardous materials transport and handling, data/information management, education/public involvement and other topics.

In 1998, LWWSD formalized their joint commitment to protect and manage the lake through the joint adoption of an interlocal agreement and allocation of funding toward protection and management efforts in the watershed. In 2000, a five-year program plan was adopted for ten program areas. Specific priority was placed on activities related to watershed ownership, storm water management and urbanization/land development.

There are four urban areas in the watershed: the City of Bellingham, which straddles the upper portion of the northernmost basin of the lake; Geneva, which is immediately south and east of the City limits and is part of the city's UGA; Hillsdale, which is immediately north and east of the City limits and is also part of the City's UGA; and the Sudden Valley Provisional UGA. In addition, the watershed includes a variety of other zones, including resource, rural and suburban zones. Over 75 percent of the watershed is in Forestry zoning and more than 83 percent of the current land use is forestry.

As previously discussed, the LWWSD provides water and sewer services in parts of the watershed. Capacity problems in the District's sewer line, which serves Geneva and Sudden Valley, have caused overflows into the lake in the past. An aggressive program to preclude storm water infiltration has greatly reduced the overflows. The Lake Louise Road sewage interceptor was completed in January 2003 to carry wastewater from Sudden Valley and Geneva. It serves as a complement to the Lake Whatcom Boulevard trunk line. The interceptor was designed to service full build-out of Sudden Valley and Geneva. Properties with septic tanks are required to connect to the sewer system within five years of completion of the project (by January 2008).

The Lake Whatcom watershed includes approximately 35,435 acres. The 970-acre Geneva UGA is entirely within the Lake Whatcom watershed, as well as 310 acres in the Hillsdale/Britton Road area. Lake Whatcom is divided into three large basins separated by underwater sills: Basin I, Basin II, and Basin III, each of which has its own drainage basin. All of the Lake Whatcom Watershed inside the Bellingham City limits and most of the watershed area in the UGA drain to Basin I. A small portion of the Geneva UGA drains to Basin II. The City of Bellingham's water supply intake is in Basin II and the LWWSD draws its water from Basin III.

- Silver Beach Drainage Basin - A sliver of the north end of this 400-acre drainage is in the UGA. The remainder is inside the Bellingham city limits. Silver Beach Creek, under City and County jurisdiction, drains this basin into Lake Whatcom.
- Hillsdale Drainage Basin - This drainage is approximately 700 acres in size. Less than half of this lies in the planning area and UGA. One unnamed stream drains into Lake Whatcom in this basin.
- Academy Drainage Basin - A small corner of this 780-acre drainage is in the City's planning area and UGA.
- Oriental Drainage Basin - This drainage is approximately 600 acres, two thirds of which are in the Geneva UGA. One unnamed stream drains this basin into Lake Whatcom.
- Geneva Drainage Basin - This drainage is approximately 200 acres in size, of which, about two thirds are in the Geneva UGA. At least two unnamed streams are in the UGA portion of this basin.
- Cable Drainage Basin - This drainage is approximately 100 acres in size and lies entirely within the Geneva UGA.
- Strawberry Drainage Basin - This drainage, which drains to Basin II, is approximately 800 acres in size. At least two unnamed streams are in the planning area portion of this basin.

The most urbanized basin, Basin I, is located at the northwest end of the lake and holds approximately 2 percent of the lake's volume. This basin exhibits the most significant impacts to water quality, primarily on a seasonal basis during the spring and summer when the lake is stratified.

NWI maps show approximately 30 acres of wetlands in the UGA portion of this drainage basin. The complex of wetlands most significant in size, approximately 20 acres, is located in the Britton/Hillsdale Residential Area (north of Hillsdale Road and east of Britton Road). In addition, two wetlands are located in the Silver Beach Drainage Basin. These include Scudder and Big Rock Ponds and their surrounding wetlands.

The portion of Lake Whatcom that lies in the planning area has been designated as a FEMA Zone A (100-year floodplain).

2.8.4 Bellingham Bay Watershed

Bellingham Bay Watershed encompasses the smaller drainages of Whatcom, Padden and Chuckanut Creeks, as well as Fragrance and Padden Lakes.

Whatcom Creek is the outlet for Lake Whatcom located in the northeast section of Bellingham bay watershed. Whatcom Creek is combined with four smaller streams. Of these, Lincoln Creek, Cemetery Creek (East and West Forks), and Hannah Creek emanate from the Yew Street Road/Samish Hill/Galbraith Mountain area. Whatcom Creek serves as a major channel for Bellingham's storm water drainage system. The north half of the Yew Street Road UGA drains to the Whatcom Creek Drainage Basin. The Whatcom Creek Gorge Sub-basin drains the area adjacent to the eastern half of Whatcom Creek between Lake Whatcom and the freeway interchange at Ohio Street and Interstate 5. This stretch of Whatcom Creek includes the headwaters flowing from the Lake and the cascading waterfalls in Whatcom Falls Park. The Fever Creek sub-basin drains the area bounded by Sunset Drive, Interstate 5, and the Lake Whatcom watershed.

The stream has been affected by major channelization and flood control projects, vegetation removal and pollution from urban runoff. There is little flushing action where the stream enters Bellingham Bay, so contaminants in sediments and water negatively affect shellfish and other estuary wildlife. Abandoned landfills also have some bearing on estuary water quality.

To control flooding, Whatcom Creek has been dredged and gabbioned for much of its length after leaving the gorge. Filling of an extensive wetland complex adjacent to the mouths of Fever, Cemetery and Lincoln Creeks caused significant flooding for years. The Creek is now managed to reduce the impact of flooding along Iowa Street.

Padden Creek drains the area generally lying between the headwaters and outflow from Lake Padden, South Samish Way, Old Fairhaven Parkway, Sehome High School, the Sehome Hill Arboretum, Lowell Elementary School, Viewcrest Drive, Fieldston Road, and the inter-tidal Padden Lagoon.

The Chuckanut Creek Drainage Basin drains the land area generally lying between the Lake Whatcom watershed, the Lake Padden cliffs above Interstate 5, and the ridge of Chuckanut Crest Drive. This drainage includes Chuckanut Creek, as well as four unnamed streams that flow into Chuckanut Creek. This drainage is steeply sloped and mostly forested.

Bellingham Bay Watershed houses significant wetland areas. The National Ecological Services (NES), which contracted with Whatcom County and the City of Bellingham to conduct a wetland inventory in 2003, identified an approximately 175-acre complex of wetlands throughout Bellingham Bay Watershed. An approximately 18-acre complex of wetlands connected to the Cemetery Creek drainage system east of Yew Street. These wetlands form the headwaters of Cemetery Creek and help protect the integrity of the creek.

NWI maps show approximately 7 acres of wetlands in this drainage. This complex is located in the Governor-Samish South Residential Area. Several wetland areas were identified during a 1992 field survey; however, the majority of this area's wetlands have been filled.

The NES wetlands study identified an approximately six-acre complex of fragmented wetlands north of the Mahonia Place and South Hills Drive residential developments in the Padden drainage basin. The main function of this complex is seasonal drainage into Lake Padden.

Approximately 140 acres of these wetlands lie within the planning area, as indicated by the U.S. Fish and Wildlife Service NWI maps. One complex, approximately 20 acres of tidelands/wetlands, is located along the shoreline between Bellingham Bay and Marine Drive (northwest of Bennett Drive). A second complex, approximately 120 acres of wetlands, is located on the Bellingham International Airport property, north of Country Lane. Half of this wetland drains into the Fort Bellingham drainage and half drains into the Silver Creek drainage.

The portion of this drainage that lies in the planning area has been designated as a FEMA Zone C (area outside a 500-year flood). The Fort Bellingham Reach of the marine shoreline is designated as a FEMA Zone V (coastal flood zone with velocity hazard/wave action) on the shoreline west of Jones Lane. The remaining portion of the Reach, east of Jones Lane, is designated as a FEMA Zone A (100-year floodplain).

2.9 SERVICE AREA GOALS AND POLICIES

The City is charged with managing and operating its sewer system in accordance with all known state, local, and federal regulations. These policies, from the City's Draft 2005 Comprehensive Plan, guide the development and financing of the infrastructure required to provide sewer service. These polices are provided to seek uniform treatment to all the

City's customers and to provide documentation of the City's commitments to current sewer system customers, as well as those considering service from the City.

While the City has discretion in setting performance and design criteria and standards for its sewer system, the criteria set must meet or exceed the minimum standards for public sewers as set forth by the Washington State Department of Ecology (DOE) through the Revised Code of Washington (RCW) Chapters 90.48, 90.52, and 90.54. The City's design criteria and standards are discussed in Chapters 6 and 9.

A general description of the City's goals and policies is provided below, followed by the identification number of the supporting goals and policies. Specific information on these goals and policies can be found in Chapter 5 of the City's 2005 draft Comprehensive Plan.

2.9.1 Goals

It is the goal of the City sewer utility to minimize degradation of water quality and to maintain compliance with the effluent standards for discharged waste. An ongoing inflow and infiltration removal program and annual replacements help keep combined sewer overflows from occurring more than once per year, and leakage of sewage out of manholes and pipes is minimized through enforcement of development standards. These efforts promote the continued health of the environment in and around Bellingham.

It is the City's intent to provide appropriate, safe, reliable sewer service at a fair and reasonable price to customers while protecting and preserving the integrity of the environment. Specifically the City intends to provide good low-cost public utility service to users within the City while providing utility service appropriate to the land use. The City remains committed to providing customers opportunities for participating in public comment in the development of policies that govern sewer service.

The primary objectives of wastewater treatment within the City of Bellingham are to produce high quality effluent that is protective to Bellingham Bay and low cost service to the ratepayers. Included in these objectives is the goal to maintain compliance with the requirements of the appropriate federal and state environmental regulations and the goal to operate the sewer system in such a manner that maximizes the useful life of all parts of the system.

The following policies support the overall sewer system goals:

- CFV6
- CFG3 and 4
- CFG26-31

2.9.2 Policies

2.9.2.1 Service Area

Sewer service is given priority to areas where service already exists or where service surrounds that area. Service can be provided outside the City limits when an agreement for annexation has been executed and a Capital Facilities Plan has been completed. This is supported by the Whatcom County Comprehensive Plan that governs the entire County. The following City policies support the sewer service area policies:

- CFP36-38

2.9.2.2 Conditions of Service

The City Council established it will not provide sewer service outside the City limits unless an annexation agreement has been executed. However before the execution of such agreement there must be a review and update to the City/County interlocal agreement (1997) of the Bellingham UGA, and update to the 1997 Urban Fringe Plan, and an ordinance that creates a new service zone. The City Council will determine that it is in the best interest of the community to provide sewer service and reserves the right to make exceptions, in cases such as a health and safety risk.

It is the City's intent to not provide service outside the UGA. This is supported by the Whatcom County Comprehensive Plan. Urban services are discouraged outside of this area. The following City policies support the conditions of service policies:

- LU119-124

2.9.2.3 Capital Facilities

It is important to maintain sewer services in a cost-effective manner. Any sewer service outside the City limits will be considered only if an agreement for annexation is executed and other criteria have been met, as discussed above. New sewer service must be included in an adopted Capital Facilities Plan. Any exceptions will be guided by the policies adopted in the City's Comprehensive Plan or approved by the City Council. The following policies support the Capital Facilities policies:

- CFP1-11

2.9.3 Capital Facilities Project Funding Priorities

The City Council is committed to providing cost-effective services to its customers. Capital facilities projects will be considered by providing the most public benefit. Five priorities were adopted by the City Council in 1987 that guide the process by which projects are selected for implementation. These include: health and safety concerns, replacement of existing facilities, generation of an immediate or cost-effective long-term income, and producing a measurable cost benefit. The following policies support the Capital Facility Project Funding Priorities policies:

- CFP12-16

2.10 RULES AND REGULATIONS

The effluent from the City of Bellingham Post Point Wastewater Treatment Facility is regulated by the United States Environmental Protection Agency (USEPA) through the Federal Water Pollution and Control Act (more commonly known as the Clean Water Act) and the Washington State Department of Ecology (DOE).

2.10.1 Federal Water Pollution and Control Act (Clean Water Act)

In 1972, the Federal Water Pollution and Control Act (more commonly known as the Clean Water Act) established the structure for regulating effluent discharges from wastewater treatment plants into waters of the United States and gave the Environmental Protection Agency (EPA) the authority to set wastewater standards. In 1995, the EPA launched the Code of Federal Regulation (CFR) Title 40 project to expand access to environmental regulations.

Section 133 of 40 CFR requires that all publicly owned wastewater treatment facilities `provide a minimum of secondary treatment unless a waiver is obtained. This act requires the following minimum effluent limitations of discharge from publicly owned wastewater treatment facilities:

- BOD_5 and TSS: 30-day average shall not exceed 30 mg/L, 7-day average shall not exceed 45 mg/L and the 30-day average percent removal shall not be less than 85 percent.
- pH: effluent pH shall be maintained within the limits of 6.0 to 9.0.

There can be exceptions to these regulations when treatment works receive combined sewer flows, dilute separate sewer flows or certain industrial wastes. However, in general, these are the minimum federal requirements for effluent quality.

Section 402 of the Clean Water Act established the National Pollution Discharge Elimination System (NPDES), which gave the USEPA the authority to limit pollutant discharges into the water bodies by settling effluent limits for point sources. The USEPA has delegated their authority to the State of Washington to administer the NPDES permit program. Section 122 of 40 CFR defines the minimum federal regulations for the NPDES permits. Section 122 of 40 CFR also defines the federal policy on “blending” or bypassing of primary effluent around the secondary processes during peak events. Section 122 of 40 CFR prohibits the intentional bypass of the waste stream from any portion of the treatment facility unless “(A) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage [or] (B) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance" (40 CFR 122.41(m)).

Since the 1983 amendment of the Clean Water Act, 40 CFR 503 (The Standards for the Use or Disposal of Sewage Sludge) regulates the disposal of sewage sludge. The 503 Act regulates the use and disposal of biosolids that are: "applied to land to condition the soil or fertilize crops or other vegetables grown in the soil; placed on a surface disposal site for final disposal; or fired in a biosolids incinerator." (US EPA Guide to Part 503 Rule). Since the Post Point Treatment Plant incinerates their biosolids, subpart E of 40 CFR 503 (503.40 - 503.48) applies. This section regulates the concentration of metals fed to the incinerator.

Section 403 of 40 CFR establishes pretreatment programs for publicly owned treatment works (POTWs). The pretreatment program was created:

a. To prevent the introduction of pollutants into POTWs, which will interfere with the operation of a POTW, including interference with its use or disposal of municipal sludge;

b. To prevent the introduction of pollutants into POTWs which will pass through the treatment works or otherwise be incompatible with such works; and

c. To improve opportunities to recycle and reclaim municipal and industrial wastewaters and sludges. (40 CFR 403)

Section 303 of the Clean Water Act provides the water quality standards and implementation plan. Section 303 requires that each state identify those waters for which previously described limits (such as those identified by best practice control technology) are not stringent enough to implement applicable water quality standards. The City of Bellingham discharges into Bellingham Bay, which currently has no Category 5 listings (most impacted waters). The inner bay has a Category 2 listing for DO and Category 1 listing for fecal coliform, pH, and temperature.

2.10.2 Department of Ecology

The Washington State DOE has the responsibility to administer and enforce the requirements of the federal Clean Water Act and state regulations pertaining to environmental protection.

2.10.2.1 Water Quality Regulations

The Washington State DOE establishes the standards for surface waters within the State of Washington through WAC 173-201A. This regulation specifies that:

(a) All surface waters are protected by narrative criteria, designated uses, and an antidegradation policy.

(b) Based on the use designations, numeric and narrative criteria are assigned to a water body to protect the existing and designated uses.

(c) Where multiple criteria for the same water quality parameter are assigned to a water body to protect different uses, the most stringent criteria for each parameter is to be applied. (WAC 173-201A-010)

The antidegradation policy is described in WAC 173-201A-300. This section specifies that "…all human activities that are likely to contribute to a lowering of water quality, at a minimum, apply all known, available, and reasonable methods of prevention, control, and treatment (AKART)…" (WAC-201A-300)

The Washington State DOE's policies on allowable mixing zones are defined in WAC 173-201A-400.

2.10.2.2 NPDES Regulations

The NPDES permit program is described in WAC 173-220, the discharge standards and procedures for determining effluent limitations for domestic wastewater facilities are described in WAC 173-221, and the permit fees are described in WAC 173-224.

The current NPDES permit (Permit No. WA-002374-4) was issued on September 15, 2000, and expired on June 30, 2005. The City is currently negotiating a new permit with DOE. The permit is included in Appendix E.

2.10.2.3 Infiltration and Inflow

The Washington State DOE follows the federal regulations and requires that applicants for federal grant assistance must "demonstrate to the Regional Administrator's satisfaction that each sewer system discharging into the treatment works project for which grant application is made is not or will not be subject to excessive infiltration/inflow. A determination of whether excessive infiltration/inflow exists may take into account, in addition to flow and related data, other significant factors such as cost-effectiveness (including the cost of substantial treatment works construction delay…), public health emergencies, the effects of plant bypassing or overloading, or relevant economic or environmental factors." (40 CFR 35.927). Determination of excessive infiltration and inflow is described in 40 CFR 35.927-1.

2.10.2.3.1 *Engineering Design Criteria*

The DOE publishes the *Criteria for Sewage Works Design* manual, often referred to as the "Orange Book". This manual provides a basis for design of sewage collection, treatment and reclamation systems and ensures that the design of such systems is consistent with water quality objectives for Washington State. This Comprehensive Plan has been prepared in accordance with the most recent version of the *Criteria for Sewage Works Design*, published in 1997.

2.10.2.3.2 *Contract Documents*

Chapter 173-240 of the WAC governs the submission of plans and reports for construction of wastewater facilities. This chapter specifies that:

> "before constructing or modifying domestic wastewater facilities, engineering reports and plans and specifications for the project must be submitted to and approved by the department, except [when] the local government entity has received department approval of a general sewer plan and standard design criteria, engineering reports and plans and specifications for sewer line extensions, including pump stations, are not required to be submitted for approval. In this case the entity need only provide a description of the project and written assurance that the extension is in conformance with the general sewer plan. However, in the following situations specific department approval is necessary for sewer line extensions before construction:
>
> (a) The proposed sewers, or pump stations involve installation of overflows or bypasses; or
>
> (b) The proposed sewers, pump or lift stations discharge to an overloaded treatment, collection, or disposal facility. (WAC 173-240-030)."

The requirements for a general sewer plan report are given in WAC 173-240-050 and have been followed for the preparation of this report.

2.10.2.4 Shorelines

As the effluent from the Post Point Wastewater Treatment Plant (WWTP) discharges to the Bellingham Bay, chapter 173-27 of the WAC governing the shoreline management permit and enforcement procedures may apply. This chapter "requires local governments to establish a program, consistent with rules adopted by the Department of Ecology, for the administration and enforcement of the permit system for shoreline management." (WAC 173-27-020).

2.10.2.5 Blending

The Washington State Department of Ecology requires that treatment plants are designed for maximum month/maximum week flows without blending but allows blending for peak flow conditions for combined sewer systems. Additionally they allow blending for certain treatment plants that precede the regulations.

2.10.2.6 Combined Sewer Overflow (CSO)

The regulations of CSOs are described in Title 173-245. The code states that "Municipalities shall propose a schedule for achieving the 'greatest reasonable reduction of combined river overflows at the earliest possible date' (RCW 90.48.480)" (173-245.2e).

2.10.2.7 Storm Water Permit

As part of the Post Point Wastewater Treatment Plant and Alternative Outfall Investigation and Alternatives Analysis (Hart Crowser 2004), the City has planned for up to 3.6 mgd of storm water to be diverted through the alternate outfall. This storm water is regulated by a general western Washington Phase II Storm Water Permit No. WAR04-5550.

2.10.2.8 Future Regulations

The DOE has identified metals and toxins as a potential issue on the horizon once the new non-diffused outfall goes into service. Nutrient limitations are not on the horizon within the planning period.

2.10.3 Other Regulations

2.10.3.1 U.S. Army Corps of Engineers Permit

The United States Army Corps of Engineers regulates the development of the Nation's aquatic resources. An Army Corps permit could be required if a wastewater treatment plant were to modify an existing outfall, or if the treatment plant were to have construction on a wetland. In an effort to balance economic growth and infrastructure development with potential impacts on the waters of the United States, the Army Corps permits are reviewed by federal, state, and local agencies along with the general public.

2.10.3.2 State Environmental Policy Act (SEPA)

The State Environmental Policy Act (SEPA) establishes a way to identify possible detrimental environmental impacts that may result from state and local agencies within Washington State. The SEPA applies to cities, ports and special districts such as water or wastewater districts. The state's environmental policies are described in RCW 43.21 while the SEPA rules are described in WAC 193-11.

2.10.3.3 Northwest Air Pollution Authority (NWAPA)

The Northwest Air Pollution Authority is a local regulatory agency with jurisdiction over air emissions in Island, Skagit and Whatcom counties. The Authority's primary concern with the Post Point WWTP is the incinerator exit gas and odor generation.

2.10.3.4 Fish and Wildlife

Chapter 77.55 of the Washington State RCW establishes that any government agency that desires to undertake a hydraulic project will be required to obtain a permit from the

Department of Fish and Wildlife so as to insure the protection of fisheries. The Washington Department of Fish and Wildlife administers the WAC hydraulic code (WAC 220-110).

DEMOGRAPHIC ANALYSIS

3.1 INTRODUCTION

This chapter summarizes the demographic analysis utilizing information from Chapter 2 Basis for Planning Data, pertaining to the existing and future sewer service area. The primary objective was to develop population and employment forecasts for the City sewer service area that are consistent with Growth Management Act (GMA) planning goals. Two forecasting scenarios have been considered, both utilizing the City's planning data for 2002 and 2022: first, a baseline scenario assuming a constant growth rate across the service area; and second, a customized scenario considering the timing of development.

An overview of the City's updated Land Use element of the Comprehensive Plan is provided, which includes GMA history and the Capital Facilities element. Also included is a summary of the forecasting approach based on the Traffic Analysis Zones (TAZ) intersecting the City limits and the surrounding Urban Growth Area (UGA). Finally, results from existing and future land use, population, and employment forecasts are provided for the future sewer service area.

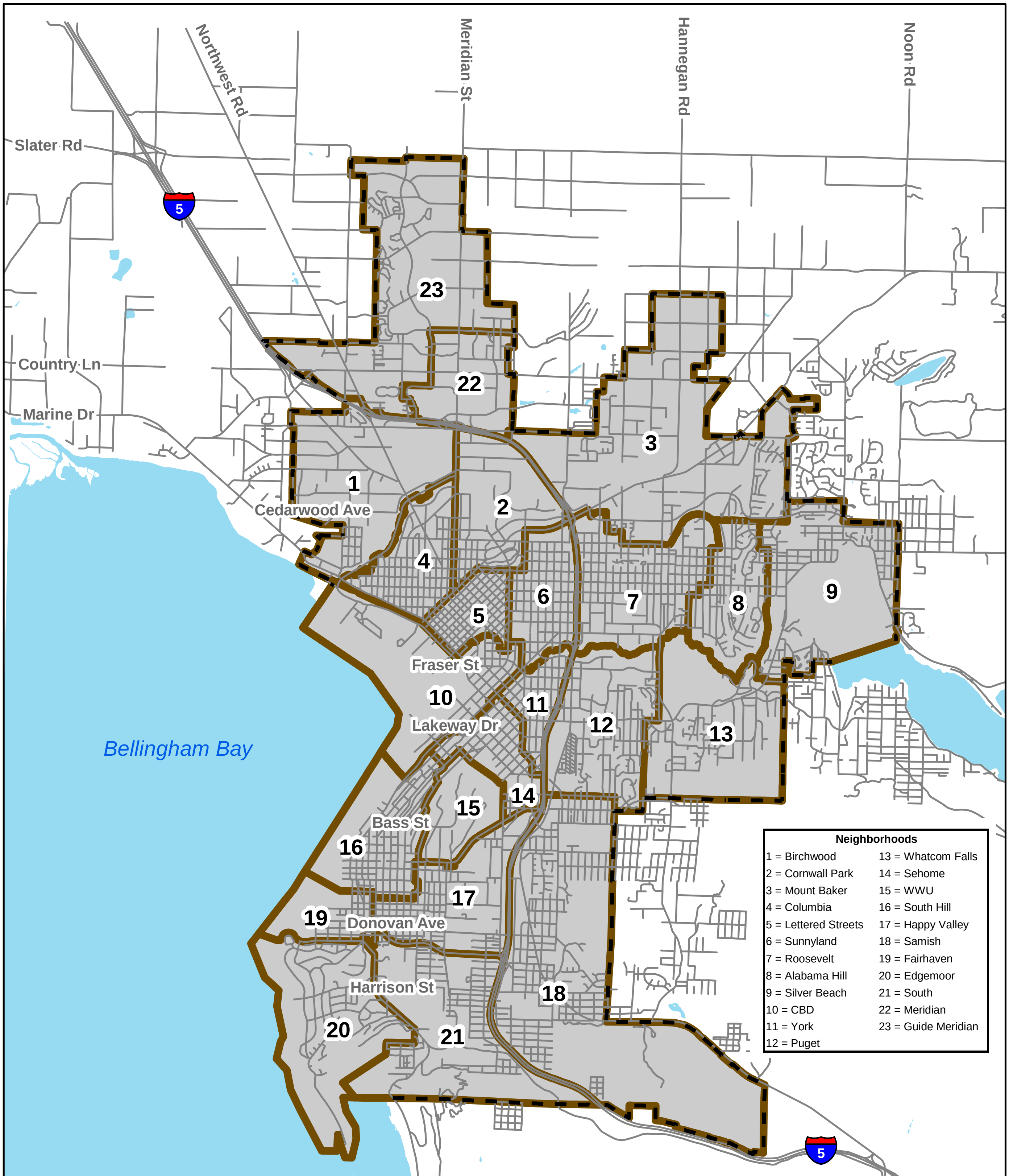
3.2 OVERVIEW OF LAND USE

Many factors influence population growth in the Greater Bellingham region. The state of the economy, interest rates, demands for annexation by neighboring cities, and up-zoning all influence new development and population growth. Growth management policies, along with coordination between local and county governments should make development more predictable and projections more accurate than they historically have been. However, significant changes to the regional economy, land use and development policies, and open space preservation movements will continue to affect growth timing and patterns.

3.2.1 GMA/Comprehensive Plan History

The planning area for the City of Bellingham (City) includes areas within the City limits, urban growth areas, and 5-year review areas. These designations were established when the City updated its 1980 "Bellingham Plan" to fulfill the requirements of the State Growth Management Act in 1995. The Bellingham Plan addressed issues such as housing, land use, parks, and traffic circulation and served as a guideline for future growth.

The area within the City limits is currently divided into 23 neighborhoods (Figure 3.1). The last neighborhood, Meridian, was added between the time of the 1995 Comprehensive Plan and the 2004-2005 Comprehensive Plan Update. This was in response to the 1,500 acres that was annexed by the City due to rapid population growth experienced in the preceding 10 years. Neighborhoods originally submited plans for land use and zoning for inclusion in



NEIGHBORHOODS

FIGURE 3.1

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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the Bellingham Plan. These plans were incorporated into the 1995 Comprehensive Plan and were readopted in 2006. Ideally, as suggested by City planners, these Plans are to be updated every 10 years.

In 1997, the City implemented the Urban Fringe Subarea Plan (UFSP), which delineated the Urban Growth Area boundaries. These areas were divided into three distinct subareas described in Chapter 2: Northern, Yew Street, and Geneva. Also included in the UFSP were the “5-year review areas” which represented adjacent lands for possible inclusion in the UGA.

In the mid-1990s, the City experienced rapid population growth. This rapid growth prompted the City to join together with Whatcom County and the cities of Blaine, Everson, Ferndale, Lynden, Nooksack, and Sumas to update their state mandated comprehensive plans. The City led contracting with ECO Northwest, a regional economic consulting firm, to assist in the completion of the population forecasts for these areas. The objective of the report was to provide population growth projections for the County, the cities and their UGAs, two County UGAs, and the Point Roberts community; economic forecast scenarios and supporting analyses on trends for major employment sectors, and labor force projection; commercial and industrial land demand (consumption) forecasts for each jurisdiction; and housing growth projections and residential land demand forecasts for each jurisdiction. These forecasts were used to determine if there was sufficient area to support the growth or if the UGA boundaries needed to be expanded.

In 2004, the City completed a Final Environmental Impact Statement (FEIS) that was intended to provide the basis for environmental review and evaluation of four alternative growth management scenarios for the City of Bellingham, the Bellingham Urban Growth Areas, and the Urban Fringe Subarea. The FEIS is a programmatic document that provides environmental impact assessment of the range of reasonable alternatives to accommodate the projected population growth. This baseline analysis served as the final evaluation in preparation for the 2005 Comprehensive Plan update. Four alternative growth scenarios were formulated:

- Alternative 1 – “No action” states that growth will be accommodated in underused lands within the City and UGA boundaries without changing land use regulations.
- Alternative 2 – “Infill” is similar to above, but with changes to land use regulations.
- Alternative 3 – “Adjusted UGA” allows for expansion of UGA boundaries to accommodate the majority of the growth.
- Alternative 4 – “Infill and Adjusted UGA” is basically a combination of Alternatives 2 and 3.

These alternatives were developed after an extended review process, including a series of neighborhood meetings and public hearings. Growth forecasts previously adopted by the

City and County Councils were used as a basis for this formulation. The FEIS states that the population of the City and the UGA is expected to increase by 31,601 new residents to reach a total population of 113,055 by the year 2022. This is approximately 51.4 percent of the proposed growth for the entire Whatcom County area.

3.2.2 Comprehensive Plan

The City's Comprehensive Plan update was adopted in June 2006. Guidance for this document was drawn from the FEIS, the 1995 Comprehensive Plan, the State GMA, Whatcom County policies and plans, census data, and local planning entities. New UGA boundaries were also delineated for future planning areas. As discussed in Chapter 2, the future sewer service area will include only the defined City limits and UGA. This future area was defined on Figure 2.2 and does not include sewer service into the rural analysis area of the Urban Fringe Subarea. This Plan addresses the adopted 2006 Bellingham Comprehensive Plan, County-Wide Planning Policies, the UGA goals and policies of the Whatcom County Comprehensive Plan. These policies guide efforts to maintain and enhance the ecological integrity of the area, stimulate economic viability, retain and protect social equity and enhance the overall quality of life within the City and UGA.

Capital facilities planning for the City underwent a change in order to comply with GMA requirements set forth in 1992. The previous method, referred to as the Capital Improvement Program, served as a "wish list" of necessary capital projects updated on an annual basis. The Capital Facilities Plan (CFP), implemented in 1993, provided a funding mechanism for growth-related capital improvement projects based on the estimated cost of planned improvements. As part of the City's updated Plan, it was required to plan beyond a single budget year and prioritize projects by considering urgency, economic feasibility, and community benefit over a 20-year span. In short, the City must evaluate its ability to provide the public infrastructure necessary to support other Comprehensive Plan elements. The updated Capital Facilities Element (Chapter 5 of the City's 2006 Comprehensive Plan) was developed to address the financing of capital projects in Bellingham and the UGA. The Element represents the community's policy plan for the provision and financing of public facilities for the next 20 years, and includes a 6-year financing program for capital facilities from 2006 to 2011. The goals and policies in the Plan will be used to guide public decisions on the use of capital funds.

3.2.3 Recent Annexations

Since the Bellingham UGA is considered available for annexation, the City should consider working with the County to determine which areas need to be annexed. As part of the Whatcom County Plan, the City could consider:

- Encouraging existing urbanized areas to annex.
- Adopt interlocal agreements with criteria addressing size and timing of annexations and revenue sharing when appropriate.

- Ensure that rural development does not happen within the UGA in such a way as to prohibit urban levels of development upon annexation.
- Develop a strategy to guide transition of services from County to City or from other rural service providers to City services.

There have been 19 annexations since 1987. These were primarily located in the north area of town. The recent annexations resulted in the creation of the Meridian neighborhood at the north end of town. This annexation was the result of 10 petitions initiated by property owners since 1995. Most annexations in the decade prior were also in this area. Prior to 1987, there had only been 19 annexations since the time of incorporation of the City in the late 1800s. Annexations approved since 1987 can be seen in Figure 3.2.

3.3 OVERVIEW OF FORECASTING APPROACH

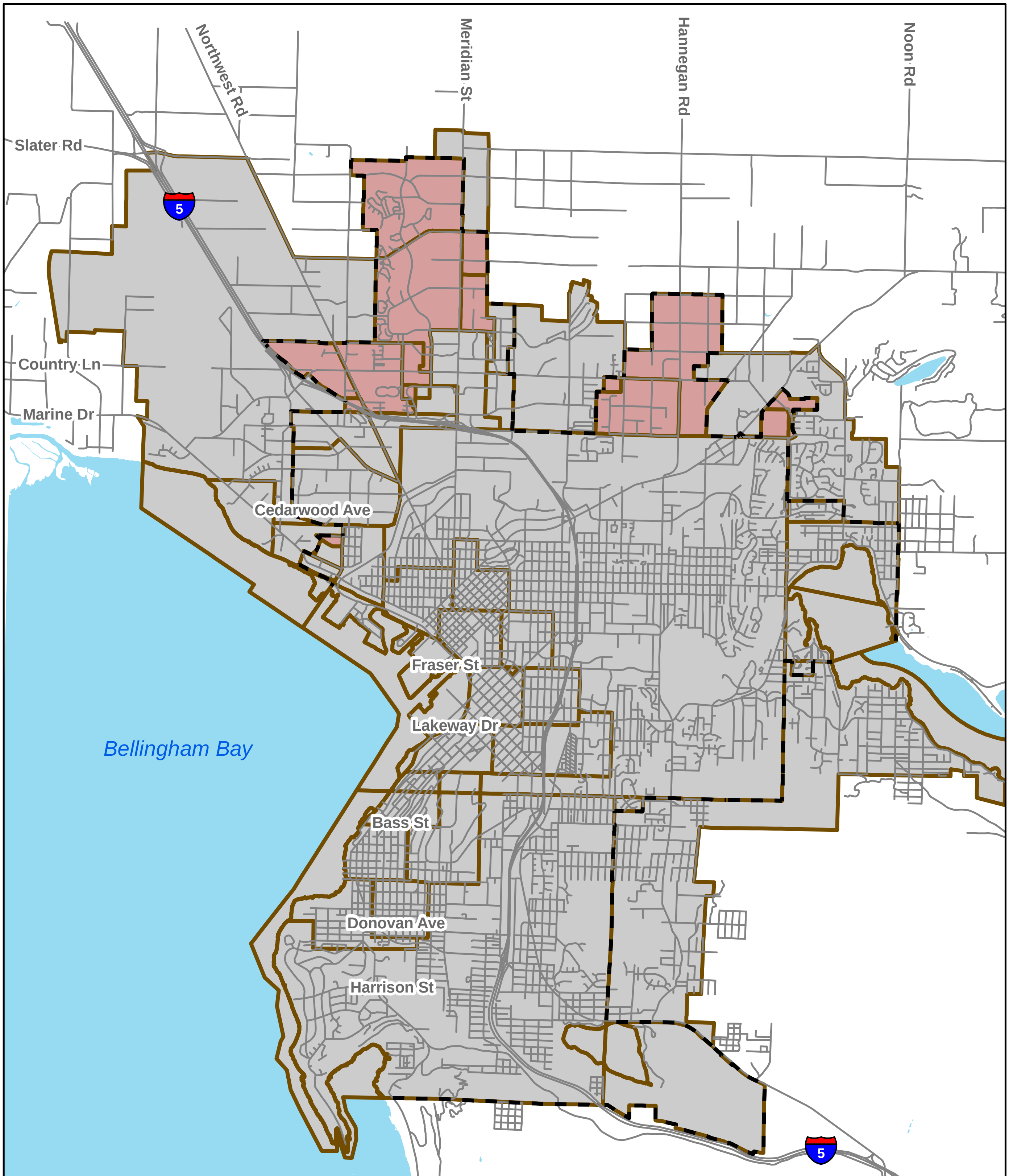
The future sewer service area demographic analysis utilized the City's current population and employment data with the Traffic Analysis Zones (TAZ) of the City's Geographic Information System (GIS). This platform made it possible to overlay TAZ, City/UGA zoning and land use, and Whatcom County land use layers in an effort to generate population and employment projection data.

Two forecasting scenarios were developed consistent with the current GMA and DOE requirements. The first scenario assumes a constant growth rate based on the 2002 and 2022 population and employment data. The second scenario alters the first scenario to account for the expected timing of growth, determined by the City, within each TAZ. Supplemental planning data is included in Appendix F for both Scenario 1 and Scenario 2.

3.3.1 Data

The future sewer service area population and employment forecasting for the Bellingham urban growth area was performed using ESRI GIS ArcGIS 9.1 technology.

Transportation analysis zone (TAZ) data used in this forecasting was provided by the City of Bellingham Public Works Department. This analysis was generated based on both 2002 and 2022 data sets. The data included population (residential), student population (college only), retail and non-retail employment, education employment and total employment by TAZ. Land use and historical annexation data was provided by the City's GIS department.



Legend

Streets
City Limits
Recent Annexations
Early Annexations

N

Miles
0 0.8 1.6

ANNEXATIONS

FIGURE 3.2

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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The Whatcom County GIS department supplied a 2005 county zoning layer used to determine land use in areas adjacent to the City/UGA boundaries. Adjustments were made to this data in order to correlate it with the population forecast from the City's 2006 Comprehensive Plan and to accurately reflect expected development.

3.3.2 Process

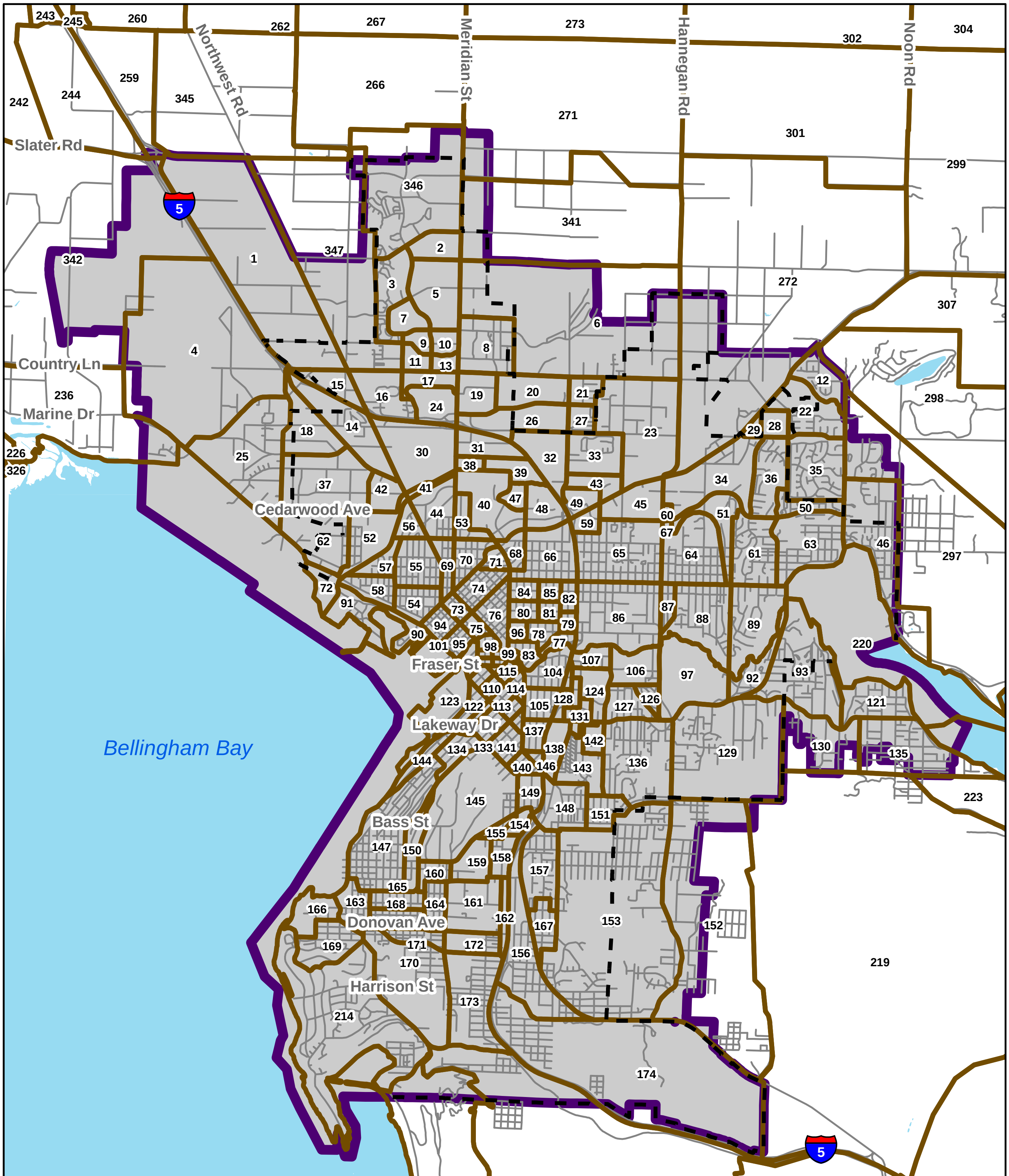
The 2002 data set served as a baseline for the analysis and 2022 data is considered the future conditions used to determine the projected growth per TAZ over the 20-year period. Land use layers were used at the boundaries to determine the distribution of population and employment relative to the City limit/UGA boundaries. Population and employment totals derived from this analysis were within 5 percent of totals listed in the Bellingham Comprehensive Land Use Plan.

The methodology involved allocating the planning data provided for each TAZ into the City limit and urban growth area. The overlay of the planning data and future sewer service area is identified in Figure 3.3. The areas that fell completely within the City limit or UGA boundaries were simply assigned 2002 and 2022 population and employment totals listed for the TAZ. However, the regions that straddled the boundaries, calculations were performed to determine the percentage of area contained on either side of the boundary. Population and employment totals were then distributed between the City limit area and UGA based on this percentage taking the land use into consideration.

Land use boundaries for the City, UGA, and county were factored in the distribution of the fringe areas. First, land use classifications were grouped into two broader classifications: residential and non-residential, then overlaid TAZ subareas. For example, residential population was distributed between the City and UGA based on the amount of residential land use area on each side of the boundary.

For Scenario 1, the rate of change was used to linearly interpolate the TAZ population and employment totals for 2006 and 2016, and linearly extrapolate the TAZ population and employment totals for 2026.

A meeting with City staff on February 20, 2007 was held to develop more detailed information for Scenario 2. Scenario 2 accounts for current expectations of the timing and location of development and growth. The majority of the modified planning values occurred in the TAZ adjacent to or within the UGA, the downtown and waterfront redevelopment areas, and in the south near Fairhaven. 2006 populations for Scenario 2 are generally estimated to be the same as Scenario 1, with the exception of TAZ 91, 101, and 123 on the waterfront, which are anticipated to be redeveloped. Estimates of growth were considered at 2012, 2016, and 2022. Detailed development plans past 2022 are not available for most areas, and population predictions for 2026 are primarily a linear extrapolation of estimates from 2002 and 2022.



Legend

Streets

City Limits

Future Sewer Service Area

TAZ Boundaries

0 0.8 1.6 Miles

TAZ OVERLAY

FIGURE 3.3

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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The 2026 projections for the waterfront redevelopment area utilized the high-density projections from the Draft EIS alternatives for the New Whatcom Redevelopment site, July 2007.

3.3.3 Issues

Although the derived totals for population and employment were within a reasonable margin of error, there were irregularities in the data that required independent judgment. Allocating population outside and inside the UGA and City limits for TAZs that intersected multiple areas was subjective to interpretation. Population forecasting was performed using the best available data. Since the only TAZ data available included 2002 estimates and 2022 projections, 2006 and 2016 estimates were based on interpolation for Scenario 1 and expectations of the timing of future developments for Scenario 2. 2026 estimates for both scenarios were based on extrapolation of the constant growth rate from 2002 to 2022.

Boundaries illustrated by the various GIS layers used did not always precisely match. This complicated area calculations. The population density of outlying county planning areas was not considered when allocating population to adjacent UGA or City limit areas, resulting in “best estimates” as to how TAZ population should be distributed.

The 2002 TAZ employment data entry scheme differed from its 2022 counterpart. This had to be reconciled before proceeding with the analysis. Additionally, the sum of individual stratification of data (i.e., retail vs. non-retail) did not always match the total employment totals stated. In most cases, the sums of individual totals were used as opposed to the totals listed in the tables.

3.4 LAND USE, POPULATION, AND EMPLOYMENT

3.4.1 Land Use

This section summarizes the zoning, land use population, household, and employment data that are utilized to predict future growth needs for the sewer system.

Future sewer system requirements of the City will be based upon future growth projections such as land use, zoning capacity and historic sewer data for the established sewer service area. Future sewer demands are used to establish criteria for the hydraulic analysis of the sewer system and for development of the Capital Improvement Plan (CIP).

Land use and zoning designations and regulations are important factors in determining sewer service. These determine the area available for various types of development including both single-family and multifamily residential development, as well as the commercial and other types of land use that provide the economic base necessary to support development.

3.4.1.1 Existing Land Use

The City of Bellingham land use regulations provide a guideline by which it implements a community vision. Affordable housing, environmental stewardship, growth planning, economic development, and public participation are all considerations taken into account during the planning process. Currently, approximately 58 percent of the land within the city limits is zoned for residential use only, while the remaining land is classified for non-residential or mixed-use. A breakdown of general land use classifications can be seen in Table 3.1.

Table 3.1 General Land Use Classifications
Comprehensive Sewer Plan
City of Bellingham

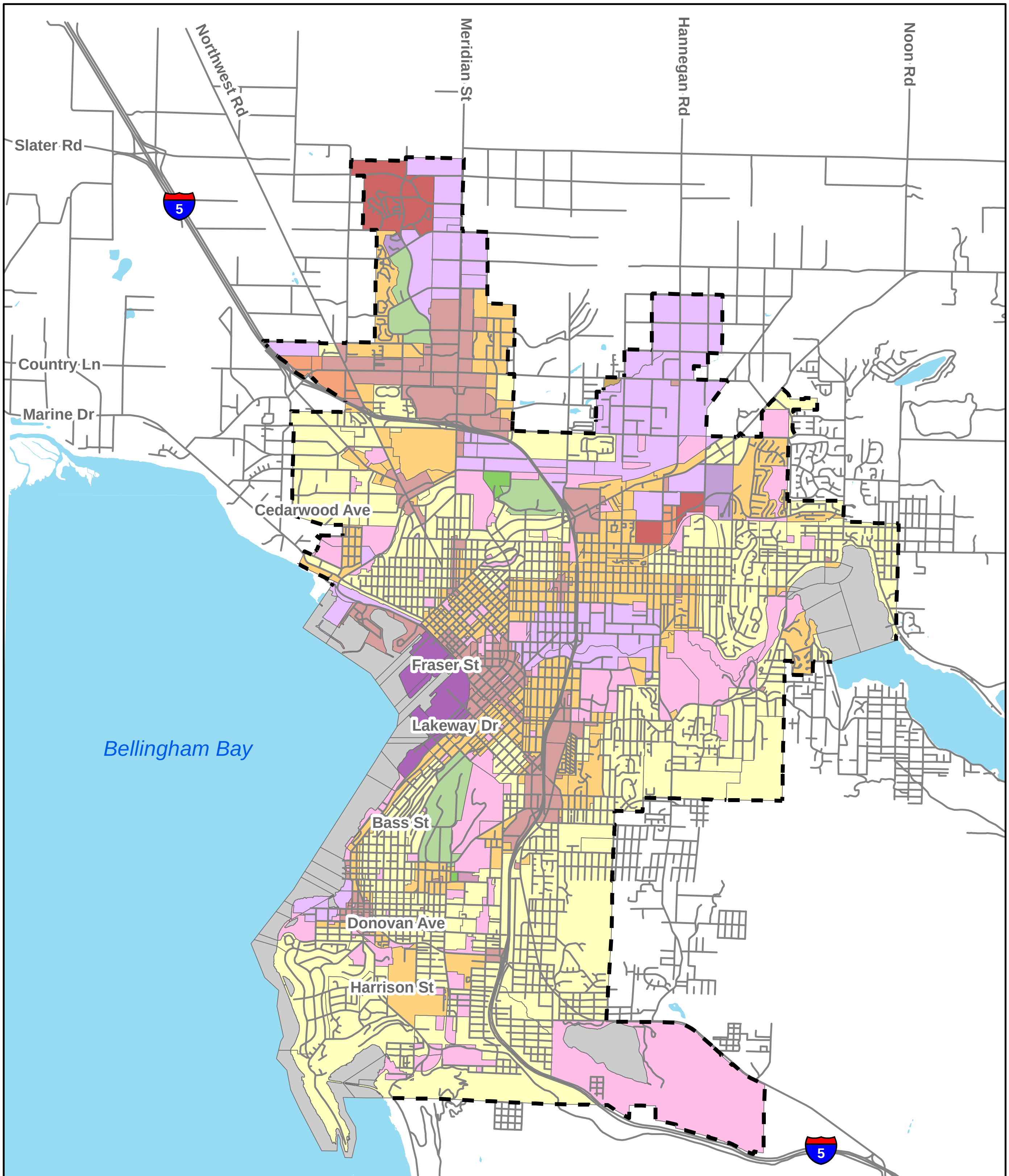
City Zoning (general use type)	Acreage	% of Total
Residential Single-family	6,868	42
Residential Multifamily	2,653	16.2
Commercial	1,336	8.2
Industrial	2,348	14.4
Public	2,261	13.8
Institutional	336	2
Mixed -- Commercial/Industrial	102	0.6
Mixed -- Industrial/Residential Multifamily	86	0.5
Mixed -- Residential Single/Residential Multifamily	6	-
Mixed -- Institutional/Residential Multifamily	29	0.2
Mixed -- Public/Institutional	9	-
Mixed -- Commercial/Industrial/Residential Multifamily	305	1.9
Total	16,339	99.8

Most of the land in the UGA is zoned for residential use. There are concentrations of commercial/industrial use near the airport, near Marine Drive adjacent to the city limits, along Guide Meridian Road, and scattered along the Mount Baker Highway.

3.4.1.2 Future Land Use

The addition of 5-year review areas into the current UGA made it possible for the City to compensate for an initial shortfall of land deemed suitable for residential commercial, and industrial use. This was based on employment growth estimates projected out to 2022. A majority of the remaining land in the UGA will be zoned for residential use to accommodate population increases in the greater Bellingham region. As stated in the new comprehensive plan, and per state laws, all UGA land has the potential for future annexation.

Much of the remaining residential land within the city limits is zoned multifamily. However, the City allows single-family development within multifamily zoning. Therefore, a demand analysis model used by planners assumes 67 percent of future housing needs will be met by multifamily development – compared to the current single-family/multifamily ratio of 50 percent. Land use (zoning) classifications are shown in Figure 3.4.



Legend

- Streets
- City Limits

Land Use Designations

- Residential Single
- Residential Multiple
- Res. Single/Res. Multi.
- Commercial
- Commercial/Industrial
- Com./Ind./Res. Multi.
- Industrial
- Industrial/Res. Multi.
- Ind./Waterfront Mixed Use
- Institutional
- Institutional/Res Multi.
- Public
- Public/Institutional
- Public/Waterfront Mixed Use
- Unknown

Miles
0 0.8 1.6

LAND USE

FIGURE 3.4

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

Currently, 47 percent of the single-family dwellings have been built in multifamily zones. Infill strategies will also be used to absorb some of the projected growth anticipated in the region. The City will balance the need for infill while protecting the character of existing neighborhoods by:

- Making more efficient use of developable land in the City by using higher density residential zoning.
- Encouraging and facilitating urban center development, i.e. mixed use, high rise and/or high density.
- Evaluating and potentially rezoning underdeveloped, low density designated areas of Bellingham and the UGA to higher density zoning.
- Proactively encouraging and supporting annexations of undeveloped UGA land.

City planners predict that the combination of new land utilization priorities in the UGA and City limits should accommodate population and employment growth over the next 20 years.

3.4.2 Population

Historically, the City of Bellingham has accounted for approximately 50 percent of the population of Whatcom County. Increased development in rural Whatcom beginning in 1970 slightly decreased the City's share of the population. The City also experienced concurrent growth in the same time period. The implementation of the Growth Management Act in 1997 led to the creation of the Bellingham UGA and required the City and County to plan for higher densities in these areas. This has resulted in the City's share of the total County population again increasing slightly. Table 3.2 demonstrates the population growth trend since the City's incorporation in 1904 and extends out to 2022 population estimates.

Another notable trend is the accelerated rise in population beginning in 1980 and forecasted through 2020. In fact, the City experienced a population increase of approximately 22 percent in the 1990s alone. This trend is mainly due to immigration, which accounts for over half of the region's growth in the past decade.

3.4.2.1 <u>Existing and Future Population</u>

Population values for sewer service estimates were derived based on the forecasting approach and the land use described above. The resulting total population projections within the City limits and UGA can be seen in Tables 3.3 and 3.4 for Scenarios 1 and 2 respectively.

Table 3.2	**Bellingham Population Growth Comprehensive Sewer Plan City of Bellingham**												
Year	**1900**	**1910**	**1920**	**1930**	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2002**	**2022**
Population	11,062	24,298	25,585	30,823	29,314	34,112	34,688	39,375	45,794	52,179	67,171	81,454[1]	113,055[2]

Notes:

1. Includes UGA.
2. Adopted official agreement between the City and County Councils.

Table 3.3	Population Distribution by Planning Area Scenario 1 – Constant Growth Rate Comprehensive Sewer Plan City of Bellingham				
Area	**2002**	**2006**	**2016**	**2022**	**2026**
City Limits(1)	69,260	76,144	82,853	88,678	92,561
UGA(2)	12,194	14,630	20,722	24,377	26,814
Total	81,454	90,774	103,575	113,055	119,375

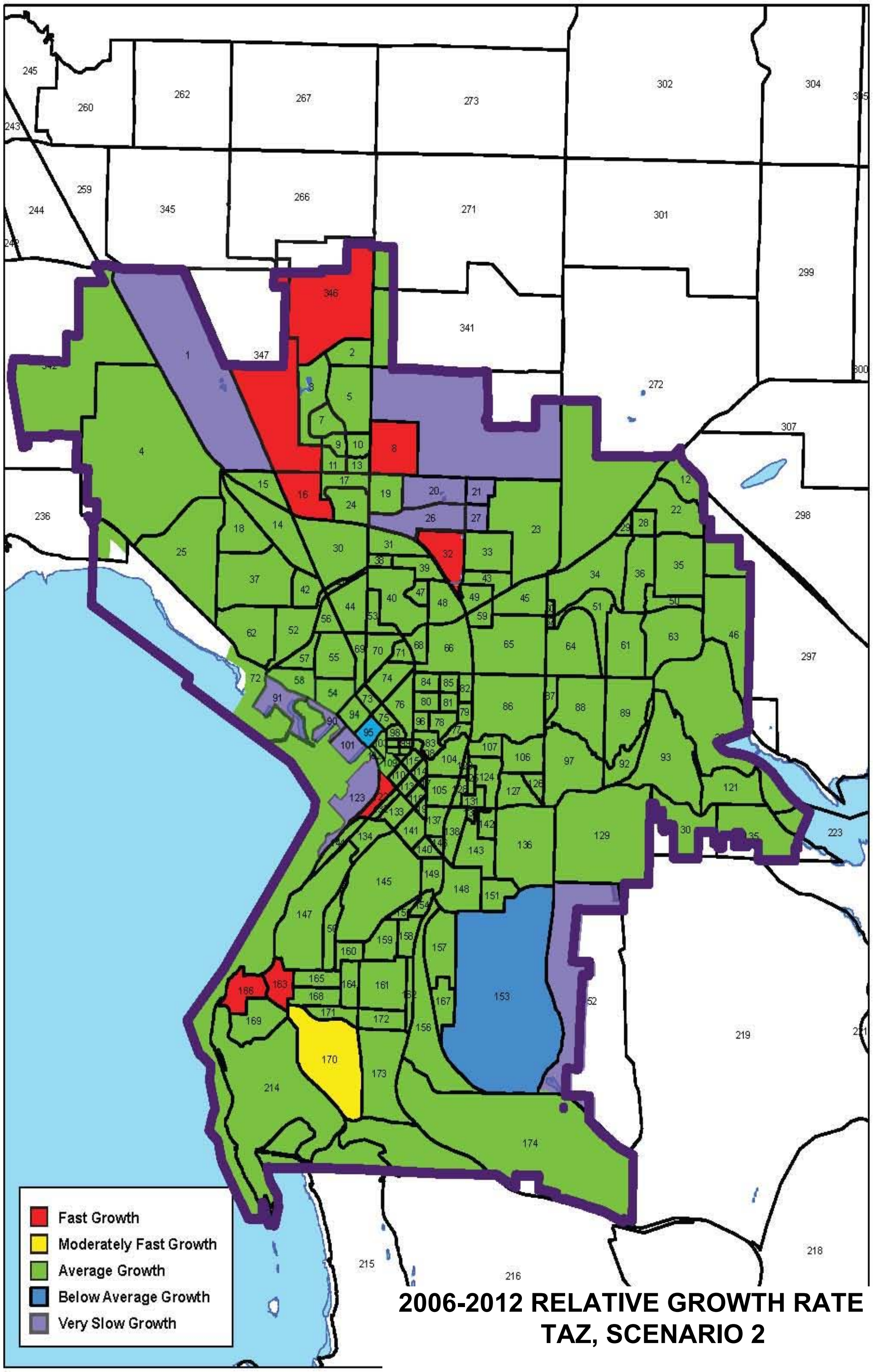
Notes:
1. Assumes a constant 1.40% annual growth rate.
2. Assumes a constant 5.00% annual growth rate.

Table 3.4	Population Distribution by Planning Area Scenario 2 – Custom Variable Growth Rate Comprehensive Sewer Plan City of Bellingham					
Area	**2002**(1)	**2006**(2)	**2012**(3)	**2016**(4)	**2022**(1)	**2026**(4)
City Limits(1)	69,260	72,597	78,948	82,660	88,577	95,072
UGA(2)	12,194	14,651	17,158	20,557	24,478	26,935
Total	81,454	87,248	96,107	103,217	113,055	122,007

Notes:
1. Based on available TAZ data.
2. Generally based on linear interpolation from 2002 to 2022 with the exception of TAZ 91, 101, and 123.
3. Based on assumptions of timing and locations of future development.
4. Assumes a constant growth rate based on 2002 and 2022 populations with the exception of TAZ 123.

Overall, the growth rate of the two scenarios is very similar. Scenario 2 predicts growth from 2006 to 2012 to be slightly slower than Scenario 1, faster from 2012 to 2016, and almost the same from 2016 to 2022. Although the same method was used to estimate the population in the city limits and UGA at 2022, there is a discrepancy of 200 people between Scenario 1 and Scenario 2. This is because development that was originally assumed to be in TAZ 152 is now planned for TAZ 153. TAZ 152 is completely outside the city limits while TAZ 153 is partly within the city limits. As a result, the extrapolated population at 2026 is also different.

Although the total population at 2006, 2012, and 2016 for Scenario 1 and 2 is similar, it does not reflect the differences in the timing and location of growth. Figures 3.5, 3.6, and 3.7 show the expected rate of growth during three different time periods, 2006 to 2012, 2012 to 2016, and 2016 to 2022 for Scenario 2.



Source:
TAZ data: Bellingham Department of Public Works
Planning Area: "Zoning" file from COB GIS Website

2006-2012 RELATIVE GROWTH RATE BY TAZ, SCENARIO 2

FIGURE 3.5

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COMPREHENSIVE SEWER PLAN

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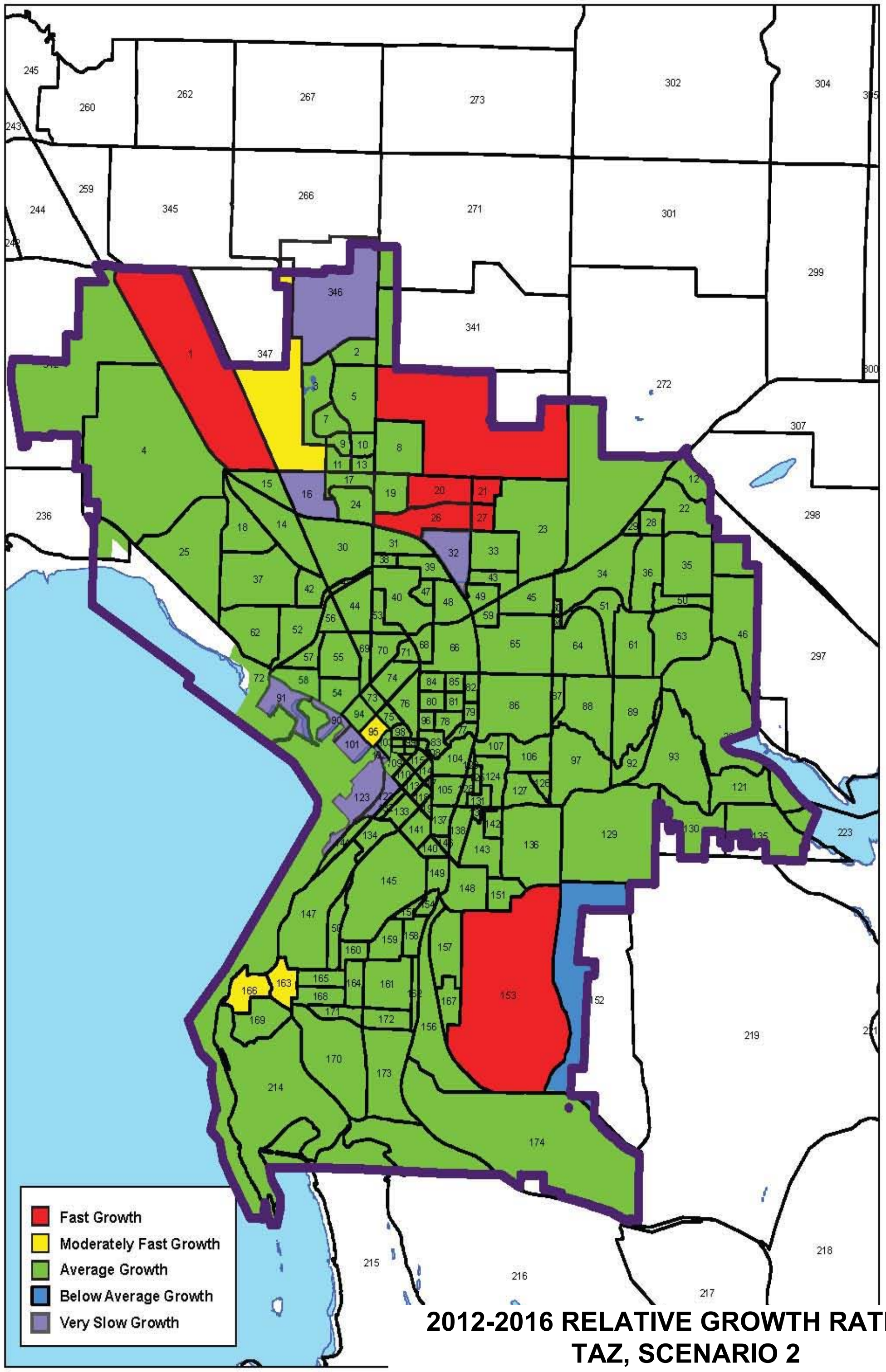

Source:
TAZ data: Bellingham Department of Public Works
Planning Area: "Zoning" file from COB GIS Website

2012-2016 RELATIVE GROWTH RATE BY TAZ, SCENARIO 2

FIGURE 3.6

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COMPREHENSIVE SEWER PLAN

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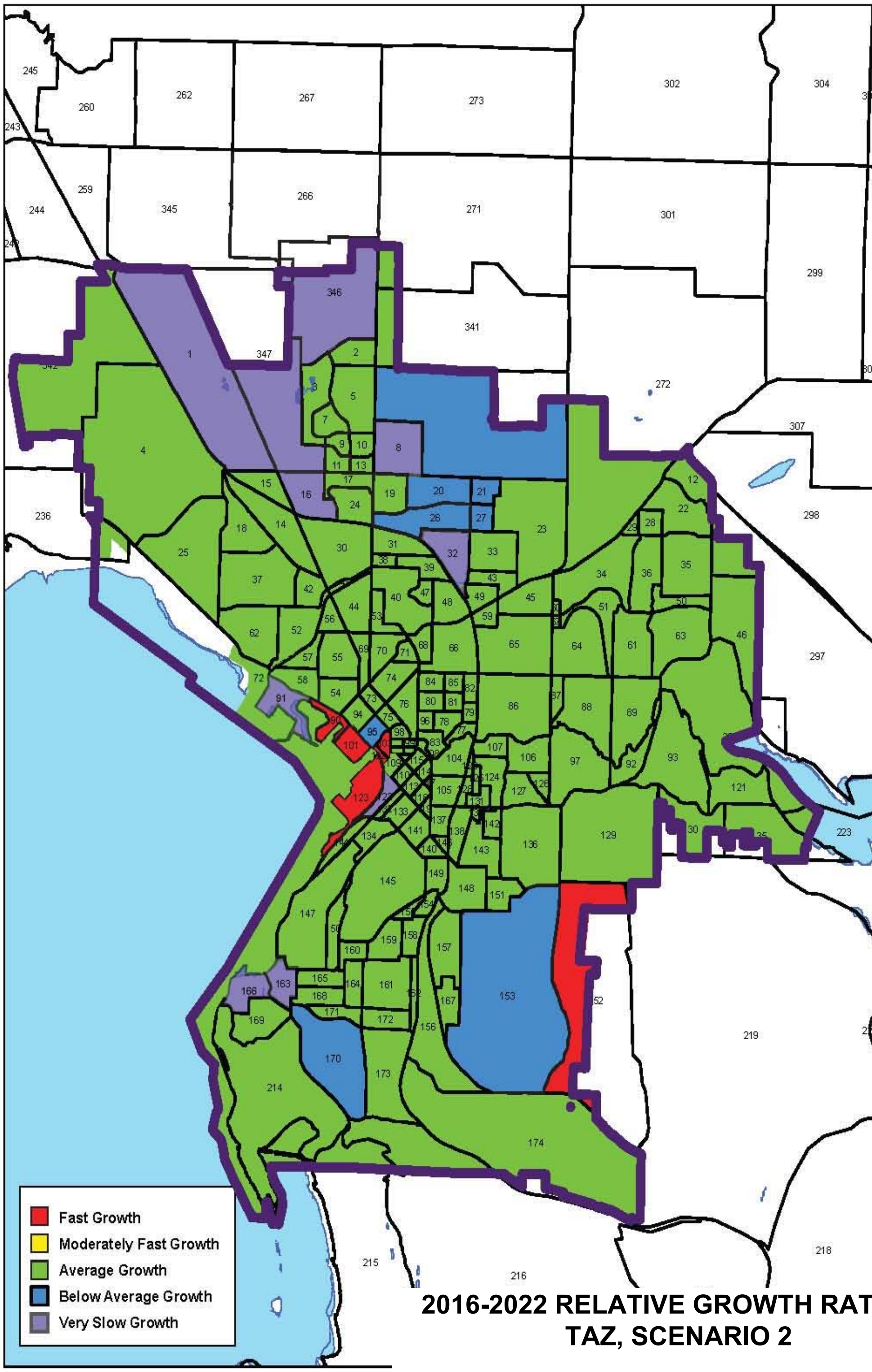


Source:
TAZ data: Bellingham Department of Public Works
Planning Area: "Zoning" file from COB GIS Website

2016-2022 RELATIVE GROWTH RATE BY TAZ, SCENARIO 2

FIGURE 3.7

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

Population projections for the Lake Whatcom Water & Sewer District (LWWSD) were not considered in the analysis, as this adjacent purveyor is limited based on flow rate. It is expected that the District will serve an additional 1,650 residences on the South Shore and an additional 50 to 100 on the North Shore within the next 20 to 25 years. While the District is adjacent to the City sewer service area and partially within the City's UGA (Geneva Neighborhood), there are no current plans to assume service.

3.4.3 Employment

Employment in the Greater Bellingham area has grown steadily with the population over the past 20 years. During this period, service and retail sector jobs have outpaced the growth experienced in other sectors (government, manufacturing, etc.) and now make up over 60 percent (2002 est.) of employment in the region. This trend is expected to continue over the next 20 years with the service sector growing at a more rapid pace than other sectors. Proportional to the rest of the county, it is estimated that Bellingham will employ 68 percent of the county's workforce by 2022, up from 62 percent in 2002.

3.4.3.1 Existing and Future Employment

Employment data analysis mirrored that of the population projections. The data was basically stratified into retail and non-retail categories with education-related jobs separated from the totals. Education related employment is included in the education totals. Allocations of employment values between the City limits and the UGA differed somewhat from City forecasts, but the overall totals were within 2 percent when education employment was removed from the calculation (not included in the ECO Northwest analysis).

The total estimated 2006 employment data analysis shows that the City limits contain 38,784 jobs, with the UGA also containing approximately 2,811 jobs. It is anticipated that the annual growth rate to 2026 in the UGA will be less than within the City, at an estimated 3.43 percent versus 5.02 percent. These estimates do not include education employment for 2006, 4,893, which is expected to increase by 0.7 percent per year over the next 20 years.

In addition to a constant growth rate projection (Scenario 1), a second projection (Scenario 2) was done based on the same growth rates used for the population forecast.

Current and projected employment levels for the City limits and UGA are shown in Table 3.5 and Table 3.6 for Scenario 1 and Scenario 2 respectively.

Table 3.5 Employment Distribution by Planning Area Scenario 1 – Constant Growth Rate
Comprehensive Sewer Plan
City of Bellingham

	2002	2006	2016	2022	2026
City Limits(1)	32,297	38,784	55,001	64,731	71,218
UGA(2)	2,472	2,811	3,658	4,166	4,505
Total	34,769	41,595	58,659	68,897	75,723

Notes:

1. Assumes a constant 5.02% annual growth rate.
2. Assumes a constant 3.43% annual growth rate.

Table 3.6 Employment Distribution by Planning Area Scenario 2 – Custom Variable Growth Rate
Comprehensive Sewer Plan
City of Bellingham

	2002(1)	2006	2012(2)	2016(2)	2022	2026(3)
City Limits(1)	32,297	38,784	51,725	59,406	64,731	71,218
UGA(2)	2,472	2,811	3,442	3,913	4,166	4,505
Total	34,769	41,595	55,166	63,319	68,897	75,723

Notes:

1. Based on available TAZ data.
2. Based on assumptions of timing and locations of future development.
3. Assumes a constant growth rate based on 2002 and 2022 populations.

Areas where significant growth in employment is expected to occur are anticipated to be built prior to 2016. Therefore, the 2016 employment for Scenario 2 is higher than that predicted by the constant growth rate in Scenario 1.

3.4.4 Education

There are several education facilities within the sewer service area. The Bellingham School District schools (K-12) include student population and employment totals. The Bellingham School District has completed growth projections through 2009, and this is included in the City's 2006 Comprehensive Plan. The sewage contribution from schools is included as it may vary from the anticipated population growth. For school population in 2016 and beyond, existing schools were assumed to be at capacity. Land has been purchased for another elementary school on Aldrich Road, which is also assumed to be at capacity by 2016. No planning data beyond 2009 is currently available from the School District.

In addition, there are the facilities of higher learning such as Western Washington University and Whatcom Community College. This and the education employment data were included in the TAZ data received from the City. Populations for Education Employment, K-12 Schools, and Higher Learning are shown by year in Table 3.7.

Table 3.7 Education Population
Comprehensive Sewer Plan
City of Bellingham

	2002	2006	2012	2016	2022	2026
Total Education Employment	4,744	4,893	5,118	5,267	5,491	5,640
Total Schools (K-12)	4,401	4,578	4,844	5,700	5,700	5,700
Total Higher Learning Students	21,142	21,312	21,567	21,736	21,991	22,161
Total	30,287	30,783	31,529	32,703	33,182	33,501

FLOW AND LOAD PROJECTIONS

4.1 INTRODUCTION

This chapter presents an evaluation of historical wastewater flow and loads entering the City of Bellingham's (City) Post Point Wastewater Treatment Plant (WWTP) and establishes flow and load projections for the future scenarios associated with anticipated growth based on population and land use.

4.2 PLANNING BASIS

4.2.1 Definitions

See the section entitled "Definitions" following the Table of Contents for a complete list.

4.2.2 Raw Sewage Flows and Loads

The WWTP influent flow has several distinct sources based on the contributors in the Post Point service area:

1. Residential flow and base infiltration.
2. Flow from the Lake Whatcom Water & Sewer District (LWWSD).
3. Commercial, industrial, and education system (employment flow).
4. Wet weather infiltration and inflow (I/I).

The flows from these sources have been grouped into these categories based on typical analysis procedures and the availability of information for each source. Residential flows include contribution from single as well as multifamily units. Commercial, industrial and education system flow are grouped together and defined as employment flow. Based on data the City uses to calculate sewer rates, approximately 30 percent of the 2003 wastewater flow was from employment sources. The Washington State Department of Ecology (DOE) currently maintains the list of industrial discharges for the City, which is summarized in Appendix G. Wet weather I/I flow is caused by rainfall events and includes contribution from connected impervious areas such as roof drains and catch basins (inflow), and groundwater (infiltration) leaking into the collection system.

4.2.3 Population and Employment

The service area population and employment forecasts were determined in Chapter 3, Demographic Analysis. Population, employment, and educational system estimates were provided by traffic analysis zones (TAZs) for the years 2002, 2006, 2012, 2016, 2022, and 2026. Values for the remaining years were estimated by linear interpolation.

The current and 2026 employment estimates for the City and Urban Growth Areas (UGAs) are assumed to be 100 percent sewered. However, not all residences within the City and UGA are currently sewered, and the percentage of sewered residences is expected to change over the planning period. The City's current unsewered fraction was assumed to be 14 percent based on data provided by the City that are used for calculating sewer rates. The current unsewered fraction of residential population within the UGA is estimated at 53 percent. This fraction was calculated by using a consistent per capita flow rate between the City and the UGA, and is based on the assumption that 9 percent of the residential wastewater flow comes from the UGA. By 2026 it was assumed that 100 percent of the population within the City and UGA would be sewered.

The LWWSD population estimates are 9,190 for 2004 and 13,335 for 2026, based on data provided in The Lake Whatcom District 10 Water and Sewer Comprehensive Plan (1991). LWWSD population estimates for the remaining years were estimated by linear interpolation and extrapolation.

The sewered population estimates are summarized in Appendix H.

4.2.4 Hydraulic Modeling

Hydraulic modeling described in Chapter 6 was used to estimate the current and future peak day and peak hour flows.

4.3 HISTORIC AND EXISTING FLOWS

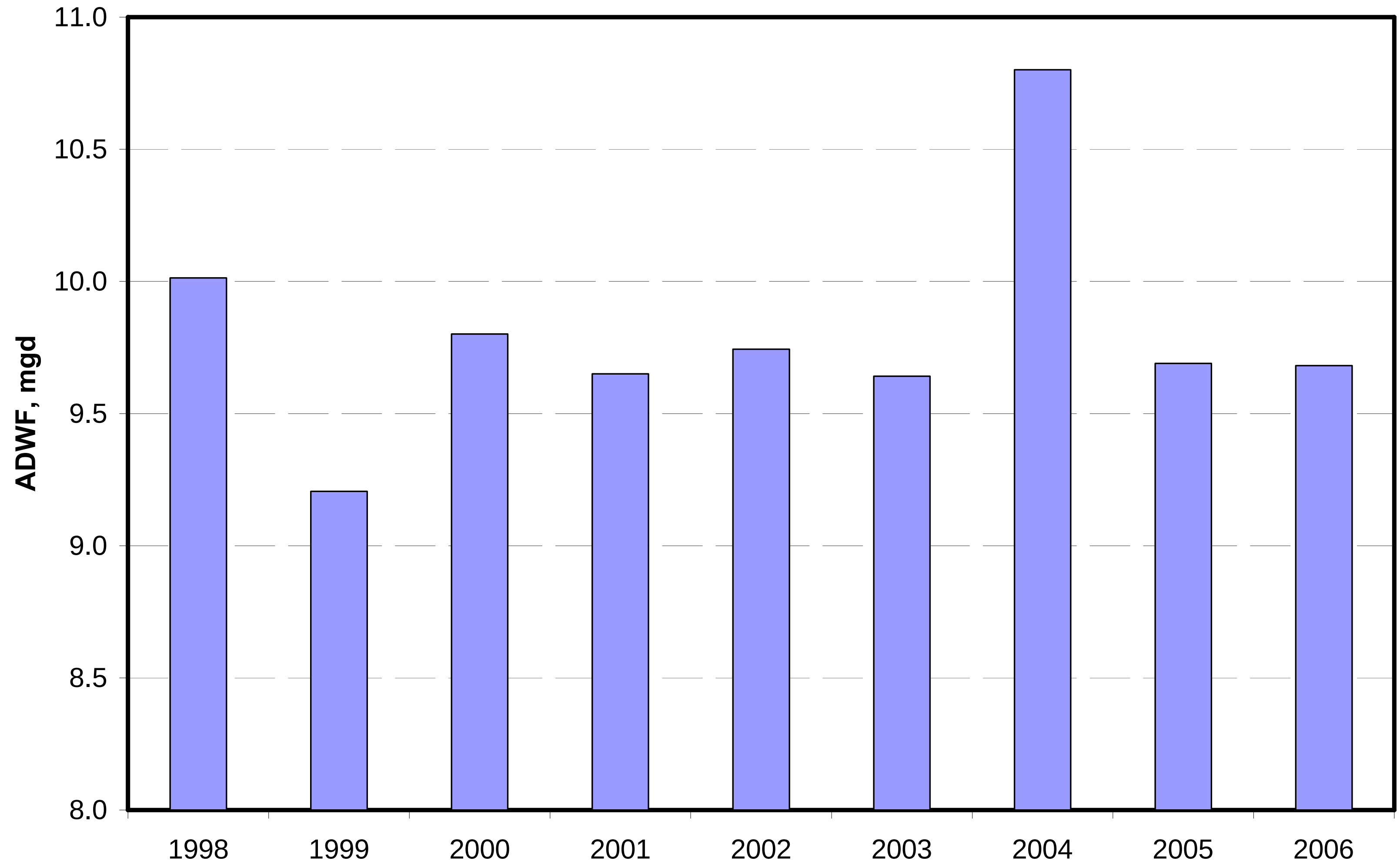
The following steps were taken to develop the historical flow analysis:

1. Develop the service area influent flows, which include residential, and employment flows.
2. Calculate peaking factors for the various flow parameters based on the historical flow data.
3. Utilize the Scenario 2 planning data summarized in Chapter 3 and estimate the sewered fraction of the population to develop unit flow factors reported as gallons per capita per day (gpcd).

4.3.1 Historic WWTP Influent Flows

The current flows tributary to the WWTP were estimated based on an analysis of the effluent flow records from 1998 though present, since WWTP influent flow data were not available for this analysis.

The average dry weather flow (ADWF) is defined as the low flow least affected by I/I. The ADWF was calculated as the average flow during the three driest months of the year (July through September). Figure 4.1 summarizes the historical ADWF. For these years of record, 2004 exhibits the highest ADWF caused by abnormally high precipitation during the dry weather season.



HISTORICAL ADW FLOW TREND

FIGURE 4.1

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The average annual flow (AAF) was determined by calculating the average of the average daily effluent flows for each year. The maximum month flows (MMF) were determined by calculating the maximum of the 30-day running averages of the average daily effluent flows. The peak day and peak hour flows were determined based on the maximum of the hourly-recorded effluent flows for each year.

Figure 4.2 plots the daily, weekly, and monthly average effluent flow from 1998 through 2006. Table 4.1 summarizes the ADWF, AAF, MMF, peak day flow (PDF), and peak hour flow (PHF) for that same period. Table 4.2 summarizes the flow peaking factors. The average of the peaking factors for each parameter is used to determine future flows.

Table 4.1 Post Point Historical Effluent Flow Summary
Comprehensive Sewer Plan
City of Bellingham

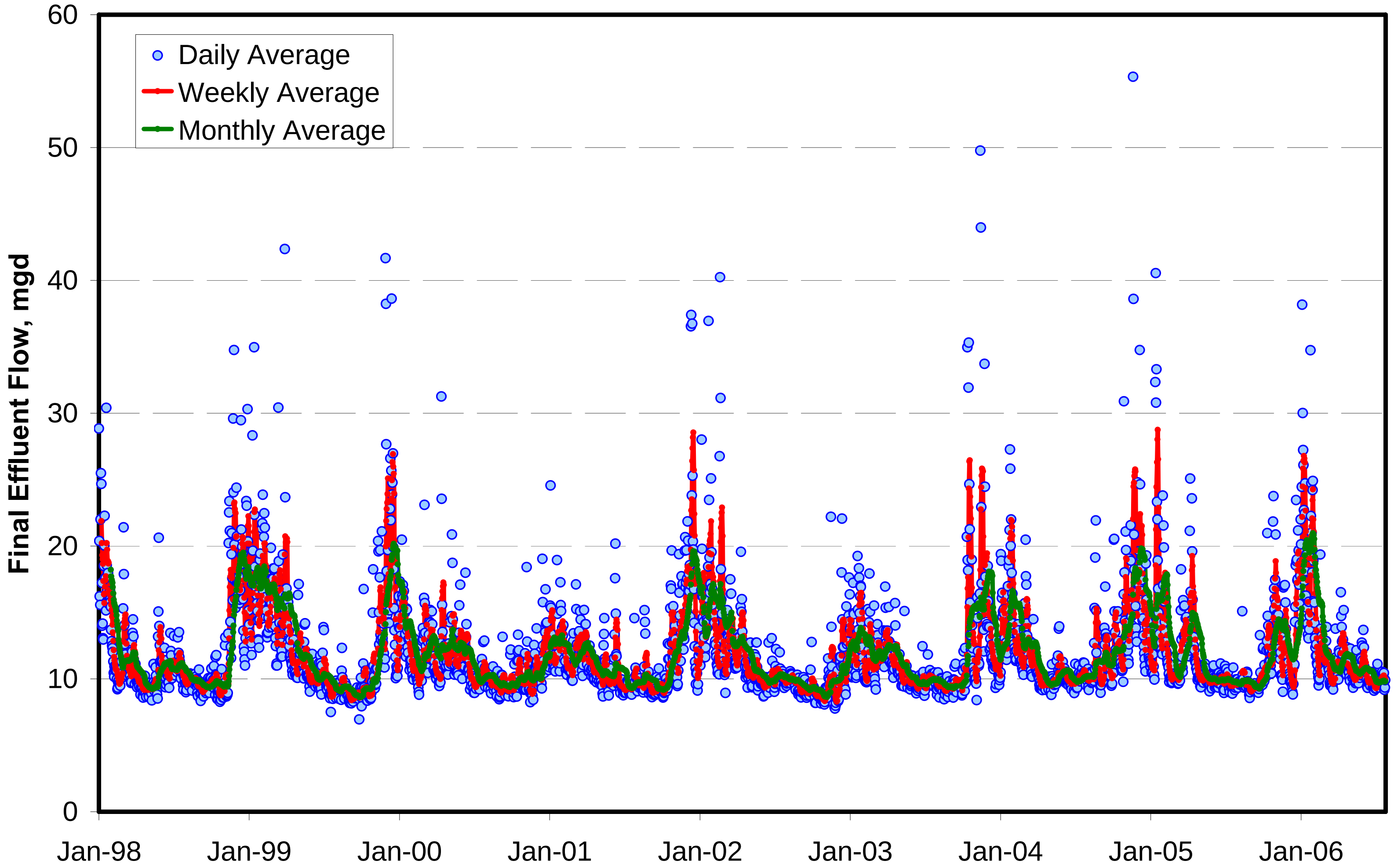
Flow, mgd	1998	1999	2000	2001	2002	2003	2004	2005	2006
ADWF	10.0	9.2	9.8	9.7	9.7	9.6	10.8	9.7	9.7
AAF	12.1	12.8	11.3	11.7	11.3	12.0	12.5	11.8	12.5
MMF	19.5	20.2	17.4	19.6	17.5	18.1	19.8	17.9	21.0
PDF	34.8	42.4	31.3	37.4	40.2	49.8	55.3	40.5	38.2
PHF							72.2	62.7	66.6

Table 4.2 Post Point Historical Flow Peaking Factor Summary
Comprehensive Sewer Plan
City of Bellingham

Flow PF(1)	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average PF
AAF	1.2	1.4	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.2
MMF	1.9	2.2	1.8	2.0	1.8	1.9	1.8	1.8	2.2	1.9
PDF	3.5	4.6	3.2	3.9	4.1	5.2	5.1	4.2	3.9	4.2
PHF							6.7	6.5	6.9	6.7

Notes:

(1) PF = peak factor. Peak factors calculated by dividing the flow by the ADWF.



AVERAGE POST POINT EFFLUENT FLOW

FIGURE 4.2

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4.3.2 Per Capita Flows

Per capita unit flow factors were calculated based on existing flow and population data to provide a basis for projecting future flows in the service area. The process used to estimate the per capita flow is as follows:

1. Estimate the total (residential and employment) wastewater flow using the City's methodology to estimate sewer rates, which starts from the total metered water use, and makes deductions for leaks, consumptive use and other losses. LWWSD water use and use from water customers that are not sewered (estimated at 14 percent) are also deducted.
2. Estimate the residential wastewater flow by subtracting out the billed employment (commercial and industrial) flows.
3. Estimate the wastewater flow generated within the city limits by multiplying Step 2 by 91 percent.
4. Determine the residential per capita flow by dividing the calculated residential wastewater flow generated within the city limits by the corresponding sewered residential population.

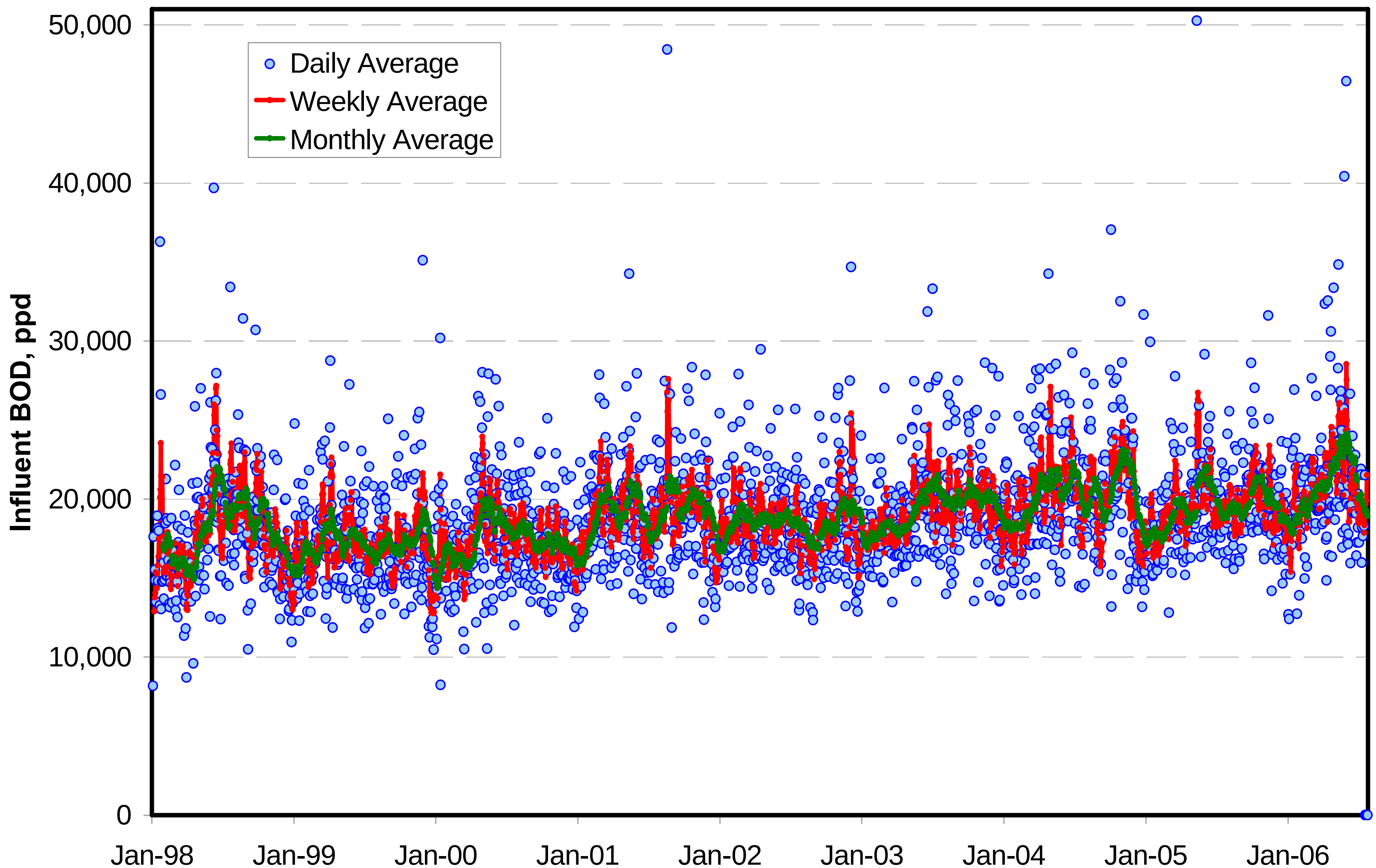
Using 2003 as the base year, the calculated residential per capita flow was 77 gpcd. This value does not include base I/I. The difference between the measured ADWF and the residential, commercial and LWWSD flows for the 2003 dry weather period equals the base I/I. When base I/I is included in the analysis, the resulting per capita flow is 102 gpcd. This equates to a base I/I of 1,460 gal/acre-d. The recommended per capita flow rate for future flow estimation is 102 gpcd.

4.4 HISTORIC AND EXISTING WASTEWATER LOADS

Wastewater loading data are important for sizing several critical treatment processes. The wastewater loading components of principal interest are the biochemical oxygen demand (BOD) and total suspended solids (TSS). WWTP operations staff measures influent TSS daily and influent BOD approximately 6 times per week.

4.4.1 Biochemical Oxygen Demand

The average daily, weekly, and monthly influent BOD loads and concentrations are presented in Figures 4.3 and 4.4, and Table 4.3 showing average annual (AA), maximum (MM), and peak day (PD) loads. Table 4.4 provides a summary of the historical load peaking factors.



POST POINT HISTORICAL INFLUENT BOD LOAD

FIGURE 4.3

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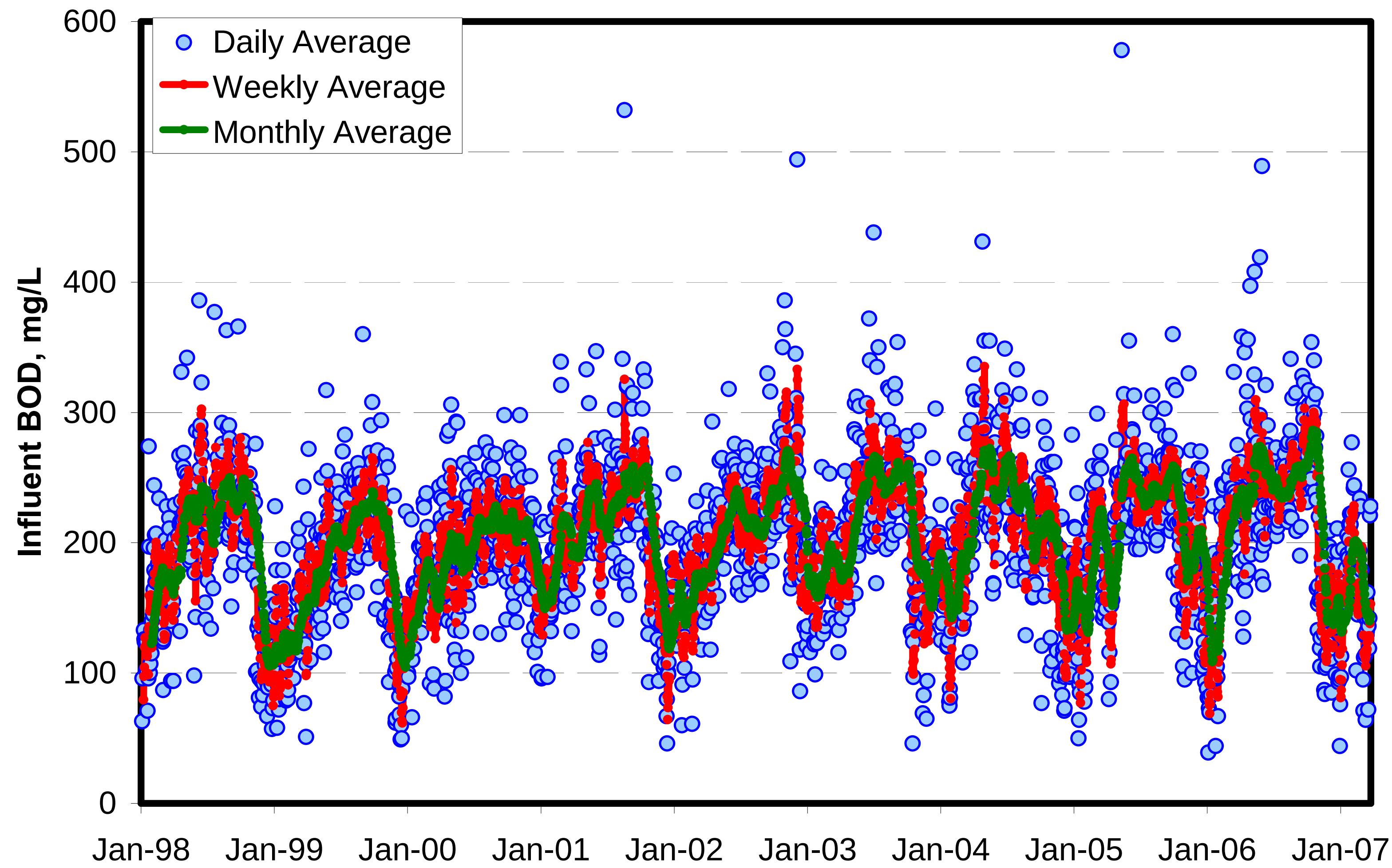

POST POINT HISTORICAL INFLUENT BOD CONCENTRATION

FIGURE 4.4

CITY OF BELLINGHAM
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Table 4.3	Post Point Historical Influent BOD Loadings Summary Comprehensive Sewer Plan City of Bellingham								
Load ppd	1998	1999	2000	2001	2002	2003	2004	2005	2006
AA	17,800	17,200	17,400	19,200	18,500	19,300	20,200	19,500	20,800
MM	22,000	19,300	20,000	21,400	20,000	21,500	23,100	22,000	24,100
PD	39,700	35,100	30,200	48,500	34,700	33,300	37,000	50,300	46,500

Table 4.4	Post Point Historical BOD Peaking Factor Summary Comprehensive Sewer Plan City of Bellingham									
Load PF(1)	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average PF
MM	1.2	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.2	1.1
PD	2.2	2.0	1.7	2.5	1.9	1.7	1.8	2.6	2.2	2.1

Note:
(1) PF = peak factor, calculated by dividing the load by the average annual load.

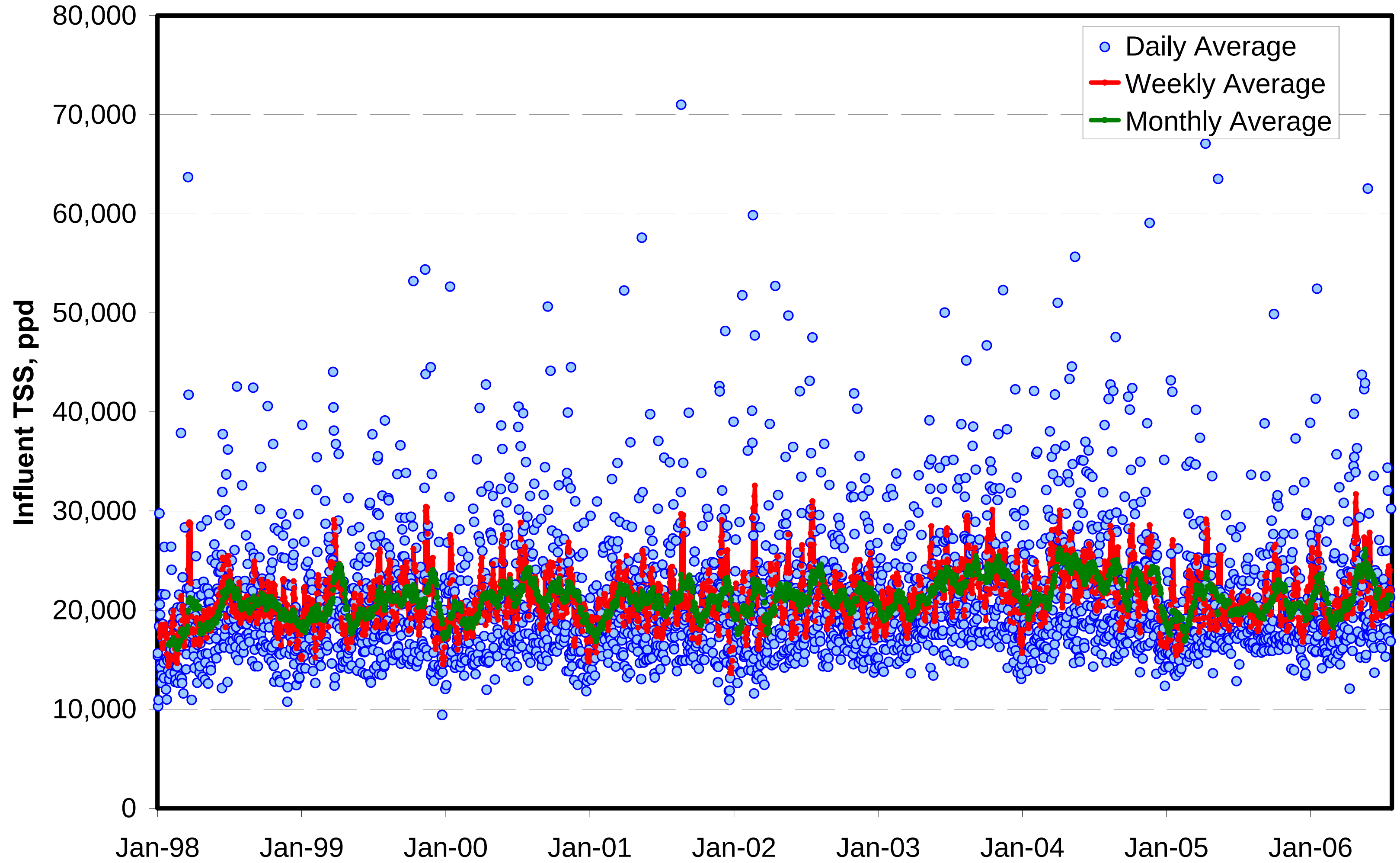
4.4.2 Total Suspended Solids

The average daily, weekly, and monthly influent TSS loads and concentrations are presented in Figures 4.5 and 4.6, and Table 4.5. Table 4.6 provides a summary of the historical load peaking factors.

Table 4.5	Post Point Historical Influent TSS Loading Summary Comprehensive Sewer Plan City of Bellingham								
Load ppd	1998	1999	2000	2001	2002	2003	2004	2005	2006
AA	19,600	20,600	21,000	20,700	21,300	22,200	22,700	20,400	21,200
MM	22,900	24,600	24,200	23,600	24,600	25,400	26,200	23,800	26,100
PD	63,700	54,400	52,600	71,000	59,800	52,300	59,100	67,100	62,500

Table 4.6	Post Point Historical TSS Peaking Factor Summary Comprehensive Sewer Plan City of Bellingham									
Load PF(1)	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average PF
MM	1.2	1.2	1.2	1.1	1.2	1.1	1.2	1.2	1.2	1.2
PD	3.3	2.6	2.5	3.4	2.8	2.4	2.6	3.3	2.9	2.9

Note:
(1) PF = peak factor.



POST POINT HISTORICAL INFLUENT TSS LOAD

FIGURE 4.5

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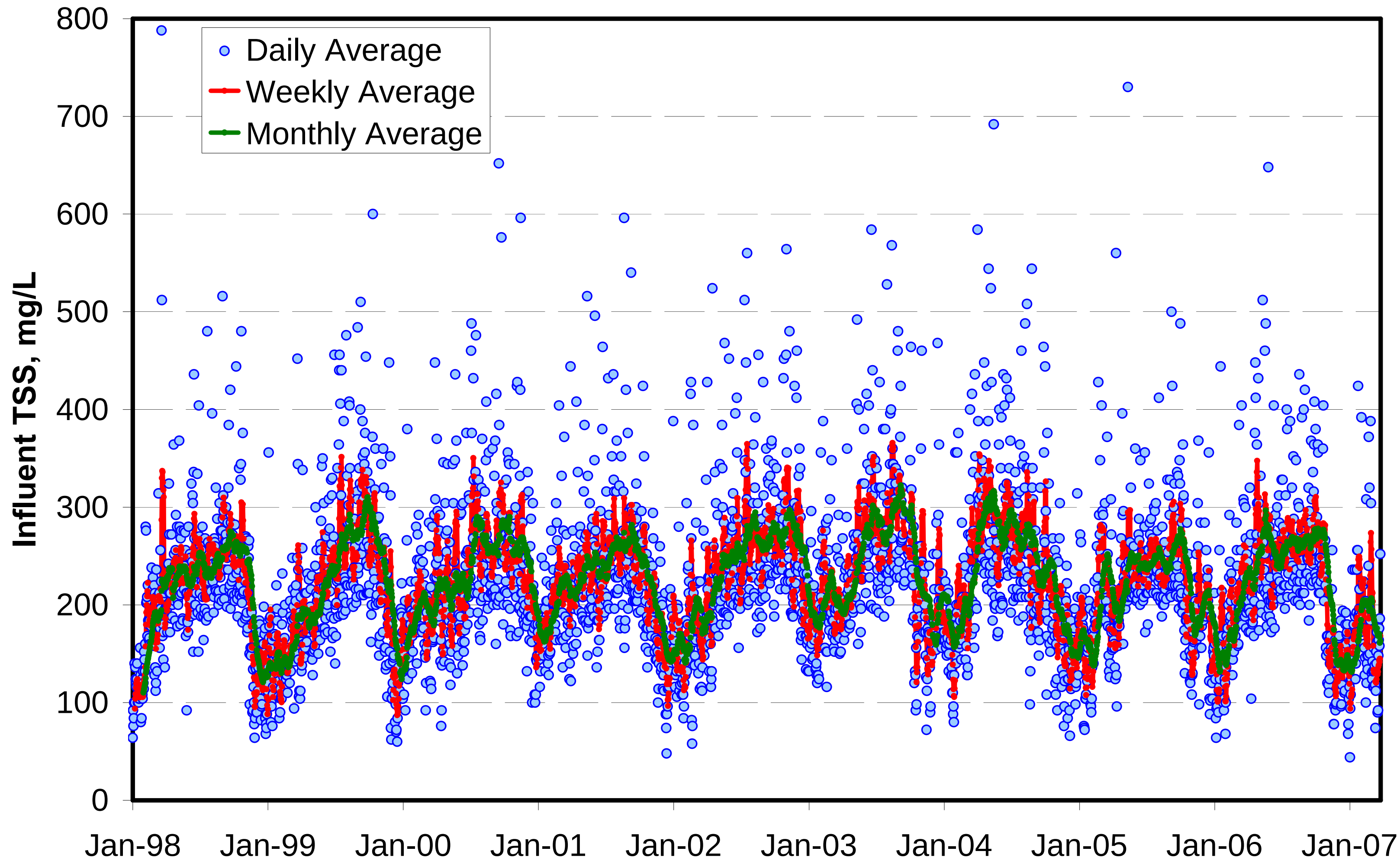

POST POINT HISTORICAL INFLUENT TSS CONCENTRATION

FIGURE 4.6

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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4.4.3 Per Capita Loads

Per capita unit load factors were calculated based on existing load and sewered population data to provide a basis for projecting future loads in the service area. The process used to estimate the per capita loads is as follows:

1. Estimate the commercial load by multiplying the estimated commercial flow (Section 3.2) by an assumed commercial BOD and TSS concentration of 220 mg/L (consistent with the City's methodology for estimating sewer rates).
2. Subtract the commercial load from the total average annual load to determine the residential load.
3. Divide the residential load by the sewered residential population, which includes population within the City limits, the UGA, and the LWWSD.

Table 4.7 provides a summary of the historical per capita BOD and TSS loads. The average BOD and TSS historical residential per capita loads are 0.20 ppcd and 0.23 ppcd, respectively.

Table 4.7 Historical BOD and TSS Per Capita Loads
Comprehensive Sewer Plan
City of Bellingham

Year	BOD, ppcd	TSS, ppcd
1998	0.20	0.23
1999	0.19	0.24
2000	0.19	0.24
2001	0.21	0.23
2002	0.19	0.23
2003	0.20	0.24
2004	0.20	0.24
2005	0.19	0.20
2006	0.20	0.20
Average	0.20	0.23

4.5 FLOW AND LOAD PROJECTIONS

Flow and load projections are developed using current flows and loads and anticipated community growth. Population projections developed in Chapter 3 along with assumed sewered fractions were used to define per capita flows and loads for the residential (including base I/I) portion of the population. Per capita rates were then used to project the base flow (ADWF) and load (AA) to the 2026 scenario.

4.5.1 Flow Projections

The future ADWF was estimated by projecting each component of the ADWF. Residential and base I/I was projected using the per capita flow rate of 102 gpcd, and the assumed sewered population within the City and UGA, which were both assessed to increase linearly from the current levels to 100 percent over the planning period. Flow from commercial and industrial sources was assumed to increase proportionally with employment growth. The base LWWSD flow was increased using the per capita rates developed in the LWWSD Comprehensive Plan Update to reflect the LWWSD population growth (LWWSD 2004).

The remaining flows (AAF, MMF) were then projected by applying the peaking factors, developed in Table 4.2, to the projected ADWF. Table 4.8 summarizes the projected flows for 2016 and the design year 2026 and includes the flows for year 2005 for comparison. Appendix H details the projected flows for each year between 2005 and 2026. The 2026 peak day and peak hour flow projections were extracted from the hydraulic model results described in Chapter 5.

Since the ADWF is determined for the months of July though September, the student population from the education data is not factored into the projection of the ADWF. The impact of the students will be seen in the AAF and is incorporated in the peak factors determined from historical data.

Table 4.8 Flow Projections
Comprehensive Sewer Plan
City of Bellingham

Flow	2005 Flows, mgd(1)	2016 Flows, mgd	2026 Flows, mgd
ADWF	10.2	14.0	17.7
AAF	12.5	17.2	21.7
MMF	19.8	27.3	34.3
PDF	52.9	58.8	64.2
PHF(2)	67.3	72	72

Notes:
(1) Flows reflect the projected 2005 flows based on the applied growth rate from the base flow calculated from the 2003 data, and are slightly higher than recorded flows in 2005.
(2) Flows capped at 72 mgd with either storage or high rate treatment in the system. Refer to Chapter 7 for more details on these conveyance options.

4.5.2 Load Projections

The AA BOD and TSS loads were projected by projecting both the residential and employment loads. The residential BOD and TSS loads were projected based on the per capita load of 0.20 ppcd for BOD and 0.23 ppcd for TSS and the assumed sewered population within the City, UGA and LWWSD. Commercial and employment BOD and TSS loads were increased by the employment growth rate.

The MM and PD loads were then determined by multiplying the AA load by the selected peaking factors for BOD (Table 4.4) and TSS (Table 4.6). The projected loads for BOD and TSS are summarized in Table 4.9 and detailed in Appendix H.

Table 4.9 BOD and TSS Load Projections
Comprehensive Sewer Plan
City of Bellingham

Load	2005 BOD, ppd	2016 BOD, ppd	2026 BOD, ppd	2005 TSS, ppd	2016 TSS, ppd	2026 TSS, ppd
AA	20,200	27,800	35,000	22,600	30,900	39,000
MM	23,000	31,700	39,900	26,300	36,100	45,500
PD	42,100	57,900	73,000	64,700	88,700	111,900

4.5.3 Potential for BOD Load Reduction

The projections shown in Table 4.9 assume a projection of “baseline” conditions for three major contributors of total BOD load to the WWTP: 1) domestic (including residential and commercial); 2) industrial (as summarized in Appendix G); and 3) septage. The majority of the BOD currently treated at the WWTP, approximately 80 percent of the maximum month load, comes from domestic sources. Separately measured industrial loads comprise approximately 17 percent of the load, with the remainder coming from septage haulers. Both domestic and industrial BOD loads may be reduced by implementing conservation measures and/or more restrictive limits on industrial sources.

Domestic BOD may be reduced by limiting the component of the load that comes from food waste, which primarily enters the collection system from in-home food waste disposers (FWDs) and other commercial (e.g. restaurant) sources. The portion of total BOD that comes from food waste is variable, and the fraction of domestic BOD from food waste is not well documented. Literature values (Metcalf & Eddy, Inc., Third ed.) as well as those prepared by the Environmental Protection Agency (EPA/625/R-00/008) suggest that in-home FWDs can contribute from 20 to 65 percent of the per capita total BOD in typical residential wastewater. Reductions in this load source can be achieved by implementing public educational programs and/or by banning FWDs in new construction. Commercial and restaurant BOD can be limited by monitoring and regulating discharges of bulk food waste. Fats, Oil and Grease (FOG) may add somewhat to the BOD load, but is primarily regulated to reduce sewer line blockage and associated maintenance in sewer collection systems.

The composition of total BOD from residential FWDs and commercial sources must be considered when evaluating the potential impact of BOD load reductions on plant capacity. Total BOD is comprised of two components: particulate BOD and soluble BOD. A large majority of particulate BOD is “settleable” or “floatable”, and is removed in the primary treatment step. Reducing the amount of particulate BOD in the influent stream may not significantly reduce the need for secondary capacity. The BOD composition in food waste is not well documented, but may be assumed to be largely particulate based on the nature of the waste stream. Additional evaluation of the composition of these BOD sources is needed to confirm their impact on the capacity needed at the WWTP.

Industrial BOD may be reduced by increasing the level of pre-treatment prior to discharge into the City’s collection system. As shown in Appendix G, there are a number of separately monitored and controlled industrial discharges in the City’s sewer service area. Achieving a reduction of BOD loading from industrial sources is most typically achieved by increasing the cost of providing sewer service, which provides incentive to reduce loads on-site prior to discharge. Depending on the type of industry, industrial BOD may be highly soluble. Therefore, reducing industrial BOD entering a WWTP can often lead to a significant reduction in the amount of secondary capacity required.

COLLECTION SYSTEM INVENTORY

5.1 INTRODUCTION

The purpose of this Chapter is to provide an inventory of the City of Bellingham's (City) current collection system tributary to the Post Point Wastewater Treatment Plant (WWTP). The City's collection system is classified as a Combined Sewer System (CSS). This Chapter describes the physical assets of the collection system basins, including pipelines, manholes, pump stations, and the Combined Sewer Overflow (CSO) structure at C Street.

5.2 SYSTEM DESCRIPTION

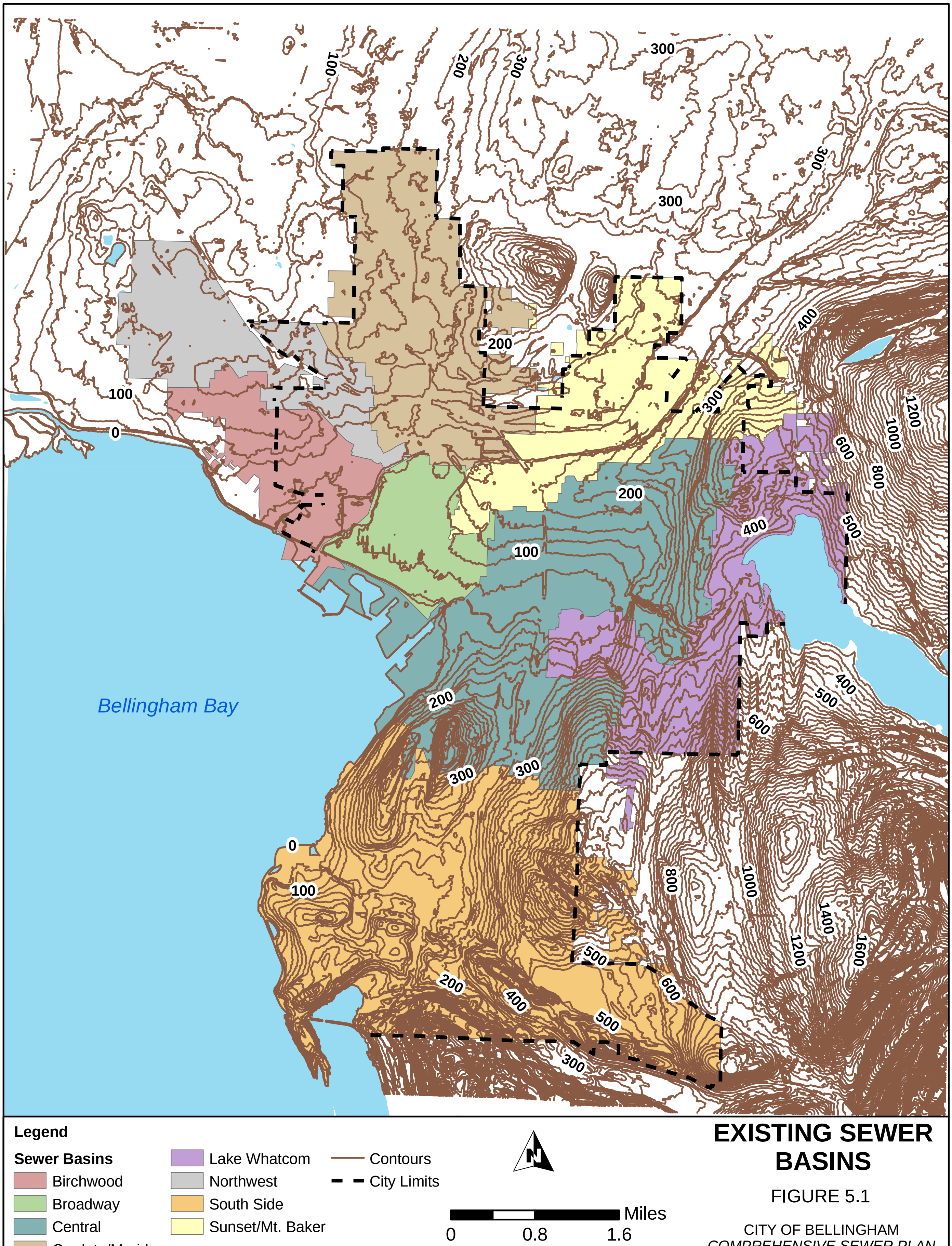
The City operates and maintains approximately 324 miles of sewer mains and force mains, servicing an estimated 26,100 residential service connections. The system includes 27 pump stations and associated force mains, and one CSO structure. The collection system covers an area of approximately 30 square miles.

5.2.1 Drainage Basins

The City has eight sewage drainage basins: Birchwood, Broadway, Central, Cordata/Meridan, Lake Whatcom, Northwest, South Side, and Sunset Beach/Mt. Baker. Table 5.1 and Figure 5.1 show the characteristics and locations of the basins. The Birchwood and Northwest drainage basins encompass the most northwest corner of the City, with the Cordata/Meridan and Sunset Beach/Mt. Baker basins encompassing the central-northern and northeast portions of the City. The Broadway Drainage Basin encompasses the downtown with the Central Basin encompassing the central portion of the city. The Lake Whatcom Basin encompasses the Lake Whatcom area and the South Side Basin encompasses the southern portion of the City.

Table 5.1 Existing Sewer Basin Summary
Comprehensive Sewer Plan
City of Bellingham

Basin	Area, acre	Sewer Pipe Length, ft
Birchwood	1,138	96,163
Broadway	865	145,610
Central	3,921	468,553
Cordata/Meridian	2,383	121,743
Lake Whatcom	2,165	229,751
Northwest	1,389	61,018
South Side	5,348	393,356
Sunset/Mt. Baker	3,002	166,343
Total	**19,211**	**1,682,537**



EXISTING SEWER BASINS

FIGURE 5.1

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5.2.2 Pipelines and Manholes

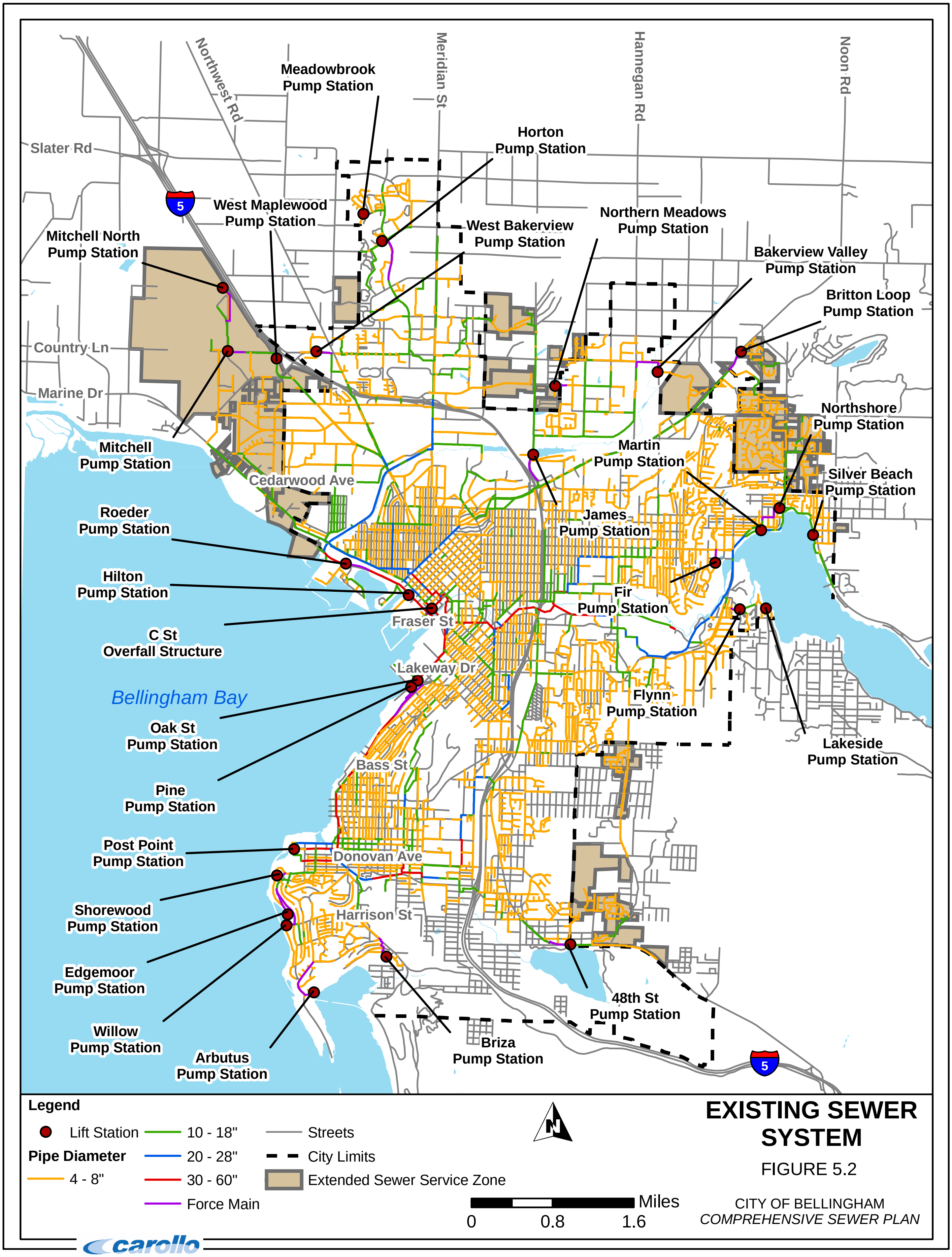
The sewer collection system shown in Figure 5.2 consists of approximately 318 miles of sewer mains and 6 miles of force mains associated with the City's 27 pump stations. The sewers range in diameter from 4 inches to 60 inches, with the majority of pipes between 4 and 8 inches in diameter. A summary of the piping by diameter is shown in Table 5.2. Trunk and Interceptor sizes and data are shown in Table 5.3. The sewer system ranges in age from 114 years to new, with an average age of 34 years. Piping installed in the 1890s and early 1900s was primarily constructed of vitrified clay while the more recent portions of the conveyance system are primarily constructed of polyvinyl chloride (PVC) and high density polyethylene (HDPE).

Table 5.2 Existing Sewer System Piping Summary
Comprehensive Sewer Plan
City of Bellingham

Pipe Diameter(1)	Length of Pipe(1)	Number of Pipe Segments
4 to 8 inches	240 miles	5,659
10 to 18 inches	59 miles	1,188
20 to 28 inches	10 miles	198
30 inches plus	9 miles	161
Force mains(2)	6 miles	25
Total	**324**	**7,231**

Notes:
(1) Data from the City of Bellingham Sewer System map updated on 12/12/2005.
(2) Force mains range in diameter from 4 inches to 48 inches. One segment is assumed per force main.

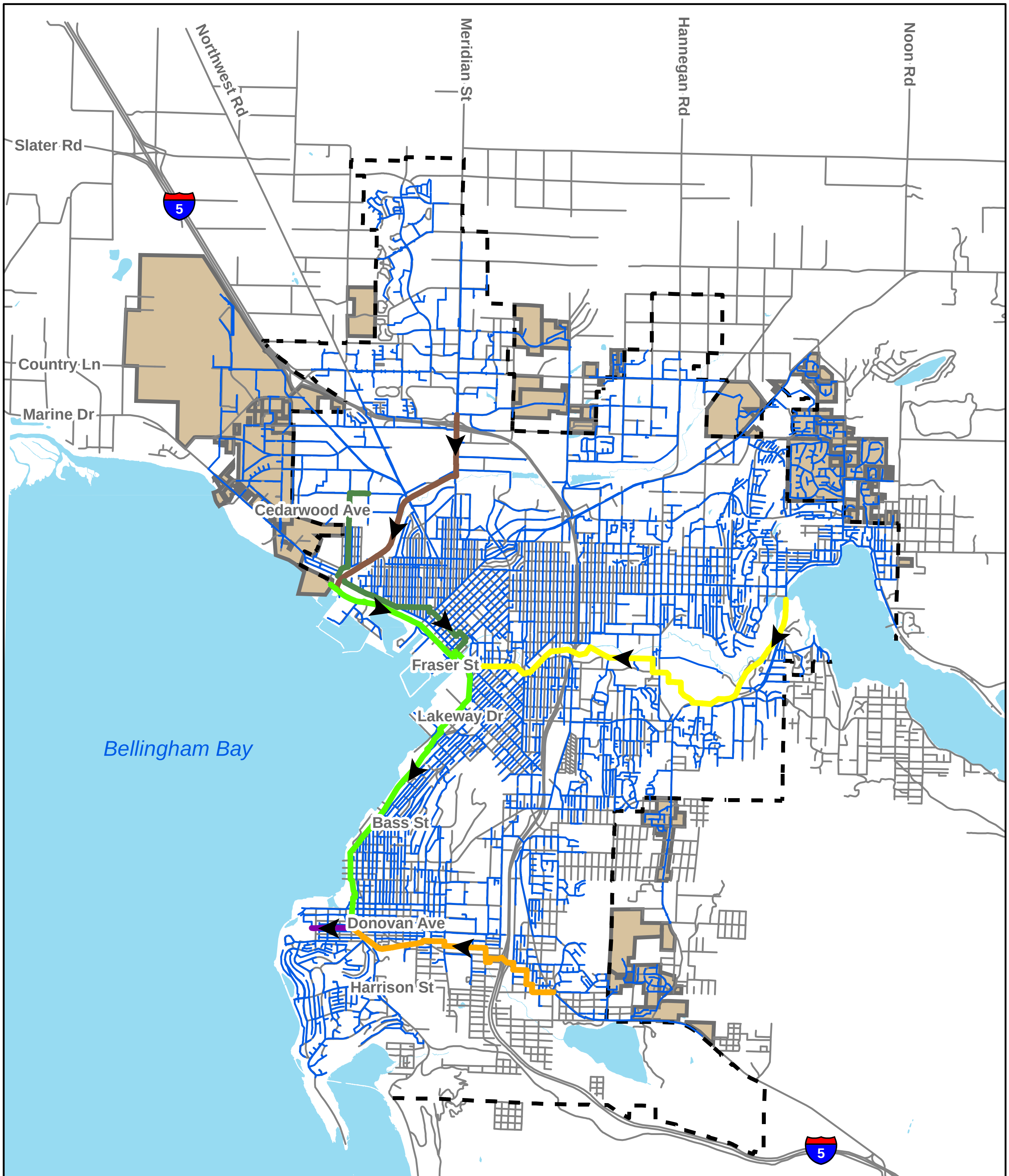
Sewer pipes in the collection system feed to four main trunks, which convey the sewage to two interceptors that lead to the WWTP. Trunk and interceptor sewers are summarized in Table 5.3 and Figure 5.3. The H_2O map hydraulic model was used to identify the capacities of the existing trunk and interceptor sewers. A working copy of the model is included in Appendix I. The Birchwood Trunk serves the northwest portion of the City and follows Birchwood Avenue to Patton Street, then runs along Bancroft to C Street. The Squalicum Trunk serves the north portion of the city and runs along Meridian Street to the Squalicum Parkway. The Champion/Silverbeach Trunk serves the eastern portion of the city and starts at the west side of Lake Whatcom, follows Silverbeach, and then roughly follows the Whatcom Creek to Champion Street. The Happy Valley Trunk serves the southern portion of the city. The trunk starts at 40th and Harrison Streets and travels west to 10th Street and West Fairhaven Parkway.



EXISTING SEWER SYSTEM

FIGURE 5.2

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN



Legend

Flow Direction

Interceptor

- Birchwood Trunk
- Champion/Silverbeach Trunk
- Donovan Avenue Interceptor
- Happy Valley Trunk
- Squalicum Trunk
- Waterfront Interceptor
- Submains
- Streets
- City Limits
- Extended Sewer Service Zone

N

Miles
0 0.8 1.6

EXISTING TRUNKS AND INTERCEPTORS

FIGURE 5.3

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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Table 5.3 Trunk and Interceptor Sewer Data
Comprehensive Sewer Plan
City of Bellingham

<table>
<tr><th>Interceptor/Trunk</th><th>Diameter (in)</th><th>Length (ft)</th><th>Average Slope (ft/ft)</th><th>Capacity(1) (gpm)</th><th>Manholes</th><th>Installation year</th><th>Age year</th><th>Material(2)</th></tr>
<tr><td>Birchwood</td><td>12-48</td><td>13,695</td><td>0.0048</td><td>12,977</td><td>58</td><td>1924, 1958, 1959, 1961, 1974, 1999</td><td>7 - 82</td><td>CI, RC</td></tr>
<tr><td>Champion/Silverbeach</td><td>15-48</td><td>21,030</td><td>0.0146</td><td>29,919</td><td>83</td><td>1908, 1909, 1980, 1991, 1997</td><td>9 - 98</td><td>RC, PVC</td></tr>
<tr><td>Donovan</td><td>60</td><td>1,757</td><td>0.004</td><td>30,498</td><td>5</td><td>1974</td><td>32</td><td>RC</td></tr>
<tr><td>Happy Valley</td><td>8-30</td><td>13,392</td><td>0.032</td><td>10,528</td><td>54</td><td>1948, 1949, 1966, 1973, 1975 - 1979, 1990, 1998</td><td>8 - 58</td><td>RC, PVC</td></tr>
<tr><td>Squalicum</td><td>18-36</td><td>12,712</td><td>0.008</td><td>1,521</td><td>50</td><td>1970, 1983 - 1986, 1993</td><td>13 - 36</td><td>RC, PVC</td></tr>
<tr><td>Waterfront Upstream from Oak Street</td><td>30-60</td><td>8,347</td><td>0.0015</td><td>47,336</td><td>27</td><td rowspan="2">1908, 1971, 1973, 1974, 1975, 1978, 1980, 1983</td><td rowspan="2">23 - 98</td><td rowspan="2">RC, DI, PVC</td></tr>
<tr><td>Waterfront Downstream from Oak Street</td><td>48-60</td><td>8,717</td><td>0.006</td><td>27,386</td><td>22</td></tr>
</table>

<u>Notes</u>:

(1) Limiting capacity calculated as d/D = 2/3 for the downstream segment of the trunk or interceptor, the capacity decreases upstream with decreasing pipe size. The model study identified segments with limited capacity.

(2) CI = Cast Iron, RC = Reinforced Concrete, PVC = Polyvinyl Chloride, DI = Ductile Iron.

The Waterfront Interceptor runs along Bellingham Bay to the Donovan Street Interceptor and collects the sewage from the Birchwood, Squalicum, and Champion/Sliverbeach Trunks. The Donovan Avenue interceptor runs along Donovan Avenue to the Post Point WWTP and collects the water from the Waterfront Interceptor and the Happy Valley Trunk. The trunks and interceptors range in diameter from 8 inches to 60 inches and range in age from 8 to 98 years old, with an average age of 40 years. The majority of these pipelines are constructed of reinforced concrete pipe (RCP), with some sections constructed of PVC

5.2.3 Pump Stations

The collection system includes 27 pump stations that were installed between 1966 and 2005. Each pump station contains a Supervisory Control and Data Acquisition (SCADA) system. These stations each include two pumps (with the exception of the Roeder Pump Station which has three pumps and the Oak Street Pump Station which has five pumps) with total capacities ranging between 86 and 52,778 gallons per minute (0.12 to 76 mgd). Specific details on each pump station are summarized in Table 5.4.

The pump station capacities in Table 5.4 are reported for each pump, and show the firm and total capacity of each pump station. The firm capacity is the capacity of the pump station with the largest pump out of service. The total capacity is capacity of the pump station with all pumps running at their operating points. The majority of the pump stations have capacities less than 2,000 gallons per minute (gpm), with the exception of the Oak Street Pump Station.

The City identified concerns with the two large pump stations: the Oak Street and Roeder Avenue Pump Stations (Earth Tech 1988). The original Oak Street Pump Station was designed for a capacity of 55 million gallons per day (mgd). The 1998 report stated that the capacity of the Oak Street Pump Station had been a concern of the City for years. However, the 1995 pump test indicated that the pump station capacity was 48.5 mgd with four pumps in service and 49.6 mgd with five pumps in service. Since the original pump capacity test, the City had replaced the Oak Street pump casings and the pump drives. Based on these modifications, the Oak Street Pump Station capacity increased to 76 mgd. The 1998 report also identified significant reduction in pump performance at the Roeder Avenue Pump Station. To address this problem, the City replaced the drives at the Roeder Avenue Pump Station.

Table 5.4 Existing Sewage Pump Station Summary
Comprehensive Sewer Plan
City of Bellingham

Pump Station	Type of Pump	Year Installed	Tested Capacity(1)						Comments
			Pump #1 (gpm)	Pump #2 (gpm)	Firm Capacity (gpm)	Firm Capacity (mgd)	Total Capacity (gpm)	Total Capacity (mgd)	
48th Street (Lake Padden)	Dry/Wet Well	1973	657	511	657	0.95	927	1.33	Install on-site generator; planned for 2009
Arbutus	Surface Mount Wet Well	1981	90	94	90	0.13	148	0.21	Site should be replaced due to flooding potential; possibly in 2009
Bakerview Valley	Submersible	1996	147	145	147	0.21	183	0.26	
Brighton Loop		Post 1998							
Briza Court	Submersible	1986	705	691	705	1.01	830	1.20	
C Street	Dry/Wet Well	1973	413	334	413	0.59	567	0.82	
Fir	Dry/Wet Well	1977	146	140	146	0.21	173	0.25	
Flynn	Dry/Wet Well	1966	525	532	525	0.76	696	1.00	Link to the Lakeside Station in future
Hilton	Dry/Wet Well	1973	1,276	1,217	1,276	1.84	1,636	2.36	
Horton	Submersible	1988	749	779	749	1.08	972	1.40	
James	Submersible	1985	1,667	1,685	1,667	2.40	1,968	2.83	
Lakeside	Submersible	1968							
Martin	Dry/Wet Well	1973	338	395	338	0.49	1,184	1.70	
Meadowbrook Court	Submersible	1997	186	198	186	0.27	234	0.34	
Mitchell Way	Submersible	1972	162	169	162	0.23	187	0.27	
North Mitchell Way		Post 1998							
North Shore	Dry/Wet Well	1980	1,623	1,657	1,623	2.34	2,206	3.18	
Northern Meadows		Post 1998							
Oak Street	Dry/Wet Well	1974							
Old Edgemoor	Dry/Wet Well	1966	147	147	147	0.21	166	0.24	

Table 5.4 Existing Sewage Pump Station Summary
Comprehensive Sewer Plan
City of Bellingham

Pump Station	Type of Pump	Year Installed	Tested Capacity(1) Pump #1 (gpm)	Pump #2 (gpm)	Firm Capacity (gpm)	Firm Capacity (mgd)	Total Capacity (gpm)	Total Capacity (mgd)	Comments
Pine	Submersible	1977	233	218	233	0.34	460	0.66	To be removed and replaced with a gravity main to Oak Street with new development in the area
Roeder	Dry/Wet Well	1976							
Shorewood	Surface Mount Wet Well	1979	71	63	71	0.10	86	0.12	To be replaced late 2008
Silver Beach	Dry/Wet Well	1973	571	569	571	0.82	1,164	1.68	
West Bakerview	Submersible	1998	251	254	251	0.36	407	0.59	
West Maplewood	Dry/Wet Well	1973	565	572	565	0.81	672	0.97	
Willow Road	Submersible	1985	356	347	356	0.51	417	0.60	Replace on-site generator late 2008

Notes:

(1) Pump station capacity tests were performed on all pump stations by the City in 1989. Pump station capacity tests were repeated on the upgraded Oak Street, Roeder and Lakeside pump stations in 1995. Pump capacity tests were not performed on the new Brighton Loop, North Mitchell Way and Northern Meadows pumps stations in 1989.

5.2.4 Overflow Structures

The Post Point WWTP began operation in 1974, treating flows collected from the Whatcom Creek Plant by way of the Oak Street Pump Station and the Waterfront Interceptor Sewer. Between 1974 and 1987 numerous storm water separation projects were completed, reducing four overflow points to one at the C Street overflow structure. These projects also significantly reduced the average overflow frequency. The frequency of CSO events was evaluated using the collection system modeling, as described in Chapter 6.

The C Street overflow is located near the downstream end of the Birchwood Trunk and is also connected to the Champion/Silverbeach Trunk via a looped connection. The structure was rebuilt in 2005 to raise the weir elevation. The structure consists of a precast vault installed inline with the 48-inch diameter truck, having internal dimensions of 8 feet 6 inches wide by 14 feet long. There is a sharp crested adjustable side channel weir along complete 14-foot length. The weir is currently set at elevation 16.4 feet, and the inflow pipe invert is at 9.06 feet. There are two 36-inch diameter overflow outlet pipes connecting the portion of the chamber on the downstream side of the weir to an abandoned storm drainage tunnel. The pipes connect with the tunnel at an invert elevation of 9.3 feet. The tunnel discharges combined sewer overflows several hundred feet downstream into Bellingham Bay.

Chapter 6

COLLECTION SYSTEM ANALYSIS

6.1 INTRODUCTION

The purpose of this Chapter is to evaluate the capacity of the City's primary conveyance system. The primary conveyance system components include the C Street combined sewer overflow (CSO) structure, Oak Street Pump Station (Oak Street), a gravity line connecting the C Street CSO structure to the pump station, two force mains from the pump station, and a gravity interceptor from the end of the force mains to the Post Point Wastewater Treatment Plant (WWTP). During peak wet weather flow events, the flow in the interceptor is operationally limited by setting a pumping rate between 55 and 60 mgd at Oak Street. The WWTP has a capacity of 72 mgd. Up to 12 mgd can enter the interceptor downstream from Oak Street from basins in the southern portion of the system. Modeling indicates that portions of the interceptor downstream from Oak Street are close to capacity at 60 mgd.

This Chapter summarizes the modeling of design storms, and presents future peak flows that must be managed. Modeling was used to evaluate the improvements necessary to convey excess flows to the WWTP. Collection system improvements required to provide service for future growth in other areas of the system are described in Chapter 7.

6.2 MODELING APPROACH

Two modeling approaches were used in this evaluation. First, peak flows generated in response to rainfall were simulated using a calibrated model of the City's collection system, H2OMap Sewer. Next, the statistical frequency and volume of CSO discharges at the existing C-Street CSO point were evaluated using Long Term Simulation modeling with EPA modeling software (SWMM). Results from both approaches were used in determining existing and future capacity limitations in the collection and conveyance system, and future improvements needed to address these limitations.

6.2.1 Design Storm Methodology

Modeling was initially developed using design storms to determine collection system capacity and to estimate peak system flows caused by major rainfall events. Peak flow values summarized in Chapter 4 were derived using the design storm approach. There are two types of design storms that can be used for planning studies: measured events and synthetic events. Measured storm events are useful if flow monitoring data are available throughout the system for the duration of the event. Synthetic design storms have been used for many years in sanitary, storm, and combined sewer studies. The advantage of using a synthetic design storm is that it can be applied even if a large event is not monitored.

Both synthetic design storms and a measured storm were used for this study. Synthetic design storms were previously used for past facility plans. Design storms are not meant to represent an actual measured storm and may not capture the effects of long duration rain events that do not have extremely high intensities, but do cause high flows due to antecedent moisture conditions.

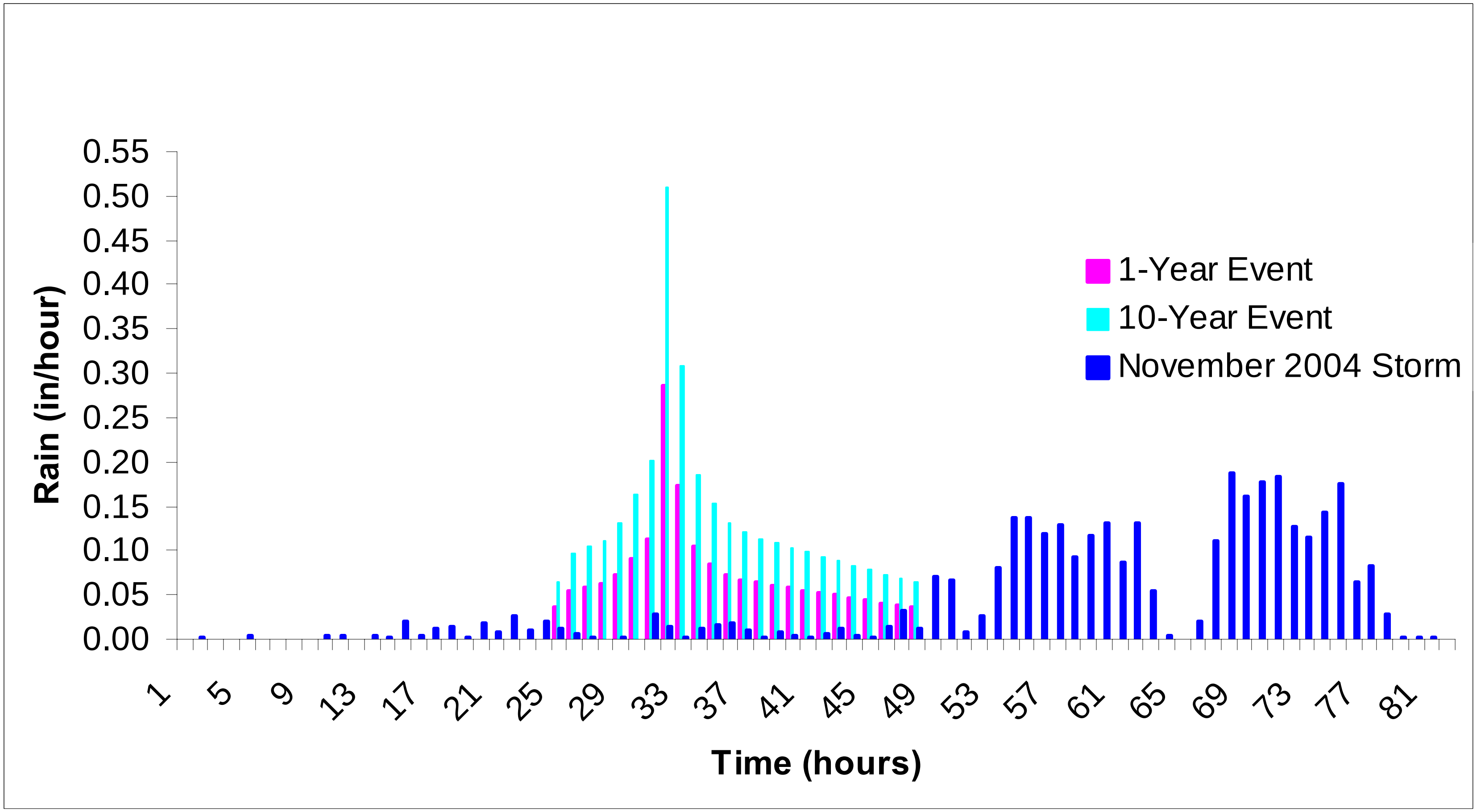
Synthetic design storms consist of a total volume of storm rainfall, and a rainfall distribution that is used to spread out the rainfall volume over a set duration. Storm characteristics are usually selected from maps that have been developed by the National Oceanic and Atmospheric Administration (NOAA), and are available for the Western United States in a document called NOAA Atlas II. A typical design storm rainfall distribution is then applied to this total rainfall volume to approximate the shape of the rainstorm. The distribution used for this project is the Soil Conservation Service (SCS) distribution (SCS is now the National Resource Conservation Service, NRCS). The SCS Type I distribution is applicable for the Bellingham area. The NOAA design storm volumes and the SCS distributions are commonly reported in either 6-hour or 24-hour durations.

Each design storm is also referenced to a recurrence interval. For example, the City's Conveyance Plan used a 10-year design storm (Earth Tech 1998). A 10-year storm means that a 10-year event could be expected to occur once approximately every 10 years, on average, if a sufficiently long period of record is examined. However, a 10-year event could occur one year after another if only a short period of record is examined. A better way to understand the implications of this event is that a 10-year design storm has a 10 percent probability of occurring in any one year.

The storms modeled in this analysis included a 1-year synthetic design storm, an actual storm that occurred in November 2004, and a 10-year synthetic design storm. NOAA does not provide a 1-year event, so the 1-year rainfall was estimated. A duration of 24 hours was assumed for the 1-year and 10-year events. The November 2004 storm was a 3-day event that produced a CSO event. Figure 6.1 shows the three storm hyetographs. Figure 6.2 shows the cumulative volume over the duration of rainfall for the three storms. The 1-year event produced a total volume of 1.82 inches. The 10-year and November 2004 events produced a total volume of 3.25 and 3.36 inches respectively.

6.2.2 Long-Term Simulation Methodology

As a refinement to the design storm modeling, Long-Term Simulation (LTS) modeling was also performed. In this approach, a calibrated model is used to run a continuous simulation of flow based on historical rainfall records measured over time. Following the simulation, a design flow is selected to meet the applicable criteria. LTS provides a more accurate representation of flow response to wet weather by considering factors such as antecedent moisture, and long duration low intensity storms. It is often applied in the evaluation of combined systems, where the goal is to limit the number of overflows in any given year.



RAINFALL HYETOGRAPH

FIGURE 6.1

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COMPREHENSIVE SEWER PLAN

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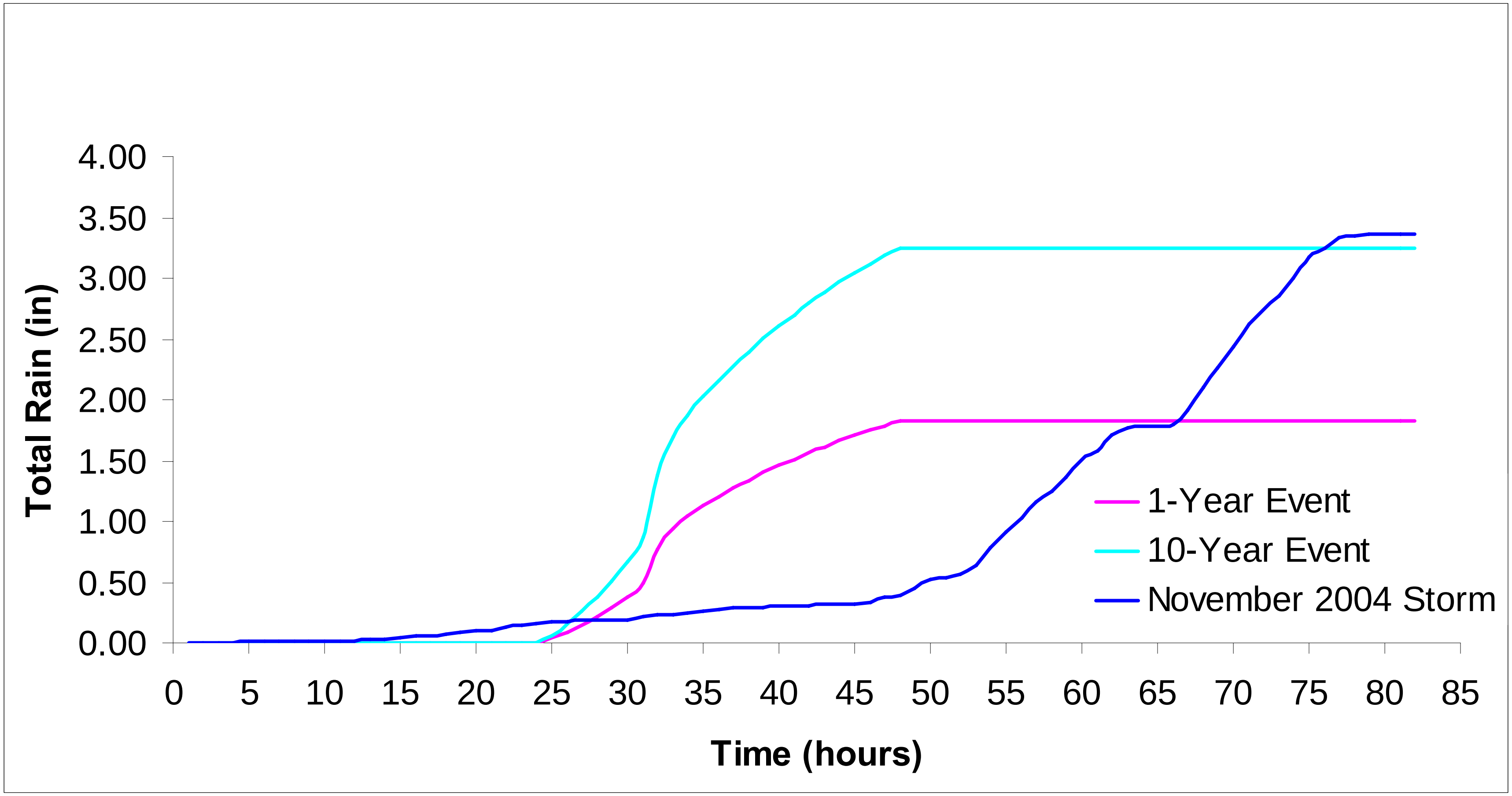

CUMULATIVE RAIN

FIGURE 6.2

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COMPREHENSIVE SEWER PLAN

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In this case, LTS was used to refine the size and nature of peak flow management facilities or collection system improvements needed to limit CSOs.

6.3 PERFORMANCE CRITERIA

Defining collection system performance criteria is a critical step in the planning process because it sets the metrics by which existing collection system infrastructure will be evaluated, and by which future facilities will be designed. Design criteria for this evaluation were defined in detail prior to the analysis. The applicable criteria that were used to size improvements in the interceptor between the C Street CSO structure and the WWTP are summarized in this section. The performance criteria used in this analysis for gravity pipelines includes:

- The peak hydraulic grade line (HGL) in any segment of sewer must be at least two feet below the rim of any manhole, except when a manhole is very shallow.
- If a manhole does not provide at least two feet of cover over the crown of the connecting pipes, then the peak HGL must be at or below the lowest pipe crown entering or exiting the manhole.
- When a capacity restriction is identified, a parallel pipeline will be used to lower the HGL to meet the above conditions. This assumes the existing pipeline that is being paralleled is in good condition and does not need replacement in the near future. Paralleling sewers are chosen over pipe replacement, to keep the HGL as low as possible to meet the above criteria in very restrictive locations.
- Parallel pipes will be placed at the same invert of main pipes within the connecting manholes. A flow split during dry weather flows may cause peak velocities to be less than two feet per second. Weirs or gates may need to be used with parallel pipes, but due to the planning level of this analysis, weir and gate structures have not been analyzed. These conditions need to be further investigated during subsequent design phases.
- A Manning’s ‘n’ of 0.013 will be used for new parallel pipelines.
- Utility crossings were not investigated along the parallel pipeline route. Utility interferences due to the parallel pipelines should be investigated for the recommended improvements.

6.4 PEAK FLOW MODELING

The existing interceptor between C Street CSO structure and the WWTP was analyzed using six combinations of dry weather flow (DWF), and Infiltration and Inflow (I/I). Dry weather flow was used to estimate the “base flow” (i.e. sanitary flow from residential, commercial, and industrial sources), and I/I represents flow response to wet weather. First, the existing interceptor was analyzed using existing 2005 DWFs in combination with I/I generated from the three storms described in Section 6.2. Second, the existing interceptor was analyzed using year 2026 DWFs and the I/I generated from the same three storms.

6.4.1 H2OMAP Sewer Model Calibration

Calibration is the process of adjusting parameters in a model to represent measured variables (e.g., flow, depths, velocity, volume, etc.) accurately and precisely. Calibration is necessary because collection system models are mathematical representations of a physical system that incorporate some level of simplification. These necessary simplifications introduce error and uncertainty into the analysis. Adjustments of model parameters are necessary to reduce error and better meet the expectations of model application.

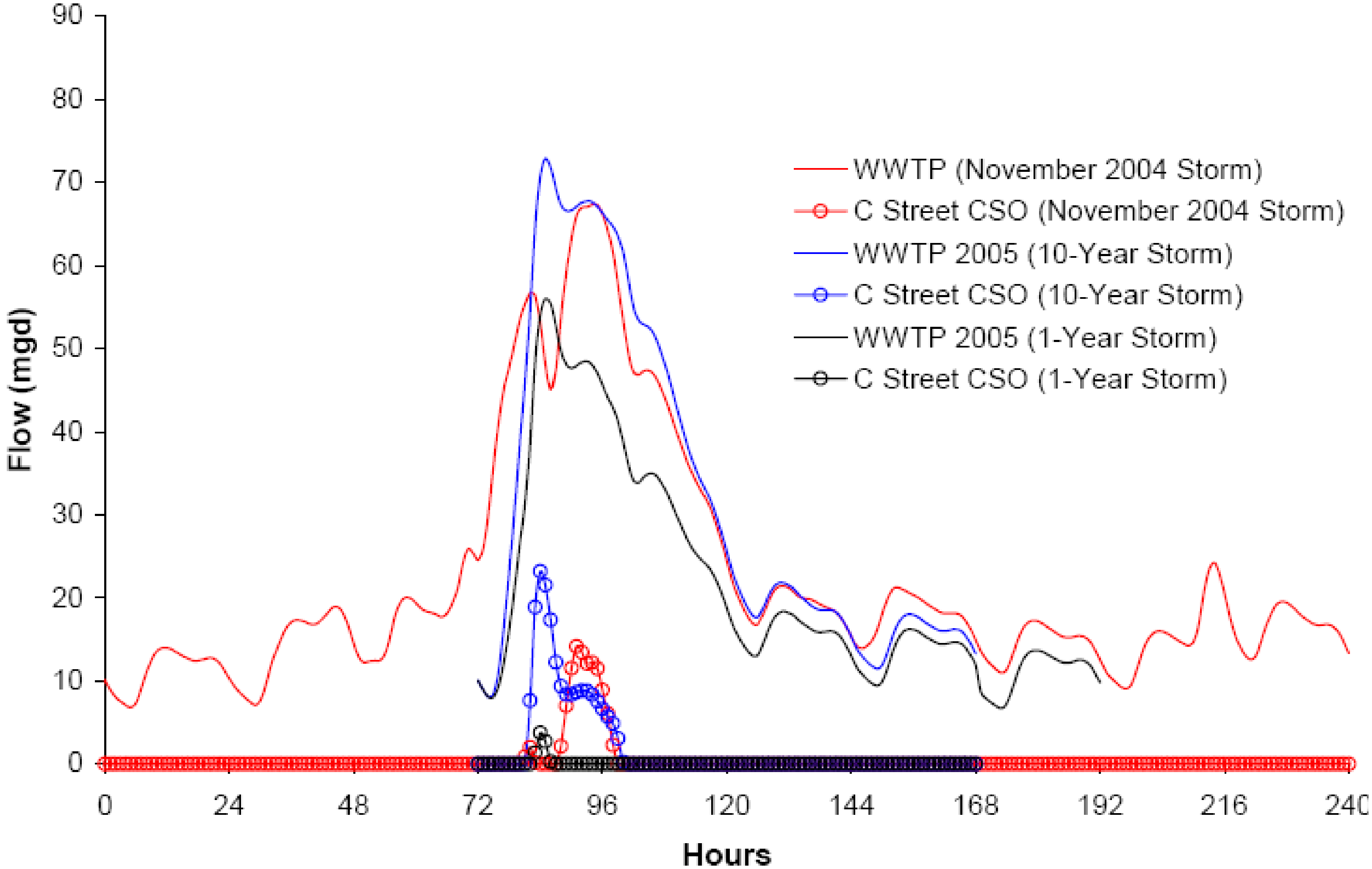
The H2OMAP Sewer model was calibrated in several steps. First, the model was calibrated to dry season flows to accurately represent only flows generated by residential, commercial, and industrial sources. Second, the model was calibrated to wet season flows without rainfall, to represent the groundwater infiltration that occurs during the wet season, also referred to as Base Infiltration (BI). Third, the model was calibrated to wet weather flows to simulate sanitary, BI, and I/I flows. This section presents a summary of the calibration results. A detailed description of the model calibration procedure is included in Appendix I.

Dry season calibration graphs for each of the basins are included in Appendix I. The precision measured by R2 for all modeled conditions exceeded 0.90. The full data set of hourly modeled dry weather flows were generally within plus or minus 15 percent of measured flows. With BI added, the modeled flow also closely matched measured flow at the WWTP. The statistics and comparative analysis indicate the model was well calibrated for dry weather conditions with and without BI.

The model was also calibrated to actual flow measurements during three storm events. Figure 6.3 shows the time series plots of total flow measured at the WWTP for each of the three calibration periods. The figure shows a good match between modeled and measured flow. One of the calibration events, the November 2004 event, also produced a measured CSO at C Street. Figure 6.4 shows a comparison of the modeled and measured CSO hydrograph. The modeled peak CSO flow was within 11 percent of the measured peak CSO flow, which illustrates the model’s accuracy at the CSO structure.

6.4.2 2005 H2OMAP Sewer Model Results

The model was calibrated based on the collection system as it existed in 2005. The C Street overflow structure was replaced in the summer of 2005, after the storms used for model calibration had occurred. System conditions were updated in the calibrated model to reflect these modifications. The estimated peak flows and overflow volumes for the three modeled storms are summarized in Table 6.1, assuming Oak Street was set at a peak flow



STORM FLOW COMPARISON (2005 DRY WEATHER FLOWS)

FIGURE 6.3

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COMPREHENSIVE SEWER PLAN

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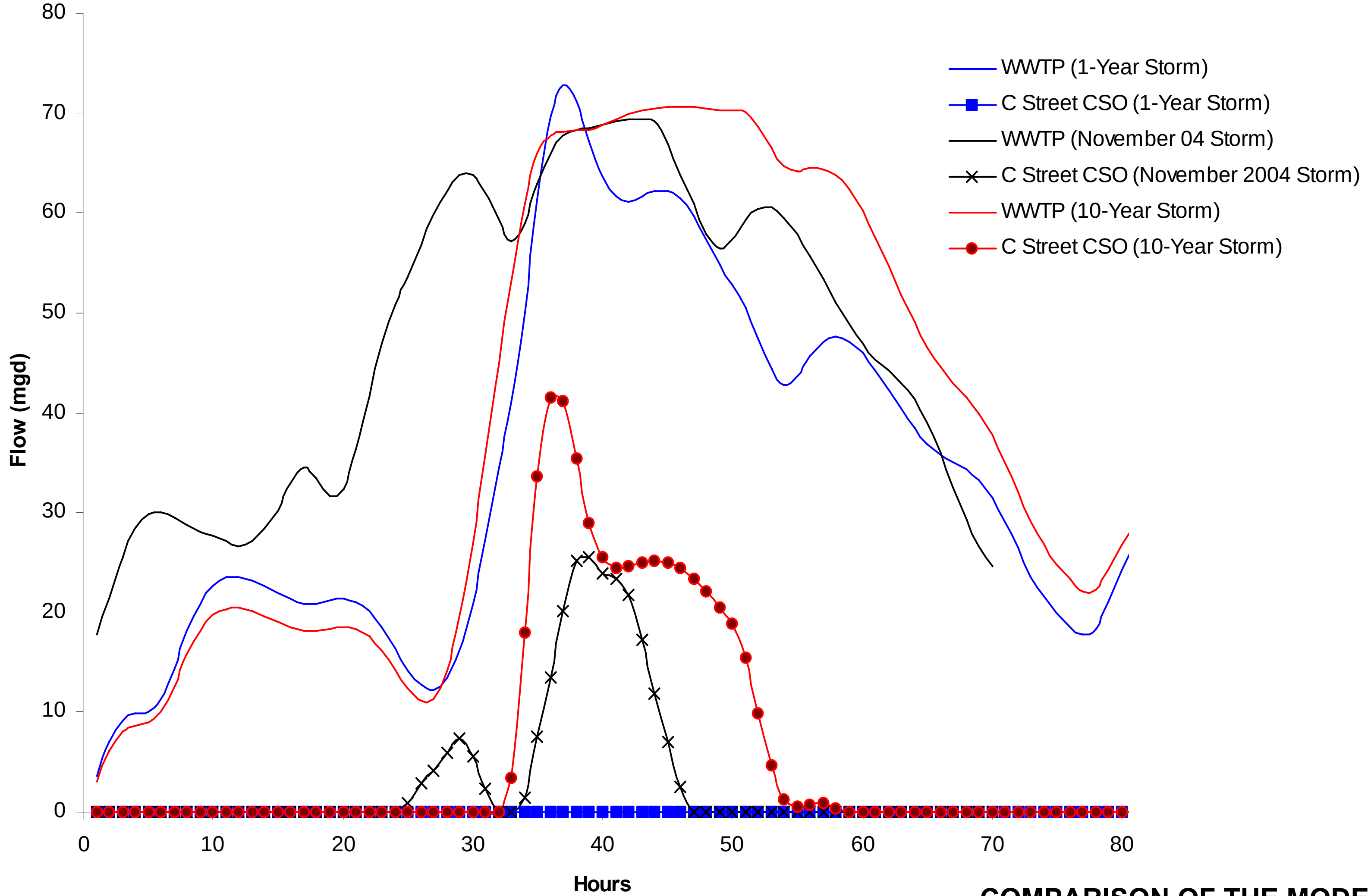

COMPARISON OF THE MODELED AND MEASURED CSO

FIGURE 6.4

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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of 57 mgd. Figure 6.3 shows the storm hydrograph at the WWTP and at the C Street CSO structure for the three events.

Table 6.1 Peak Flows from Rain Events in 2005
Comprehensive Sewer Plan
City of Bellingham

Year	Rain Event	Total System Flow (mgd)	WWTP Influent (mgd)	Peak C Street Overflow Rate (mgd)	C Street Overflow Volume (MG)
2005	1-Year	58.7	58.7	0	0
2005	Nov-2004	81.4	67.3	14.1	4.0
2005	10-Year	96.1	70.0	26.1	8.9

The I/I produced from the 1-year design storm, coupled with the 2005 DWF, produced a peak total system flow of 58.7 mgd. The November 2004 storm produced a system flow of 81.4 mgd, with 67.3 mgd reaching the treatment plant. The 10-year storm produced a peak system flow of 96.1 mgd, with 70 mgd reaching the treatment plant.

Historically, the City has observed peak flows at the WWTP in the range of 70 mgd. Therefore, the peak flow of 58.7 mgd produced by the 1-year storm appears to be low. Typical storms in the Bellingham area that cause CSOs to occur, such as those used during calibration, tend to last for several days. These storms produce peak flows at the WWTP during multi-day storms when there is extended infiltration into the system from previous rainfall, in addition to direct infiltration during the storm. Based on these results, the 1-year storm is not recommended for design, as it appears low and will not provide sufficiently conservative results. Therefore, the November 2004 storm and the 10-year, 24-hour event were used for analysis of system improvements.

6.4.3 2026 H2OMAP Sewer Model Results

The DWFs were increased through the collection system to reflect the 2026 project population and employment, as well as flows from the new portions of the system in the urban growth area (UGA). The basin loading factors developed during calibration were used for the future condition. Future flows representing the future development in the UGA were applied to the most upstream manholes in the modeled system. Most of the new area is in the eastern and northern sections of the system.

The RTK I/I coefficients developed during model calibration were examined to develop coefficients for the future sewered areas. In the RTK method, R represents the fraction of rainfall volume, T represents the time to peak, and K is a recession constant. Newer basins in the existing system were chosen for comparison to identify RTK coefficients that would likely represent I/I based on future pipelines and construction methods. It was assumed that a R value of 4 be used for future development areas and a T and K representative of newer existing basins be applied.

Estimated peak flows and overflow volumes for the 2026 conditions are summarized for the design rain events in Table 6.2. The November 2004 storm produced a peak flow of 94.8 mgd in the system, and the 10-year storm produced a peak flow of 110.6 mgd. Figure 6.4 shows the storm flow hydrograph for the two events. Figure 6.5 compares the hydrographs from the 2005 results with the 2026 results for the November 2004 event. Figure 6.6 shows the same comparison using the 10-year event.

Table 6.2 Peak Flows from Rain Events in 2026
Comprehensive Sewer Plan
City of Bellingham

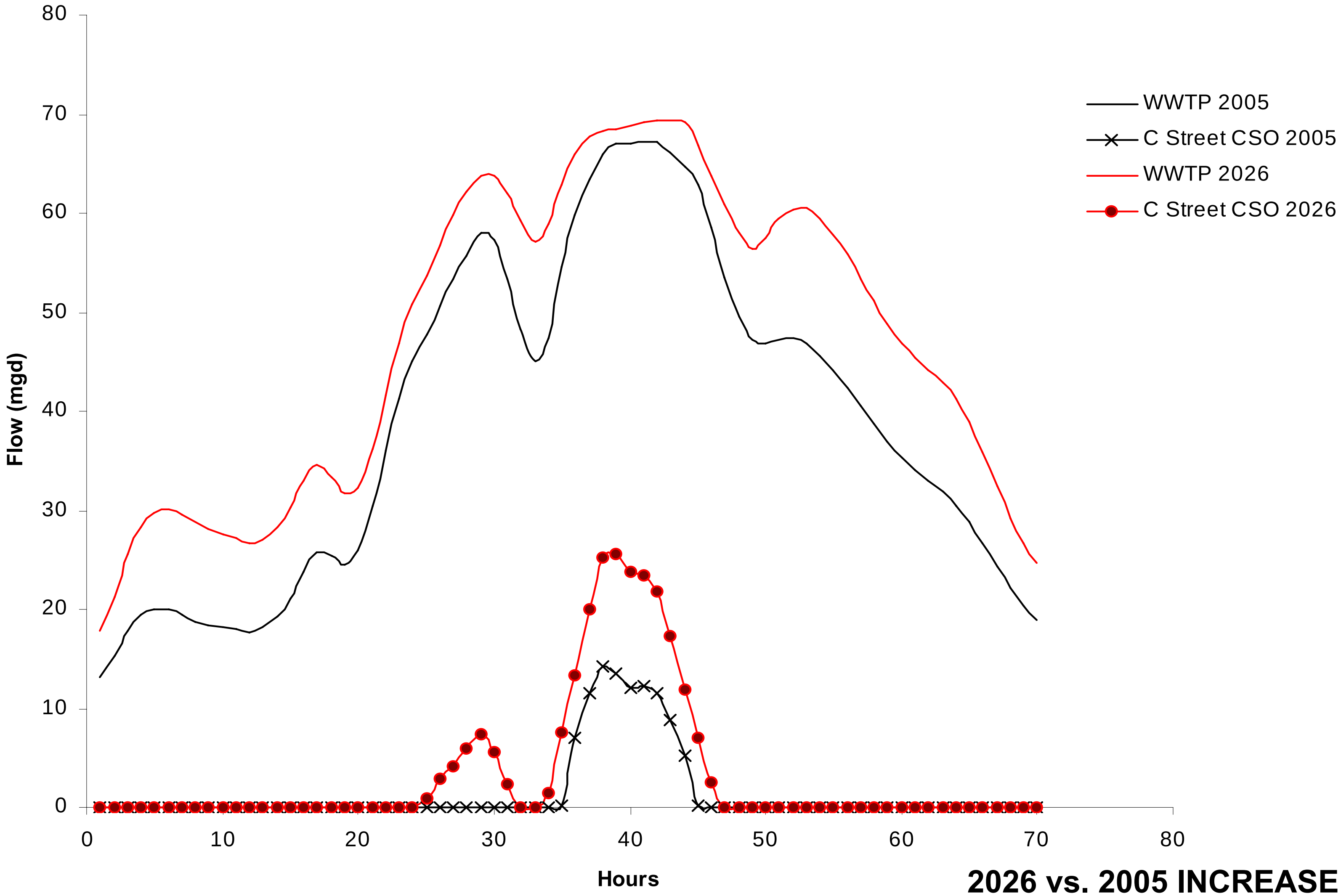
Year	Rain Event	Total System Flow (mgd)	WWTP Influent (mgd)	Peak C Street Overflow Rate (mgd)	C Street Overflow Volume (MG)
2026	1-Year	72.8	72.8	0	0
2026	Nov-2004	94.8	69.5	25.4	9.6
2026	10-Year	110.6	70.7	79.9	20.6

6.4.4 Conveyance System Capacity Limits

The capacity of Oak Street and the downstream interceptor is limited to approximately 60 mgd. Approximately 12 mgd enters the system downstream from the interceptor, and the total system capacity is approximately 72 mgd. The calculated WWTP influent for both the November 2004 and 10-year storm events shown in Table 6.2 exceeds the total system capacity. Further discussion of improvements required across the modeled collection system is presented in Chapter 7. Preliminary analysis indicates that the number of manholes in which the HGL approaches the rim increased significantly within the modeled system between 2005 and 2026 for both storms. The high HGL could lead to overflows from manholes or nearby connections. Therefore, the flows in excess of the 2005 levels will need to be managed by reducing peak flows through further stormwater separation and/or I/I control, constructing new facilities, or a combination of these approaches.

6.5 LONG TERM SIMULATION MODELING

Alternatives to manage excess peak flow all consider continued but infrequent CSO events. Regulatory requirements allow continued CSOs during extreme wet weather events, up to an average of one event per year. CSOs must also be controlled to current “baseline” volume conditions, such that future growth and expansion of the collection system does not cause an increased volume of CSOs. In order to estimate the improvements that would be needed to meet regulatory requirements, an LTS model was used to generate statistics of discharges at the existing CSO point. The statistics were used to estimate probabilities of exceedance or recurrence intervals of CSO events (such as a 10-year CSO event).



2026 vs. 2005 INCREASE FOR THE NOVEMBER 2004 STORM

FIGURE 6.5

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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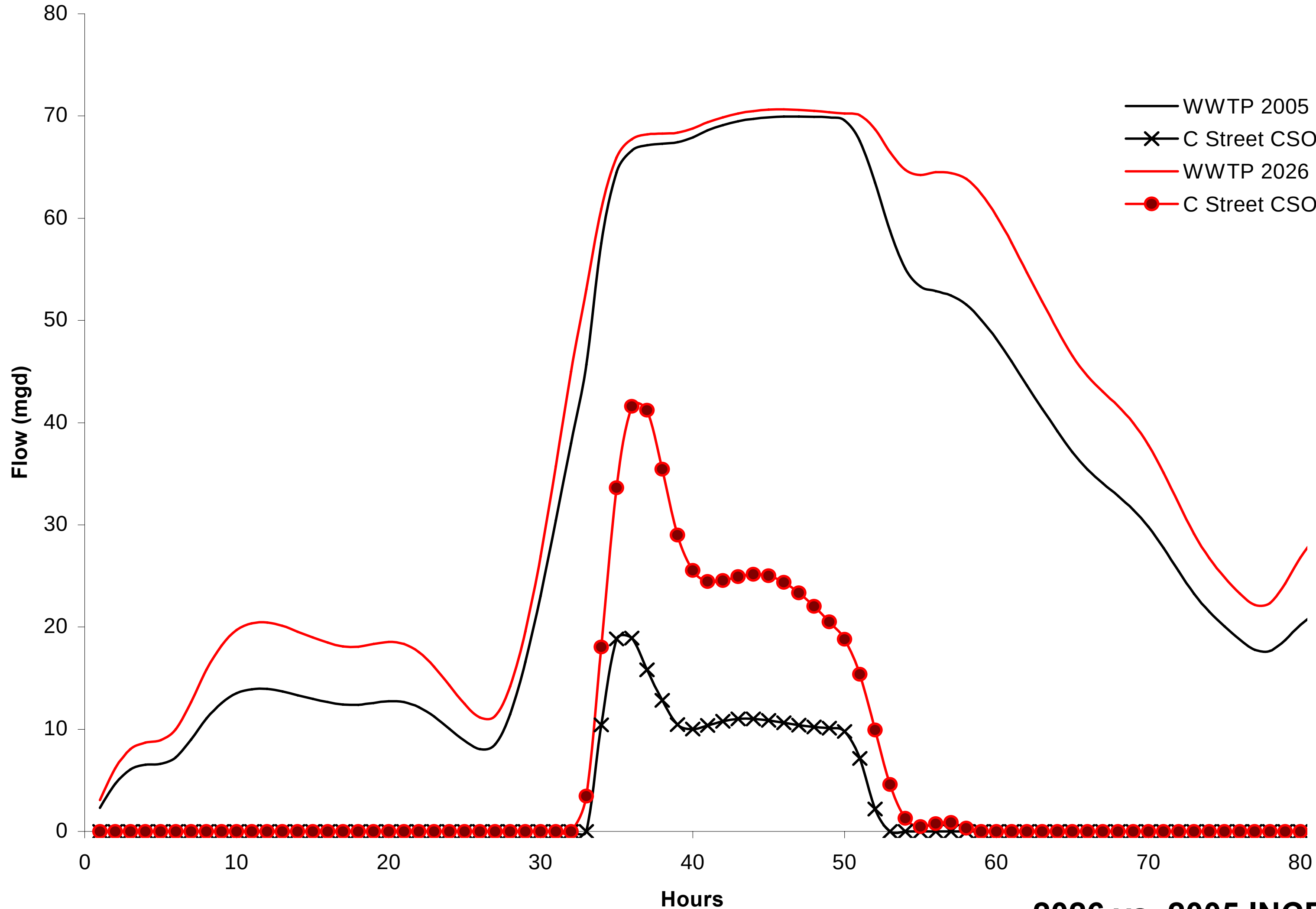

2026 vs. 2005 INCREASE FOR THE 10-YEAR STORM

FIGURE 6.6

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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6.5.1 Definition of Long Term Simulation

LTS is the process of modeling long term rainfall data (typically hourly or 15-minute rainfall volumes) to project long term hydrographs of wet weather flows within a collection system. DWFs can also be added to the projected wet weather flows to estimate flows throughout a Combined Sewer System (CSS) and analyze how these flows cause CSO over a long term period of record. The period of record varies based on the available rainfall data, but typically can include 50 years or more of hourly data.

The LTS model prepared for this analysis was a simplified representation of the City's H2OMAP Sewer model, since it is inefficient to run a detailed hydraulic model for such a long time period. The LTS model was constructed based on the hydraulics determined from the more detailed collection system model, and used to simulate the element in the network (Oak Street) that limits the amount of downstream flow and thus causes a CSO.

6.5.2 Model Construction and Assumptions

As the City's H2OMAP Sewer collection system model is not capable of LTS, the LTS model was constructed using the software package EPA SWMM 5.0.011 (SWMM). This software package is available for free download at the EPA site, and is described there as follows:

> "The EPA Storm Water Management Model (SWMM) is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The runoff component of SWMM operates on a collection of subcatchment areas that receive precipitation and generate runoff and pollutant loads. The routing portion of SWMM transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators. SWMM tracks the quantity and quality of runoff generated within each subcatchment, and the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period comprised of multiple time steps."

The features of SWMM that were utilized to construct the LTS model include the following:

- Rainfall - 15 minute and hourly rainfall for extended time periods.
- Flow - diurnal DWF data as well as Rainfall Dependent Infiltration and Inflow (RDII) can be used to simulate flows throughout a CSS.
- Hydraulics - pipelines, diversion structures, equalization basins, pumps, gates (orifices) and weirs can be used to construct a simplified, yet highly accurate representation of the system.
- Real Time Control (RTC) Algorithms - RTC routines can be programmed to control pumps, gates, and weirs based on a variety of variables (depth, flow, etc.).

- Statistical Analysis - integrated statistical routines to analyze events (such as CSOs) based on peak flow, total volume, duration, and interevent duration.

The eight sewage drainage basins as described in Chapter 5 were modified for the modeling calibration to align with the installed flow meters. The proposed North basin represents flow from all of Lake Whatcom basin and a portion of the Central, Broadway, and Sunset/Mt. Baker basins. The proposed Central basin represents flow from all Cordata/Meridian, Northwest, and Birchwood basins. The proposed South basin represents flow from all of the South side basin and a portion of the Central basin.

The model was constructed to represent the flow input and hydraulic constraints of the CSS in a simplified manner, while still maintaining accurate simulation of flow into Oak Street, overflows at the C Street CSO, and influent to the WWTP. Three flow input points were modeled, which provided DWF and RDII into the system. These input points represent the north basins, central basins, and southern basins. The north and central basins enter upstream of Oak Street, while the south basin enters below, upstream of the WWTP. Representative DWFs and RDII were input at these points. It should be noted that DWFs were not estimated, but taken from the H2OMAP Sewer model for the years 2006, 2016 and 2026. The DWFs for these three basins, along with the WWTP are summarized in Table 6.3

Table 6.3 LTS Basin ADWFs
Comprehensive Sewer Plan
City of Bellingham

Basin	2006 ADWF (mgd)	2016 ADWF (mgd)	2026 ADWF (mgd)
North	6.45	9.16	10.2
Central	0.95	2.73	3.87
South	1.96	2.39	2.62
WWTP	9.36	14.28	16.69

The C Street CSO was represented as a bypass from Oak Street when the flow into the pump station reached approximately 57 mgd. Although the C Street CSO is actually upstream of the pump station, it was found using detailed modeling that the peak rate of Oak Street is the primary factor in determining when and how much is bypassed to the CSO. Therefore, in the LTS model, CSOs occurred when the combined flow from the north and central basins exceeded 57 mgd. The CSO continued until this flow receded below the assumed pump station setpoint flow of 57 mgd.

6.5.3 Available Rainfall Data

Measured rainfall and flow data from November 2004, January 2005, and April 2005 were used to calibrate the H2OMAP Sewer model. These three events were also used to calibrate the LTS model. The H2OMAP Sewer model utilized 14 rain gauges within the City's sewered area for calibration. For LTS, one rain gauge, measuring long-term 15-minute rainfall was used. It is best to calibrate LTS models using the long-term rainfall that will be used to project other events if possible. In this case, the long-term rainfall record included the time periods for the three storms mentioned above.

A long-term rainfall record was provided for the analysis by Clear Creek Solutions, which were the same data developed for the City's Storm Water Plan. A 59-year rainfall record was generated at 15-minute intervals using two rain gauges. Although a long-term detailed rainfall record was not available for Bellingham, there was detailed information for the last 10 years. A detailed rainfall record was available for Blaine, Washington, approximately 20 miles north of Bellingham. Clear Creek Solutions overlaid the data from Bellingham and Blaine to develop a correction factor between the storm events from the respective gauges. The Blaine data was then adjusted by the correction factor to represent the storms in Bellingham for the years that Bellingham data was unavailable. The adjusted Blaine data were added to the available Bellingham data to create a 59-year, 15-minute rainfall record for the City of Bellingham.

6.5.4 LTS Model Calibration

The LTS model estimated RDII, and combined with the input ADWFs and diurnal patterns, the total flows were calibrated for each basin and at the WWTP. SWMM includes several methods to simulate wet weather flows, but to be as consistent as possible with the H2OMAP Sewer model, the triple unit hydrograph approach was applied (also called RTK approach). This method is very similar between the two models and requires estimates of short, medium, and long term R-values as well as T, and K parameters.

Since the LTS model divided the system into three basins (whereas the H2OMAP Sewer model utilized 9 basins), it was necessary to aggregate the flows predicted by the H2OMAP model into flows for the north, central and south basins for the November 2004, January 2005, and April 2005 events. The RTK parameters were adjusted in the LTS model until the calibrations provided a good prediction of peak flows and volumes. The acreages and RTK parameters for each basin are summarized in Table 6.4.

Table 6.4 LTS Model Calibration Variables
Comprehensive Sewer Plan
City of Bellingham

Basin	Area (acres)	Response Type	R	T	K
North	8,977	Short-term	0.033	2	2
	.	Mid-term	0.021	8	2
		Long-term	0.023	24	2
Central	4,782	Short-term	0.015	2	2
		Mid-term	0.012	8	2
		Long-term	0.02	24	2
South	5,403	Short-term	0.011	2	2
		Mid-term	0.015	12	2
		Long-term	0.02	36	2

Notes:

(1) Area represents the acres of each basin in year 2006.
(2) Response Type defines the three unit hydrographs used for each basin.
(3) R = fraction of rainfall that becomes I/I.
(4) T = time to hydrograph peak (hours).
(5) K = falling limb duration / rising limb duration.

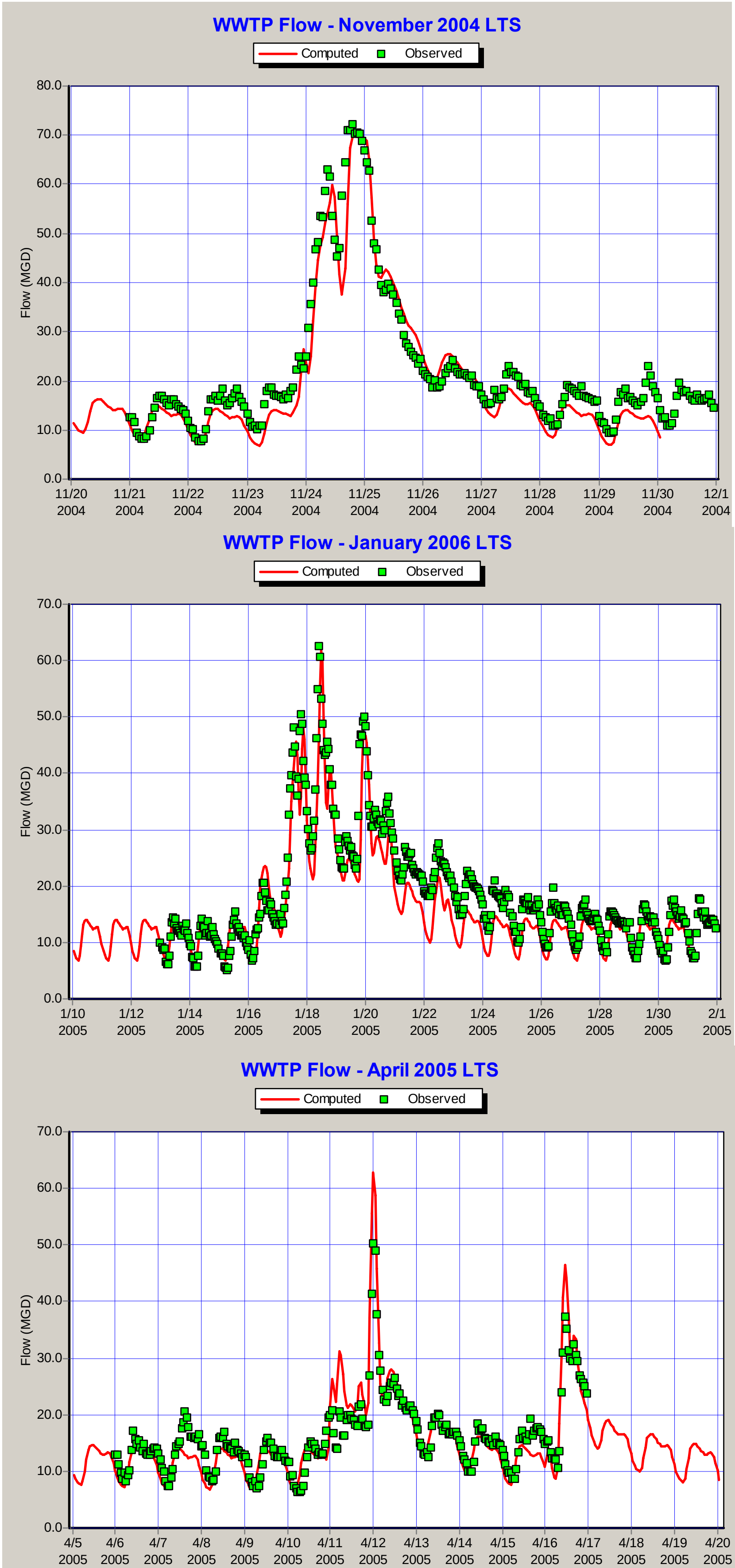
Figure 6.7 illustrates the calibration plots for the three events at the WWTP. The LTS model also predicted the CSO that occurred in November 2004 very well. Figure 6.8 illustrates a graph of the CSO calibration. Overall, the LTS model produced a very good calibration.

6.5.5 LTS Model Results

Once calibration was completed for the three events, the long-term rainfall data set was run through the model. It should be noted that the results of the LTS do not represent the flows or CSOs that would have occurred historically. This is because the model is representative of current conditions (e.g. 2006) and therefore does not represent the system configuration, DWFs, or RDII that would have been present in any past year. Therefore the results generated for 2006, although reported by historical year (e.g. 1948 through 2005), can be thought of as the current system configuration with 59 years of rainfall simulated across the system, that are representative of the current system and the flows and CSOs that would be generated if any one of the historical storm events occurred. Results generated from the LTS model were examined for the years 2006, 2016, and 2026.

6.5.5.1 Predictions for 2006

The 2006 model run results indicate a total of 45 CSO events. A CSO is considered an event if the last hour of the CSO is separated by at least six hours from the beginning of the next event. This equates to a six hour interevent duration, which is a typical interevent duration used for this type of analysis. These events ranged in total volume from 4,000 gallons to 7.4 MG. The peak rate of these events ranged from 0.1 to 51 mgd. The model estimated an average of 0.76 CSOs per year over the 59 years of record, and established the average “baseline” CSO volume at 1.2 MG per year.



CALIBRATION PLOTS FOR THE THREE EVENTS AT THE WWTP

FIGURE 6.7

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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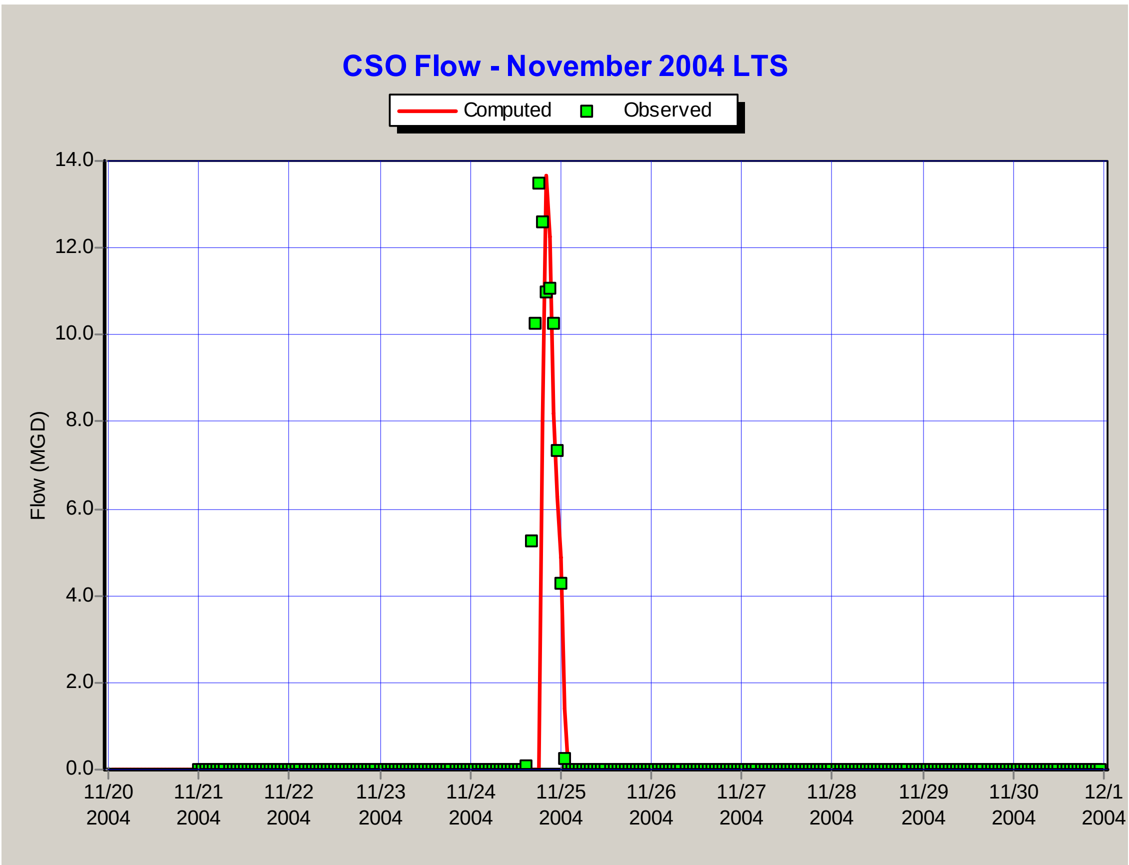

GRAPH OF THE CSO CALIBRATION

FIGURE 6.8

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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6.5.5.2 Projections to 2016

The 2016 model run results indicate a total of 93 CSO events. These events ranged in total volume from 4,000 gallons to 13.4 MG. The peak rate of these events ranged from 0.1 to 63 mgd. The model estimated an average of 1.57 CSOs per year over the 59 years of record. The average annual CSO volume for year 2016 was predicted to be 2.8 MG.

6.5.5.3 Projections for 2026

The 2026 model run results indicate a total of 157 CSO events. These events ranged in total volume from 1,000 gallons to 19.7 MG. The peak rate of these events ranged from 30,000 gpd to 72.7 mgd. The model estimated an average of 2.66 CSOs per year over the 59 years of record. The average annual CSO volume for year 2026 was predicted to be 5.2 MG.

6.5.6 LTS Model Conclusions

The following conclusions were reached based on the LTS modeling simulations:

- The likelihood of exceeding one event per year based on the long-term average is currently very low. With no future growth, the average number of CSO events predicted is approximately 0.8 events per year. Current “baseline” CSO volume is estimated at 1.2 MG per year.
- As growth occurs, the risk of exceeding the allowable CSO frequency and volume increases. By 2016, the model predicts an average of 1.57 CSO events per year. At the end of the planning period in year 2026, the model predicts an average of 2.66 CSO events per year. The predicted average annual CSO volumes for these years are 2.8 MG and 5.2 MG, respectively.
- The model predicted that the capacity of the existing conveyance system and WWTP, currently 72 mgd, would need to be increased by approximately 10 mgd to reduce the probable number of CSO events in year 2026 to one per year based on the long term average.
- The model predicted that a 10 mgd high rate treatment facility, or approximately 1.7 MG of peak flow storage constructed near the existing CSO, would eliminate the need for conveyance and treatment plant expansion, and contain CSO events to an average of one event per year in year 2026.
- The model predicted that a combination of storage, increased capacity, and/or peak flow reduction through stormwater separation and/or I/I reduction would be needed to maintain CSO volumes to the “baseline” condition through year 2026.

6.6 PEAK FLOW SOURCES

Figure 6.9 shows the approximate extent of the combined and separated sewers that combine to form the City's overall collection system. Approximately 20 percent of the system is combined, and was originally designed with the intent of conveying both storm water and sanitary sewage to the outfall. As shown in the figure, the combined system is installed in the oldest portions of the downtown core, in an area that is mostly urban with little residential flow contribution. The remainder of the system is separated, although portions of that system exhibit a relatively high response to precipitation as documented by flow monitoring and the calibrated model.Figure 6.10 compares the percentage of the collection system that is combined (20 percent) and separated (80 percent) to the relative peak flow contributions based on the calibrated model. As shown by the figure, nearly 50 percent of the peak flows originate in the combined basins. The separated basins contribute approximately 35 percent to the peak, with the remainder being base sanitary flow.

6.7 HISTORIC PEAK FLOW MANAGEMENT APPROACH

The City of Bellingham has an ongoing program to reduce peak flows through collection system improvements that dates back to the early 1970s, near the time of passage of the Clean Water Act. Between 1974 and 1987 numerous storm water separation projects were completed, reducing four overflow points to one at the C Street overflow structure. These projects also significantly reduced the "baseline" CSO frequency and volume, predicted by modeling the current system as described earlier in this chapter.

City records documenting prior collection system improvements with peak flow management are summarized in Table 6.5. The table shows the series of storm water separation and I/I reduction projects that the City has completed, along with the cost of those improvements at the time of their construction. When those costs are escalated to 2007 dollars, these improvements represent over $40 million in capital investments to reduce CSO frequency and volume.

**Table 6.5 Summary of Prior Collection System Improvements
Comprehensive Sewer Plan
City of Bellingham**

Project #	Type	Project Name	Feet of Main	Cost
N/A	?	1980-1989 Underground Sewer Collection Piping	152,915	$8,807,904.00
N/A	?	1990-1997Underground Sewer Collection Piping	87,380	$5,616,350.00
DR-308	S	1992 Inflow & Infiltration Removal	1,477	$ 147,700.00
SE-639	S	1995 Storm Sewer Separation	2,719	$ 271,900.00
SE-668	I/I	1996 Sewer Rehabilitation Trenchless I&I	2,000	$ 80,000.00
SE-675	I/I	1997 Sewer Lining	7,228	$ 440,545.00

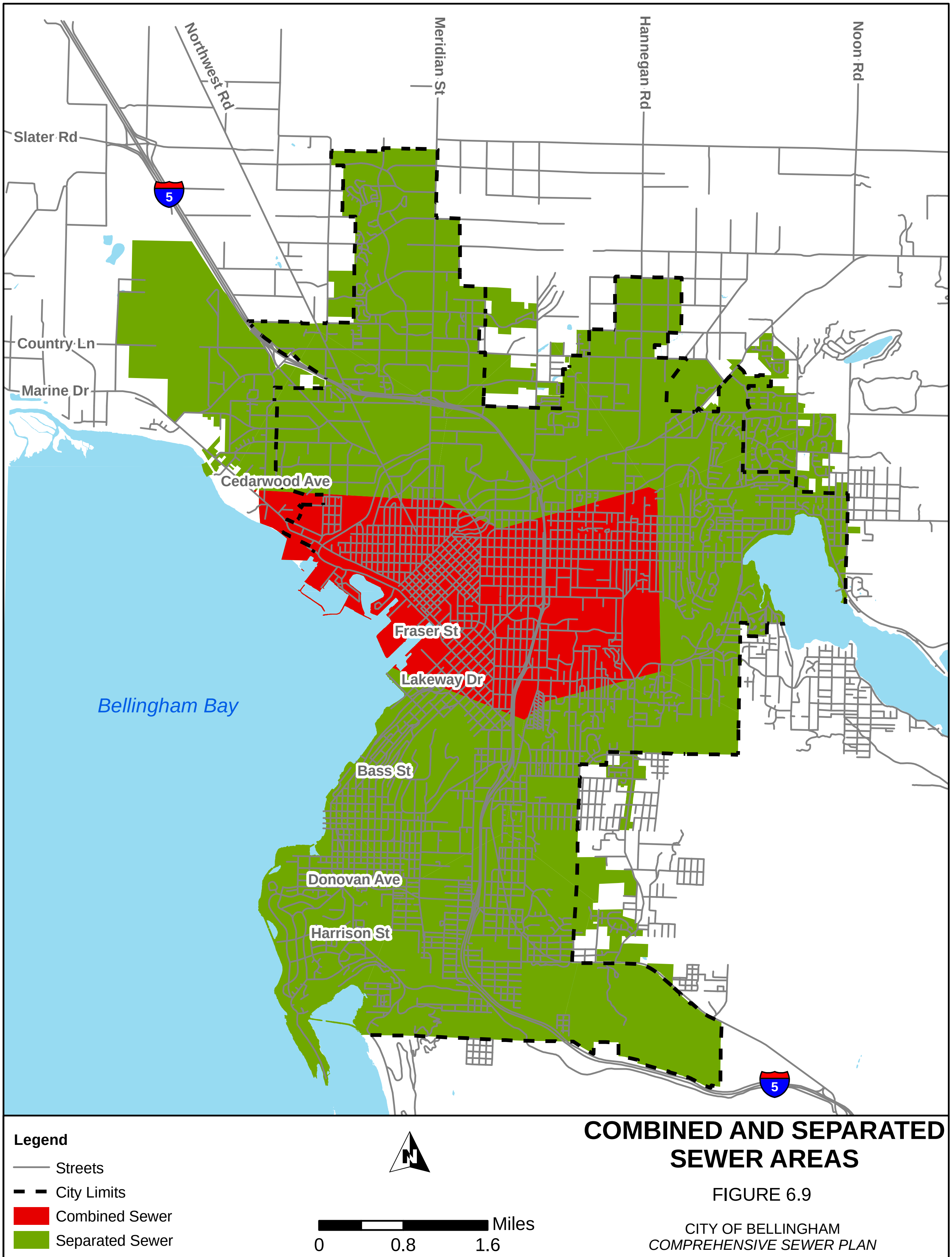
Table 6.5 Summary of Prior Collection System Improvements Comprehensive Sewer Plan City of Bellingham

Project #	Type	Project Name	Feet of Main	Cost
SE-676	I/I	1998 Sewer Main Replacement	4,008	$ 538,372.00
EU-0007	I/I	1999 Sewer Main Replacement	4,351	$ 253,334.98
EU-0025	I/I	2000 ADS Sewer Flow Meters	N/A	$ 100,319.41
EU-0033	I/I	2000 Sewer Main Replacement	3,585	$ 663,574.72
EU-0023	I/I	2000 Sewer Main Replacement	5,293	$ 645,036.73
EU-0054	I/I	2001 Sewer Main Replacement	9,628	$ 461,361.20
EU-0062	I/I	2002 ADS Sewer Main Meters	N/A	$ 74,500.00
EU-0063	I/I	2002 Sewer Main Replacement	3,847	$ 208,120.75
EU-0081	I/I	2003 Sewer Main Replacement	2,690	$ 667,034.85
EU-0071	I/I	2003 Sehome Main Replacement	3,029	$ 379,536.14
EU-0100	I/I	2004 Sewer Main Replacement	3,688	$ 1,075,885.85
EU-0116	?	2005 C Street Overflow Weir	n/a	$ 388,770.58
EU-0031	I/I	2005 Oak Street Pump Station Upgrade	N/A	$8,676,631.11
EU-0104	I/I	2006 Sewer Main Replacement	12,390	$ 1,239,798.00
		TOTAL	**306,228**	**$30,736,675.32**

Notes:

S - storm water separation
I/I - infiltration/inflow reduction
B - both
? - unknown

The city continues to proactively manage peak flows through regulation and annual repair/replacement projects. City Code 15.04.040.H prohibits any new stormwater connections to the combined or separated sewer systems. The City budgets one percent of the collection system value (estimated at over $1 million per year) with the goal of repairing or replacing aged and leaky collection system lines, and further reducing the amount of I/I that enters the system. These improvements will continue in the future, and are included in the financial and rate analysis documented in Chapter 12 of this Plan.



COMBINED AND SEPARATED SEWER AREAS

FIGURE 6.9

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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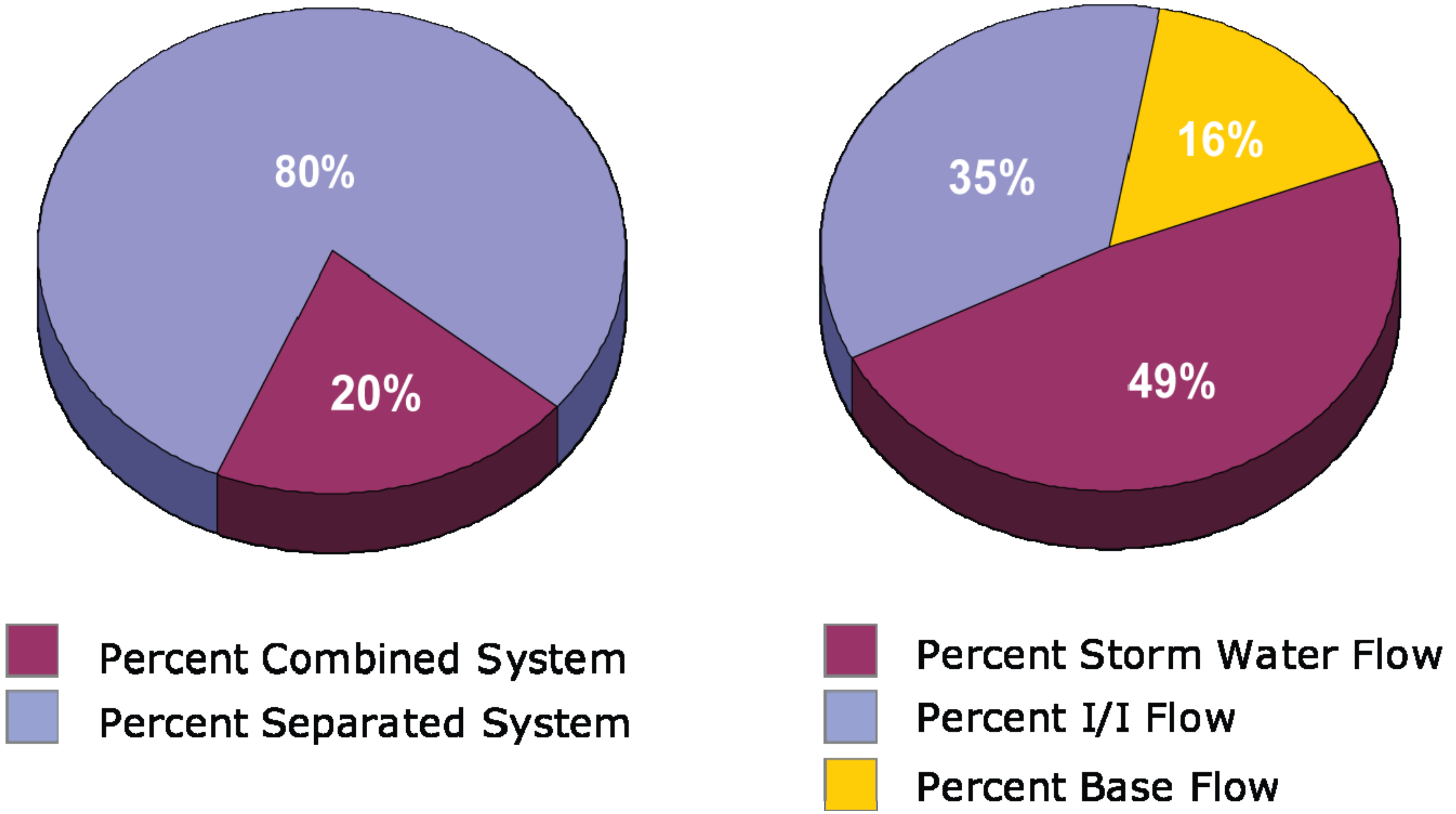

RELATIVE PEAK FLOW CONTRIBUTIONS

FIGURE 6.10

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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6.8 FUTURE PEAK FLOW MANAGEMENT ALTERNATIVES

Additional improvements (i.e., beyond the City's historic and ongoing programs to reduce peak flows) will be required to comply with CSO control regulations. Management of excess peak flows can be achieved two ways. Flows can either be managed within the collection system or conveyed to the WWTP. Alternatives that are evaluated in this study included treatment, storage, peak flow reduction, or combinations of these approaches.

6.8.1 Flow Management Within the Collection System

The peak system flows occur very infrequently and are substantially higher than the average flows. Given the lack of capacity in the collection system and at the WWTP, it may be cost effective to manage the peak flows within the collection system using remote storage or HRT, by constructing additional improvements in the collection system to further separate stormwater connections (in the combined system) and reduce I/I (in the separated system), or through a combination of these approaches. Options to manage peak flows in the collection system are evaluated in Chapter 7.

6.8.2 Convey Excess Peak Flow to the WWTP

The second wet weather flow management option is to convey peak flows to the WWTP and provide storage or increased treatment capacity at the plant site. WWTP upgrades for this option are developed in Chapter 10. Conveyance system upgrades required for this option are described in Chapter 7.

Figure 6.11 shows a plan view of the conveyance system backbone. The interceptor sewer between Oak Street and the WWTP is operating at capacity in 2005 during large storms, as defined by the performance criteria previously outlined in this Chapter. The H2OMAP Sewer model indicates that peak flows caused by the November 2004 and 10-year storms cause three manholes along the interceptor to fill within two feet of the rim. The interceptor profile and HGLs, between the end of the Oak Street force mains at manhole U0093-Y01 and the WWTP, are plotted in Figures 6.12 and 6.13, for the two storm events. The manhole locations are marked with black vertical lines. Manholes that are within two feet of the rim are noted in the figures. There are also tee fittings along the length marked with maroon vertical lines. Tee fittings are locations where a lateral trunk enters the interceptor but connect directly to the interceptor without passing through a manhole.

Legend

- Modeled Lift Station
- Permanent Flow Monitor

All Sewer Pipes Pipe Diameter

- 30"
- 36"
- 42"
- 48"
- 60"
- Existing Sewer Boundary

Miles 0 0.2 0.4

CITY OF BELLINGHAM COLLECTION SYSTEM BACKBONE

FIGURE 6.11

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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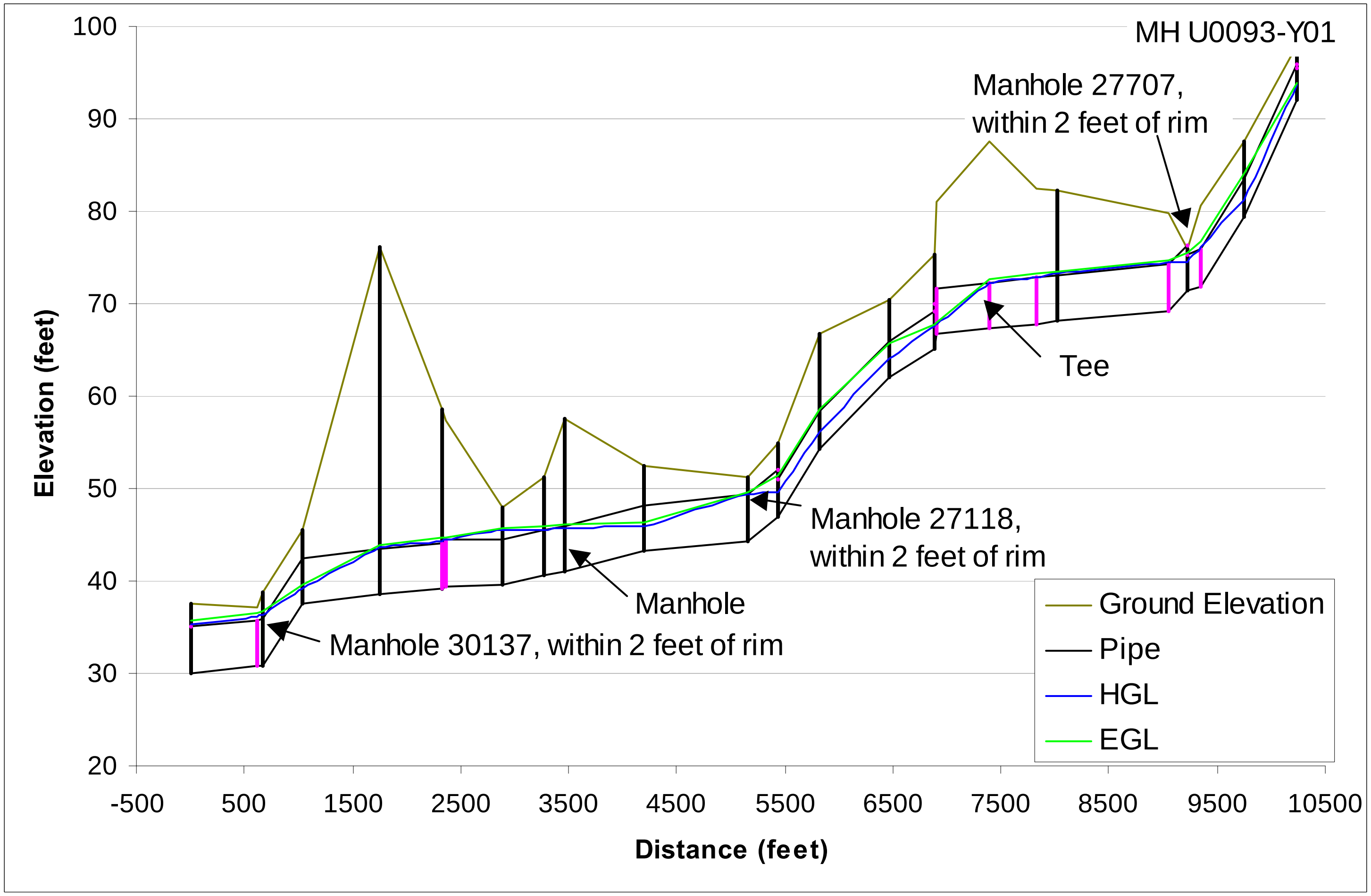

HGL FOR THE NOVEMBER STORM IN 2005

FIGURE 6.12

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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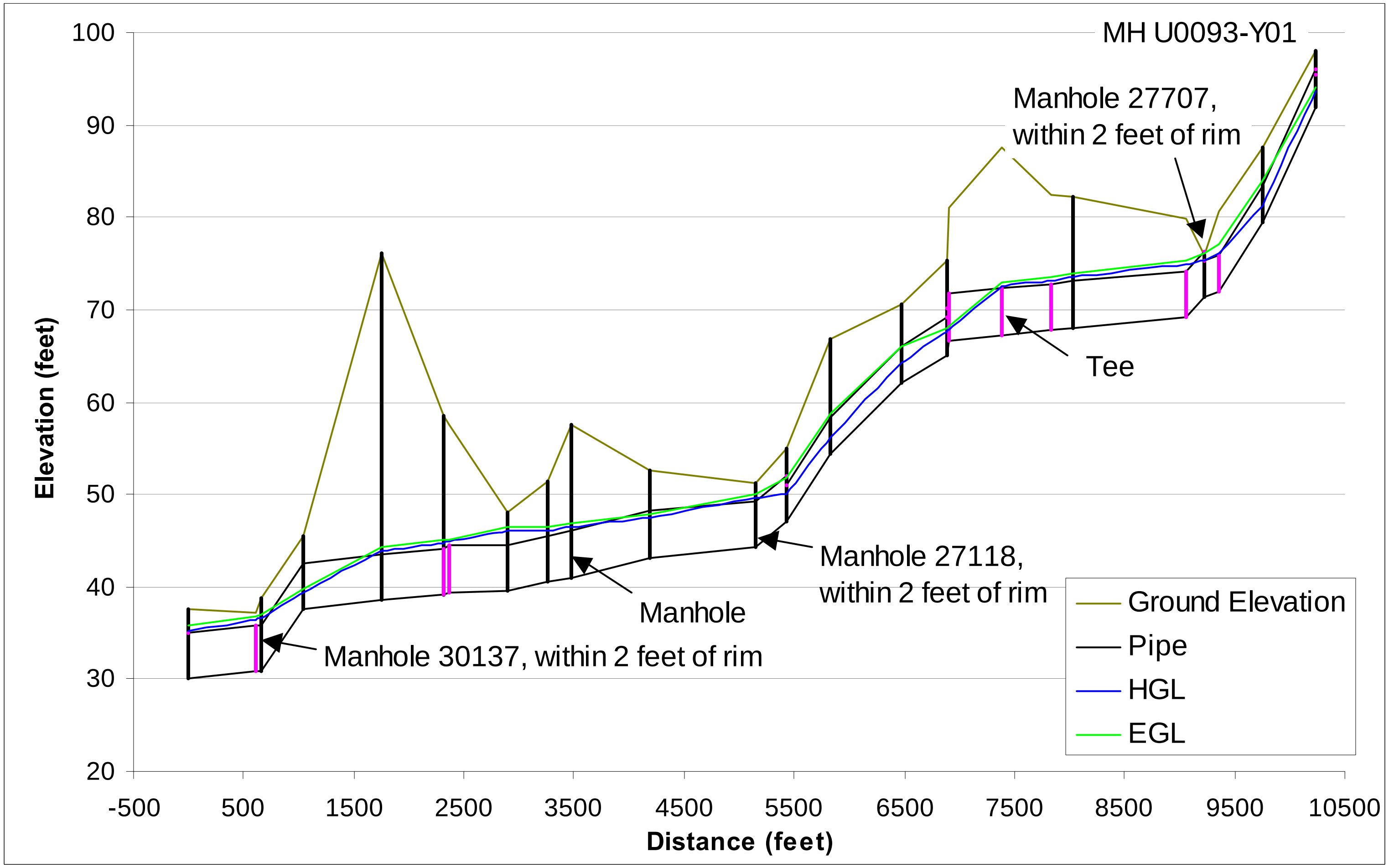

HGL FOR THE 10-YEAR EVENT IN 2005

FIGURE 6.13

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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6.9 SUMMARY AND CONCLUSIONS

Three storms were modeled and two were used to determine the peak wet weather flows in the collection system. Modeling the 1-year storm event did not produce sufficient flows to develop a reasonably conservative design. In 2005 the main system interceptor is at capacity for both the November 2004 and 10-year design storms, with depths nearing the rim elevation at several manholes in the main system interceptor.

Peak wet weather flows will increase from 2005 to 2026 due to increased population, and increased I/I resulting from new sewer development in the UGA. The increase results in excess wet weather flow that must be managed to limit CSO events to the allowable frequency and volume. LTS modeling shows the need for an additional 10 mgd of conveyance and treatment capacity, or 1.7 MG of storage to limit CSOs to one event per year in 2026. Additional improvements (i.e., more storage, greater treatment capacity, and/or low peak flow reduction) are required to maintain CSO volumes at their current "baseline" levels.

Two options for managing excess flow are evaluated in Chapter 7. The first option is to manage flows in the collection system, (remote treatment, storage, or peak flow reduction). The second option is to increase the capacity of the conveyance system, and deliver peak flows to the WWTP. This option will require upgrades at the WWTP, which are evaluated in Chapter 10 and the conveyance system upgrades described in this Chapter. The additional capacity can be provided by constructing parallel gravity sewers between critical manholes, to lower the HGL under peak flow events. The model runs for both the November 2004 and 10-year events showed very similar conveyance deficiencies. As such, the recommended system upgrades are sized to convey the 10-year peak to the WWTP.

6.9.1 Programmatic Recommendations

Regardless of which peak flow management option is selected, the City of Bellingham is committed to finding ways to reduce the response to rainfall in its combined and separated sewer systems. Several programs have been identified for early implementation, with the goal of continued peak flow reduction. Table 6.6 summarizes these programs and their anticipated implementation date. Brief descriptions of each program are included in the paragraphs that follow the table.

Table 6.6 Peak Flow Reduction Program Summary Comprehensive Sewer Plan City of Bellingham		
Program	**Benefit**	**Implementation Date**
Targeted downspout disconnection	Reduce known sources of inflow	2010
Side sewer rehabilitation incentives	Motivate home owners to reduce infiltration	2010
Field verification analysis (GIS, geotech, etc.)	Confirm site-specific conditions allow I/I reduction	2011
Green Stormwater Infrastructure (GSI) Campaign	Reduce rainfall response using GSI on residential, commercial sites	2011

Targeted downspout disconnection. There are several areas within the City of Bellingham's collection system that are known to be "partially separated". These areas have storm sewers that collect storm water from impervious areas in the public right-of-way (e.g. streets, sidewalks); however, rooftops, basement drains, and other storm water inflow sources are still connected to the combined system that was in use when the homes were built. A program to identify and provide incentive for further disconnection of storm water inflow sources in these areas is recommended.

Side sewer rehabilitation incentives. Example programs exist that provide incentives for home owners to investigate and rehabilitate their existing side sewers, which may be leaking and providing a significant source of fast response infiltration into the combined system. For example, low interest loans can be funded and used to help offset the cost of constructing new side sewers, ultimately providing benefits to the home owner as well as the utility.

Field verification analysis. Field conditions (e.g. GIS mapping, storm sewer location/capacity, soil conditions and slopes, flooding potential, etc.) should be verified as a component of all peak flow reduction programs. This will help identify any issues that may impede further disconnection from the combined system, reduce the risk of unintended flooding, and provide important communication materials during discussions with the affected public.

GSI campaign. There are many opportunities for individual homeowners to implement site improvements that will reduce the amount of stormwater that is generated in the urban and suburban landscape. Rain barrels, rain gardens, pervious pavement, and street trees are all tools that can be used in a neighborhood setting to reduce peak stormwater runoff. A public education program is recommended as the first step to building awareness and "grassroots" interest for these types of facilities in the Bellingham community.

RECOMMENDED COLLECTION SYSTEM IMPROVEMENTS

7.1 INTRODUCTION

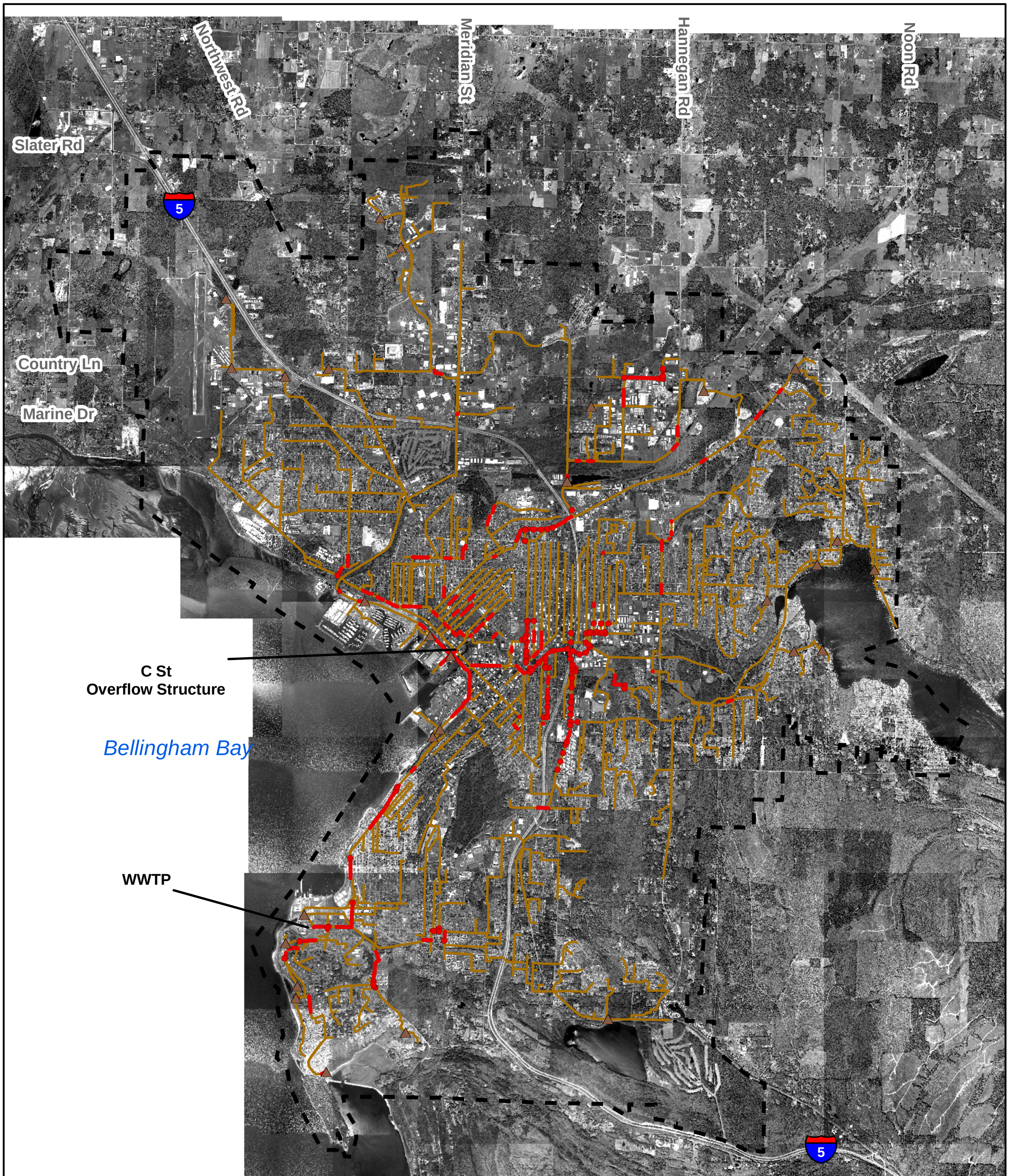
This Chapter summarizes improvements to the collection system that are needed to accommodate future flows, and to provide service to currently unsewered portions of the Urban Growth Area (UGA). Alternatives for managing peak wet weather flow are also presented. The analysis of peak flow management alternatives considers improvements required at the Post Point Wastewater Treatment Plant (WWTP), which are developed in Chapter 10. A summary of peak flow management alternatives that considers upgrades to both the collection system and the plant is presented at the conclusion of Chapter 10.

The capacity of the existing collection system is approximately 72 million gallons per day (mgd) upstream of the WWTP, as defined in Chapter 6. The majority of the system flow passes the combined sewer overload (CSO) location, then continues through the Oak Street Pump Station (Oak Street), and finally travels via gravity flow to the WWTP. Additional flows enter the system by gravity downstream from Oak Street. During wet weather events, Oak Street is used to regulate the total flow to the WWTP to approximately 72 mgd. This is accomplished using variable frequency drives (VFD) to set a maximum pumping rate, such that the pumped flow plus the downstream gravity flow does not exceed approximately 72 mgd. The pump station is typically operated with a maximum flow of 55 mgd, but may be increased to 60 mgd in extreme cases. When the inflow to Oak Street exceeds the maximum pump setting, flow backs up and is stored in the collection system. During extreme events, excess flow is discharged at the C Street CSO.

7.1.1 Basis of Collection System Capacity

As summarized in Chapter 6, two storm events were used for the capacity analysis: an actual 3-day storm that occurred in November 2004 and a 24-hour synthetic design storm based on a 10-year precipitation event. Design criteria were selected to identify capacity limitations in the collection system. The following conclusions were drawn from the modeling effort:

- The 10-year design storm produced higher peak flows than the November 2004 event.
- When the selected design criteria were applied, the model predicted that the capacity of various collection system segments was exceeded in 2005 for both the November 2004 and 10-year storms. Figure 7.1 shows the segments that are currently limited using the modeled November 2004 storm. Figure 7.2 shows the segments that are currently limited using the modeled 10-year storm. All of the components identified for the November 2004 event also present a problem for the 10-year event.



Legend

- Manholes Within 2 Feet of Rim
- Modeled Lift Station
- Modeled Collection System
- Future Sewer Service Area

November 2004 Storm

- Pipes with d/D = 1

Miles: 0, 0.8, 1.6

MANHOLES AND SEGMENTS WITH CAPACITY LIMITATIONS IN 2005 USING THE NOVEMBER 2004 STORM

FIGURE 7.1

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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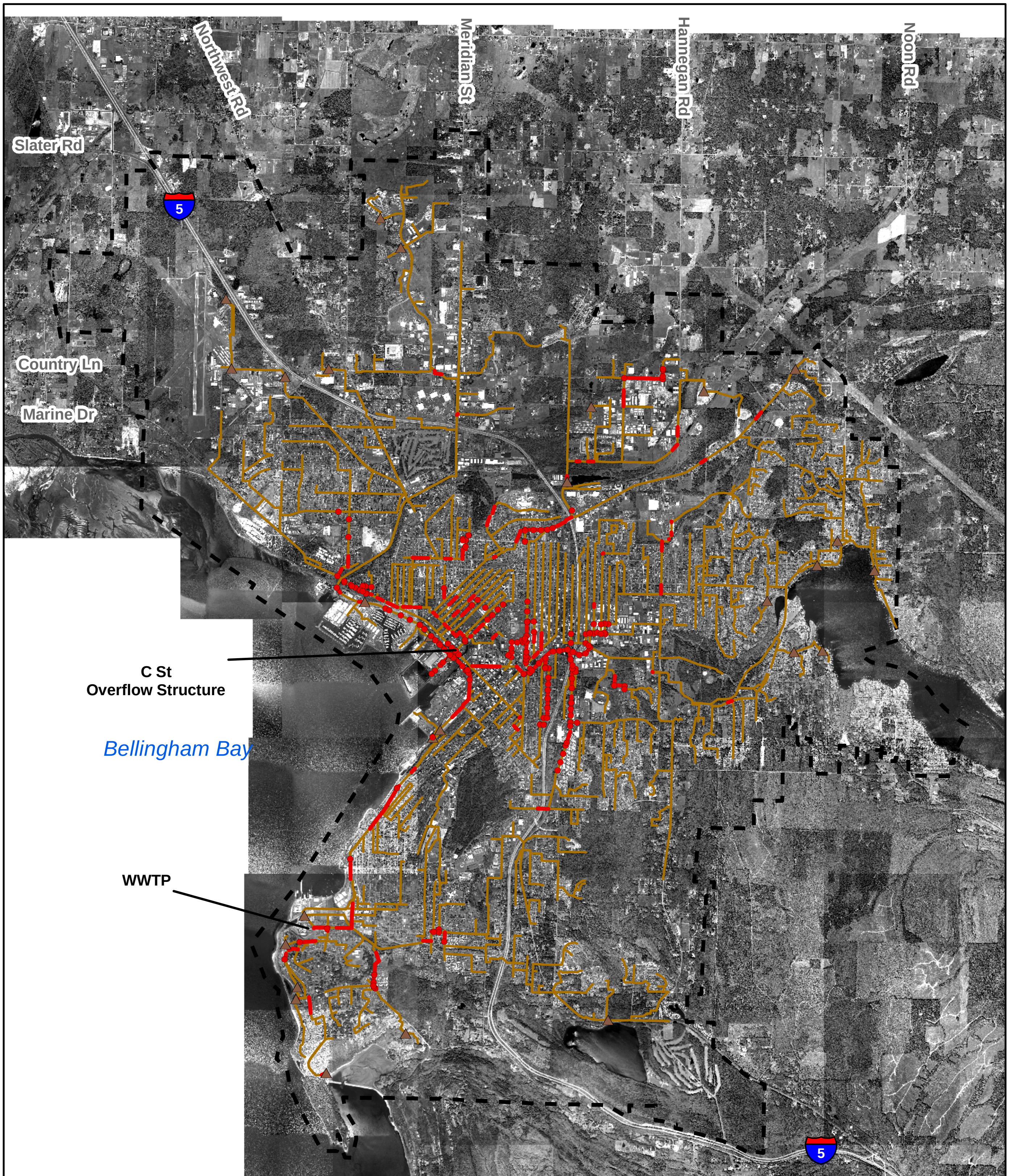

Legend

- Manholes Within 2 Feet of Rim
- Modeled Lift Station
- Modeled Collection System
- Future Sewer Service Area

10-Year Storm

- Pipes with d/D = 1

Miles: 0, 0.8, 1.6

MANHOLES AND SEGMENTS WITH CAPACITY LIMITATIONS IN 2005 USING THE 10-YEAR STORM

FIGURE 7.2

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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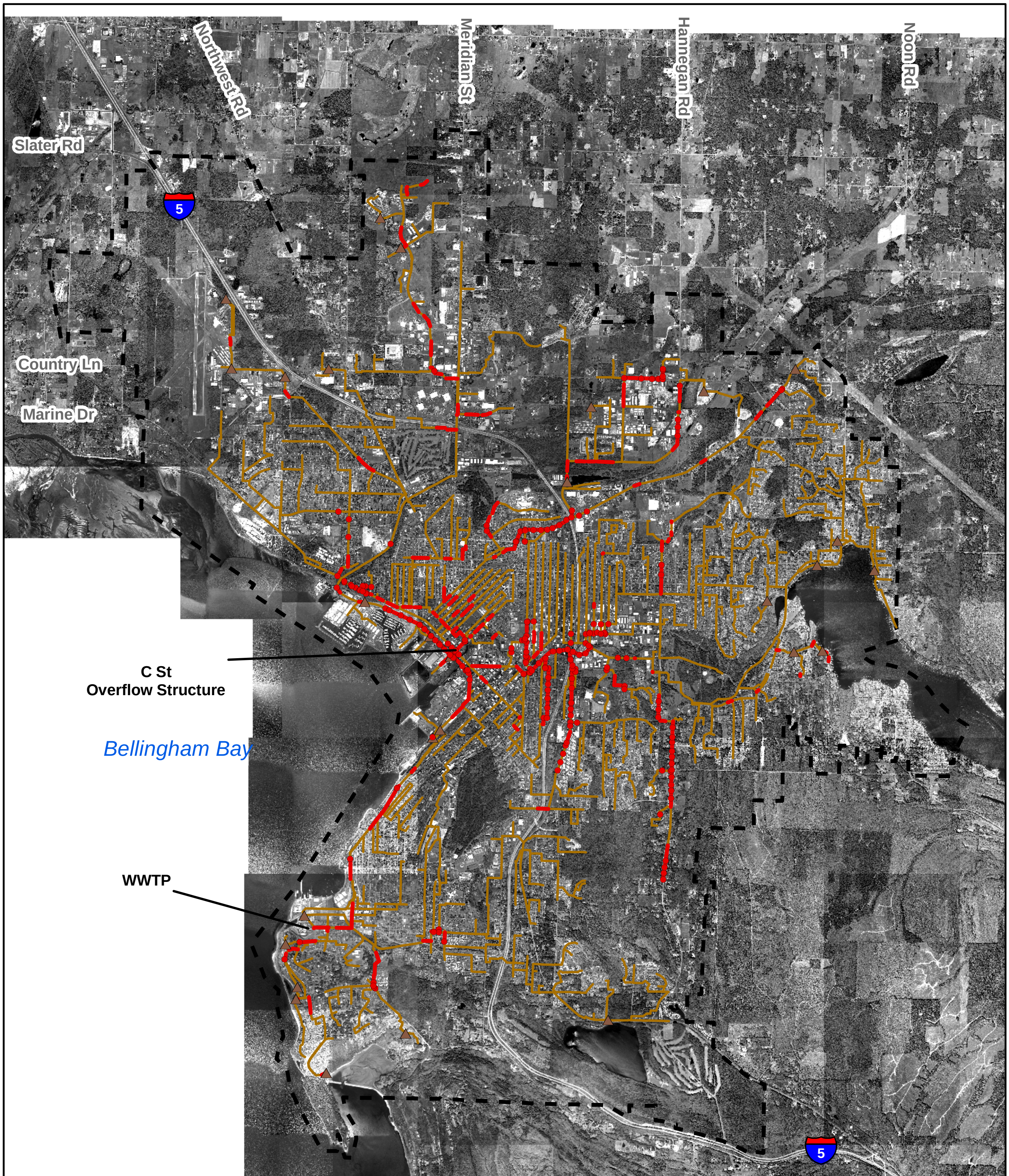
- The capacity of additional segments of the collection system will be exceeded as growth occurs through year 2026. Figure 7.3 shows the segments that will be limited in the future using the modeled November 2004 storm. Figure 7.4 shows the segments that will be limited in the future using the modeled 10-year storm.

The design criteria used to identify capacity limitations are somewhat conservative to account for uncertainties in the model. The City's experience with the collection system during recent wet weather events was considered along with the model results to develop a basis for determining capacity limitations. The collection system appears to have sufficient capacity based on recent storms, as the City has not had any permitted overflows in any of the past three wet weather seasons. Therefore, the less conservative November 2004 storm event was selected as the trigger for upsizing existing collection system segments, including smaller diameter piping within each basin as well as the conveyance system backbone to the WWTP.

While the November 2004 storm event triggers fewer segment improvements, the actual piping required to increase the capacity of any given segment is similar for both the November 2004 and 10-year events. The 10-year storm event is commonly used as the design basis for pipe sizing in many Northwest communities. This design basis provides additional capacity, reducing the risk of overflows and the potential need for future improvements. Therefore, the recommended approach to defining collection system improvements in the City's CIP is as follows:

- Estimate the new pipelines necessary to convey 2026 flows from currently unsewered areas of the UGA to existing providers of the collection system.
- Use the November 2004 storm event as the basis for identifying the length of pipe segments that must be upsized to increase conveyance capacity to accommodate flows in 2026.
- For those identified pipe segments, use the more conservative 10-year storm event as the design basis for selecting the diameter of new parallel or replacement pipe segments to accommodate flows in 2026.
- Phase in selected piping improvements as needed to accommodate future growth in the system. The phase-in of improvements is not included in this Chapter, only the total estimated improvements for 2026.



Legend

- Manholes Within 2 Feet of Rim
- Modeled Lift Station

November 2004 Storm

- Pipes with d/D = 1
- Modeled Collection System
- Future Sewer Service Area

0 0.8 1.6 Miles

MANHOLES AND SEGMENTS WITH CAPACITY LIMITATIONS IN 2026 USING THE NOVEMBER 2004 STORM

FIGURE 7.3

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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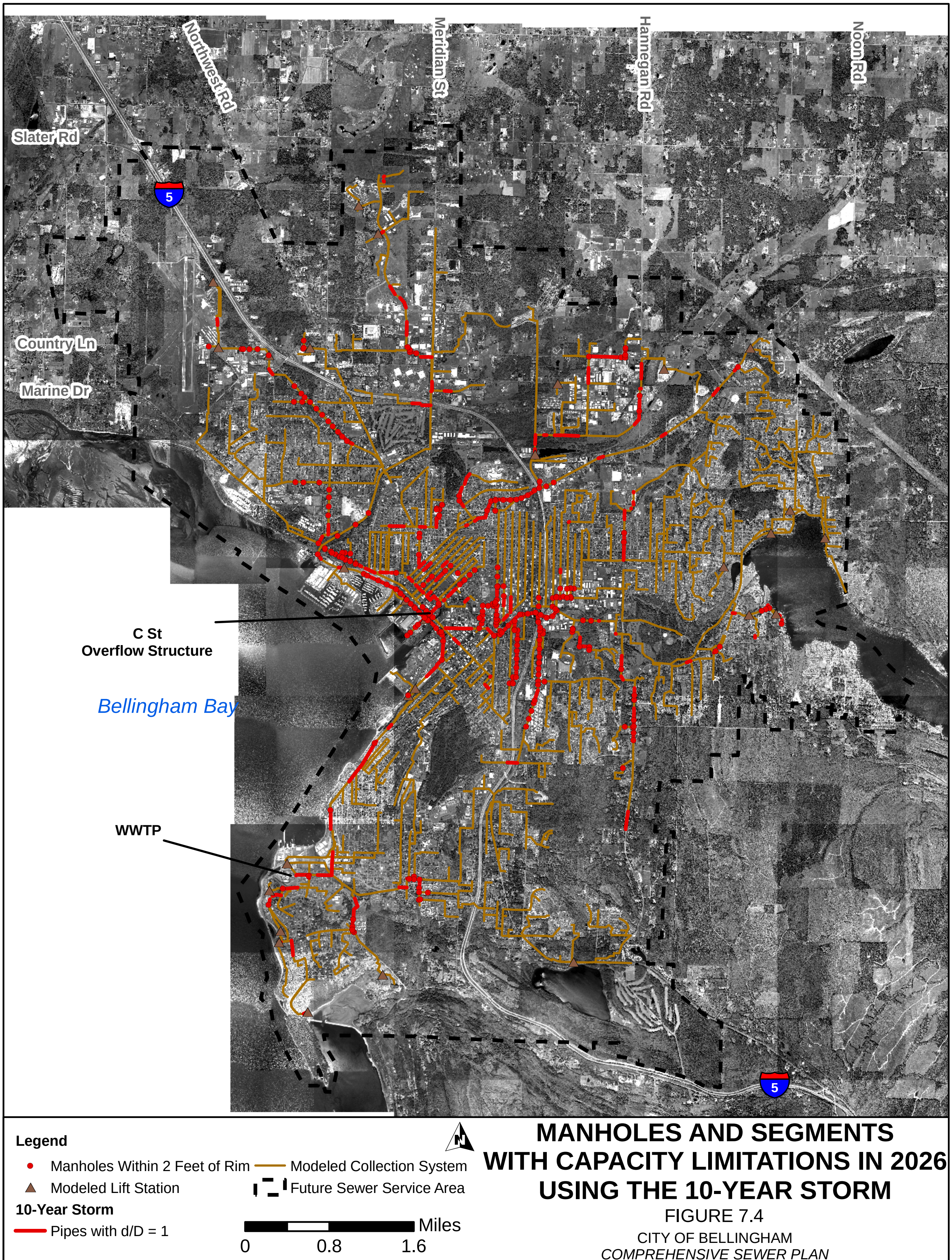

MANHOLES AND SEGMENTS WITH CAPACITY LIMITATIONS IN 2026 USING THE 10-YEAR STORM

FIGURE 7.4

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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7.1.2 Approach to Identifying Improvements

The approach to identifying collection system improvements that will be needed by Year 2026 was developed in three parts. First, improvements within the existing collection system basins that are needed to accommodate future flows were identified using the November 2004 storm event as the basis. Next, future sewer service into new areas of growth within the UGA was developed. These improvements are discussed in Section 7.2 of this Chapter. The third part of the analysis involves potential expansion of the conveyance system backbone between the C Street CSO location and the WWTP, which would be required if the selected peak flow management alternative was to convey all flows to Post Point. Section 7.3 presents the upgrades required for this alternative.

7.2 RECOMMENDED COLLECTION SYSTEM IMPROVEMENTS

The existing collection system will require improvements to increase conveyance capacity for future flows. In addition, new sewers must be added to connect newly sewered areas in the UGA with the existing system as new areas are developed.

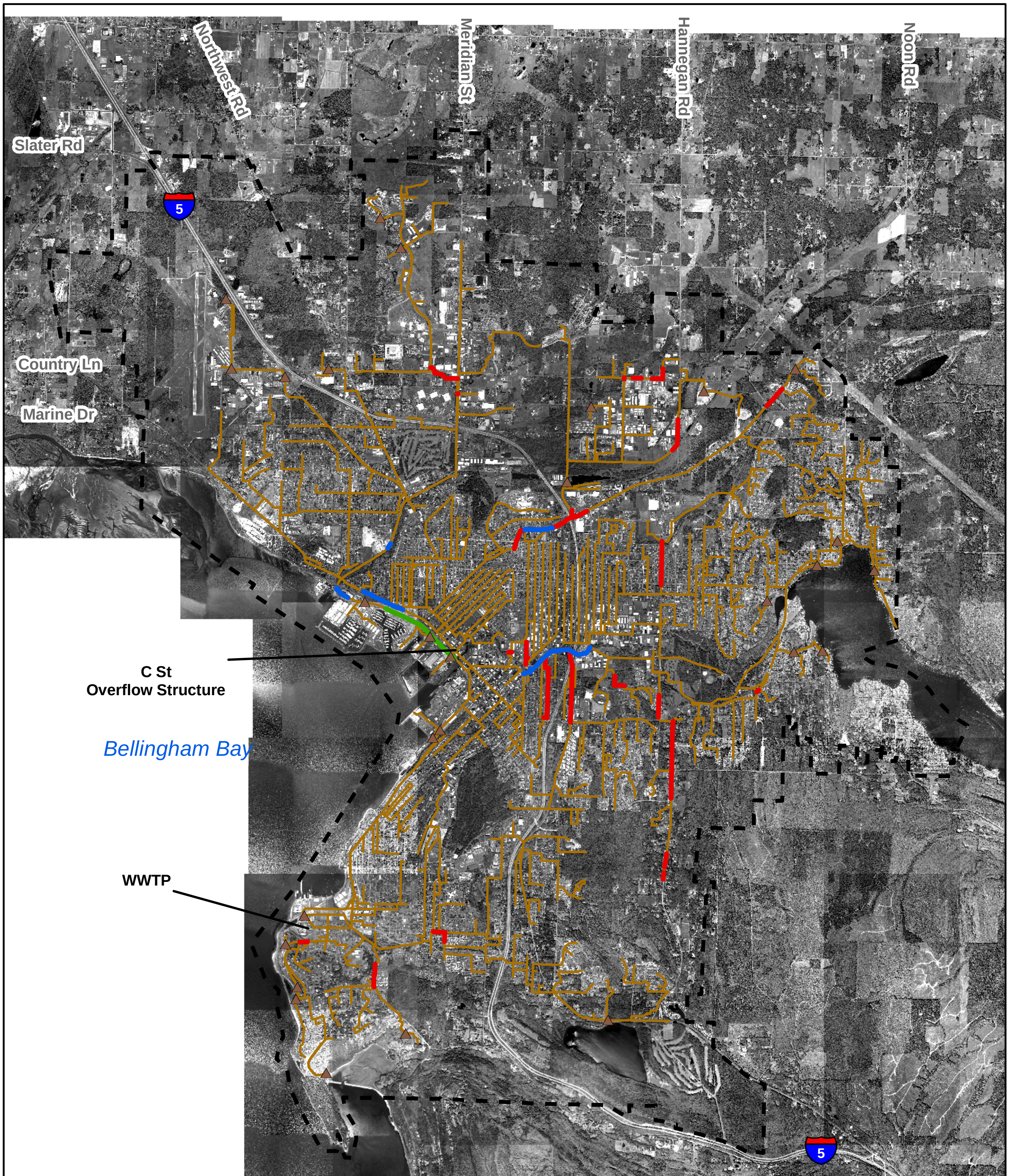
7.2.1 Existing Collection System Improvements

Model runs for the November 2004 storm were used to identify capacity limited segments in the collection system basins under 2026 flow conditions. When the system was modeled using the November 2004 rain event in 2026, water surface elevations were within 2 feet of the manhole rims in 203 manholes. The manholes that are out of criteria in 2026 are summarized in Appendix J.

System improvements focused on reducing the hydraulic grade line (HGL) in manholes that were at risk of spilling. Two approaches were used to reduce the HGL: the segment could be replaced; or a parallel pipe could be added. For both approaches, the 10-year event was used for sizing the diameters of the new pipes.

Figure 7.5 highlights the pipe segments that are recommended for improvement throughout the collection system. Typically, pipes smaller than 12 to 16 inches in diameter were replaced with new larger pipes, although occasionally larger diameters were replaced if the segment was relatively short. Parallel piping was generally used for segments with diameter 20 inches and larger. A summary of the recommended pipe replacements and parallel pipe segments is shown in Appendix J.

The existing piping replaced with new segments should be sufficiently small that the flow can be diverted or temporarily held during connections into the system. For parallel line installation, the parallel line should be isolated from the primary line and only used during wet weather events. This will maintain higher scouring velocities in the existing pipe during average dry weather conditions, and facilitate construction sequencing. The gravity pipeline from Roeder Avenue Pump Station (Roeder PS) ties into the system between the C Street



Legend

- Modeled Lift Station
- Modeled Collection System
- Roeder Street Interceptor
- New Parallel Pipes
- Replacement Pipes
- Future Sewer Service Area

0 0.8 1.6 Miles

RECOMMENDED COLLECTION SYSTEM CONVEYANCE IMPROVEMENTS

FIGURE 7.5

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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CSO and Oak Street. Many of the manholes along this pipeline have rim elevations of 17.5 feet. During CSO spills, the HGL could be near or above the rim elevation of many of these manholes. Under these conditions, the pipeline may need to be isolated from the gravity line, and instead flow may have to be conveyed to the system with a force main.

7.2.2 System Expansion in the UGA

Several sewer alignments were added to the model to connect currently unsewered portions of the UGA. These pipes were identified to convey future flows and estimate the cost of providing expanded service within the UGA. Alignments were selected to follow streets leading into the expansion areas. It is likely that one future segment in the northwestern portion of the system will require a pump station. In addition, several segments may need either drop manholes or steep grades to minimize the depth of burial.

Proposed new segments are shown in Figure 7.6. Segment sizing and alignment will likely be refined during subsequent planning of new developments in the currently unsewered portion of the UGA. Segment lengths, upstream and downstream inverts, and connection locations assumed for CIP planning purposes are summarized in Appendix J.

7.2.3 Comparison with Previous Plan

The previous CIP identified a series of projects recommended to convey wet weather flows. Some of the projects were not completed. This modeling effort has identified similar conveyance deficiencies during peak wet weather events in many of the system segments. Figure 7.7 shows the formerly recommended conveyance improvements. These improvements were reviewed and capacity limitations were included in the recommended improvements.

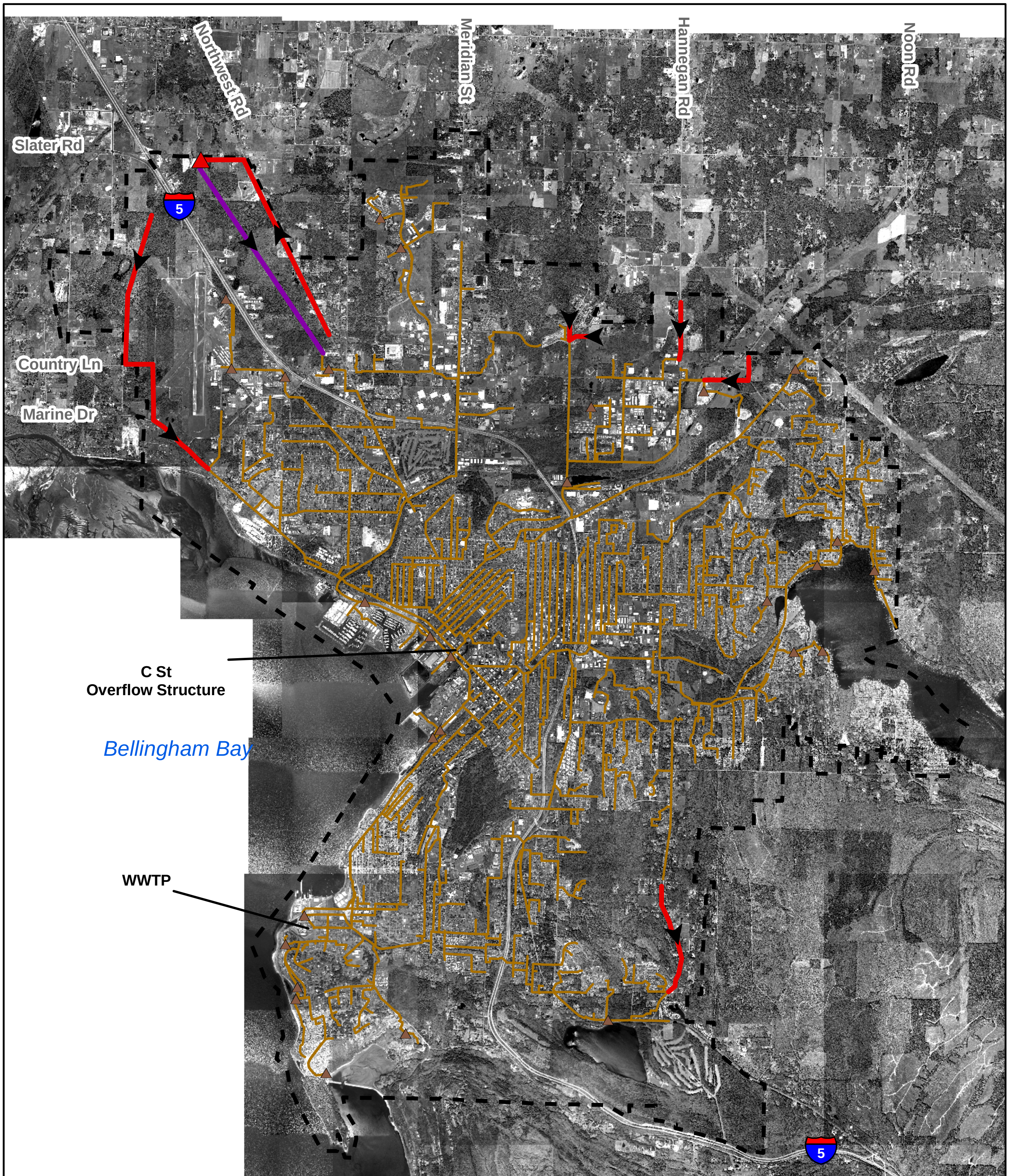
Many of the potential problem areas identified in the previous CIP could still present problems. It is possible the population growth patterns did not follow the predictions used previously. The system is highly sensitive to storm events, with peak elevated HGL only occurring for a few hours. It is possible that a storm cycle has not occurred similar to conditions modeled.

7.3 PEAK FLOW MANAGEMENT ALTERNATIVES

The analysis in Chapter 6 identified capacity limitations in the conveyance system that must be eliminated to increase system capacity and control future CSOs. Two peak flow management alternatives are further defined and evaluated in the following sections.

7.3.1 Basis of Peak Flow Management Alternatives

Alternative 1 assumes that improvements in the collection system (i.e., flow reduction, remote storage, or HRT facilities) will be constructed to control untreated overflow events.



Legend

- Existing Lift Station
- New Lift Station to Serve UGA
- Flow Direction
- Modeled Collection System
- New Force Mains to Serve UGA
- New Sewers to Serve UGA
- Future Sewer Service Area

Miles
0 0.8 1.6

NEW SEWERS TO SERVE UGA

FIGURE 7.6

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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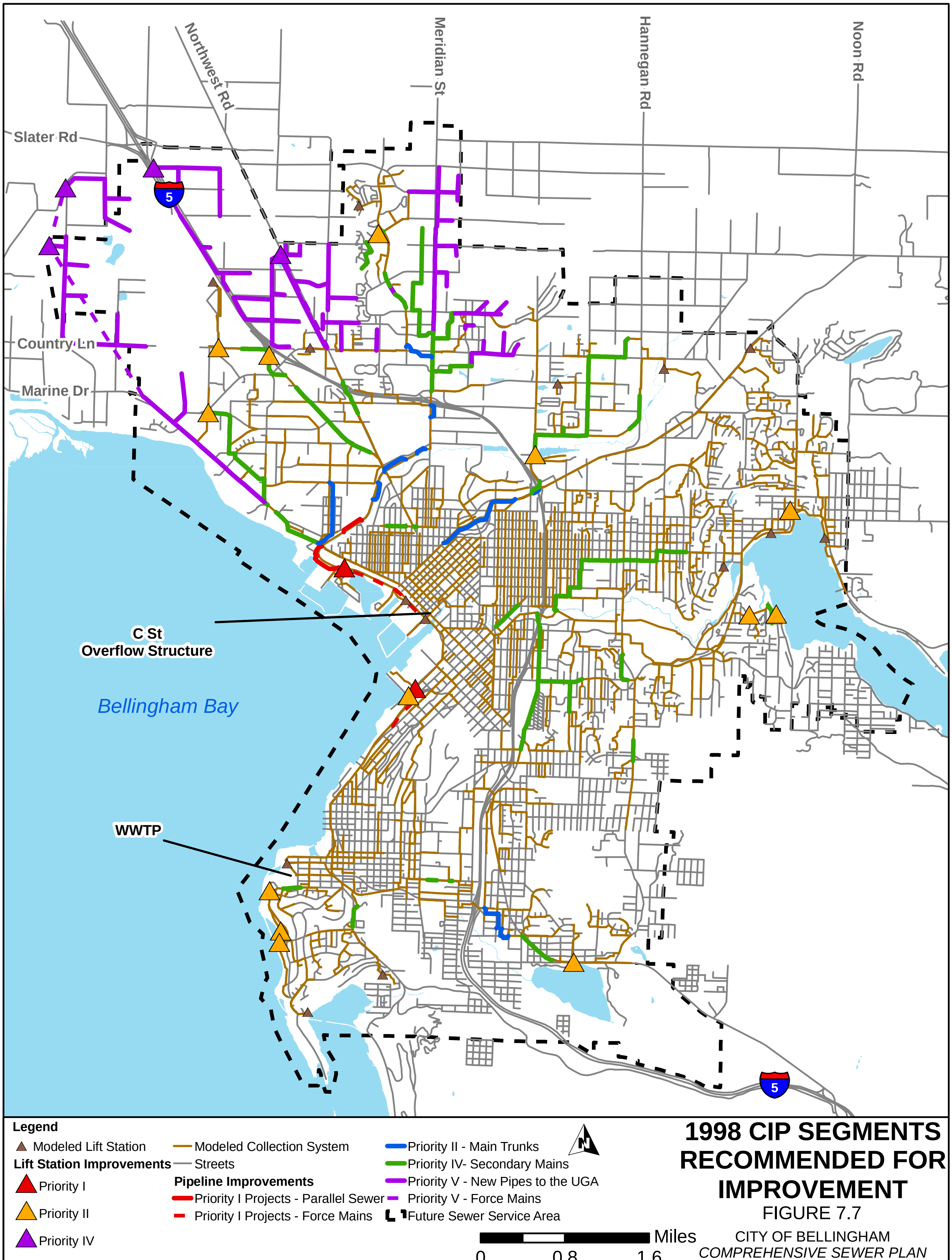

1998 CIP SEGMENTS RECOMMENDED FOR IMPROVEMENT

FIGURE 7.7

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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No improvements to increase conveyance capacity in the backbone (interceptor between Oak Street and the WWTP) are required for this alternative.

For Alternative 2 the capacity of the collection system backbone is increased to convey excess flow to the WWTP. If this alternative is selected, an increase in plant capacity and/or wet weather facilities would be required at the WWTP site. There are several subsets to each alternative as described in the following sections.

LTS modeling was developed as the design basis for sizing wet weather facilities. Consideration should be given to future expansion of wet weather facilities. Expansion may be needed to provide additional storage or treatment capacity if the capacity of facilities sized from the LTS design basis is exceeded within the planning period.

7.3.2 Alternative 1 - Manage Peak Flows in the Collection System

As described in Chapter 6, modeling of the City's combined and separated sewer collection systems indicates that over 50 percent of peak flows comes from storm water connections in the combined system, and I/I in the separated system. The City has completed, and will continue to complete projects to reduce this peak flow component. These projects comprise a major component of the City's overall CSO control strategy, but are not considered a feasible "stand-alone" approach to controlling CSOs to meet regulatory requirements for several reasons, including: 1) high relative capital cost (order of magnitude estimates for extensive flow reduction projects range from $30,000 to $50,000 per acre); and 2) schedule (CSO controls must be implemented in the near-term to meet regulatory requirements, and an extensive peak flow reduction campaign will take years to develop and implement).

Additional information beyond the scope of this Comprehensive Sewer Plan is required to better target future storm water separation and I/I reduction projects. An I/I study is recommended as an element of the City's CSO control program and CIP. The scope of this study would include more detailed flow monitoring, sewer system inspection and evaluation, smoke and/or dye testing, and development of cost-effective options to reduce future peak flows.

A combination of remote peak flow management alternatives (storage/HRT and peak flow reduction) is recommended to control CSOs under Alternative 1. Through planning level investigation of the collection system, a potential location to site a remote storage or treatment facility was identified near the C Street CSO. A large percentage of the system flow travels through this location, and controlling Oak Street currently regulates CSO events that occur here. From a technical standpoint, the site is well suited for remote wet weather management. A wet weather facility located somewhere in the vicinity of the C Street overflow could effectively intercept overflows before they are discharged into Bellingham Bay, with relatively minor piping and pumping requirements.

Figure 7.8 shows the potential vicinity for constructing a remote storage or treatment facility. The area south of the CSO is currently a combination of light industrial and manufacturing businesses. Urban planning efforts call for future mixed use in the vicinity, with continued light industrial, and open space near the current CSO outfall (Christensen Design Management 2006). The larger surrounding area is identified for redevelopment as waterfront mixed use consisting of multifamily residential and retail, allowing for recreational access to the Whatcom Creek Waterway and Bellingham Bay. A wet weather facility located in this area would likely need to address aesthetic issues such as odor and visual impacts, with a minimal footprint designed to blend into the surrounding area.

7.3.2.1 Alternative 1A - Remote Storage and Peak Flow Reduction

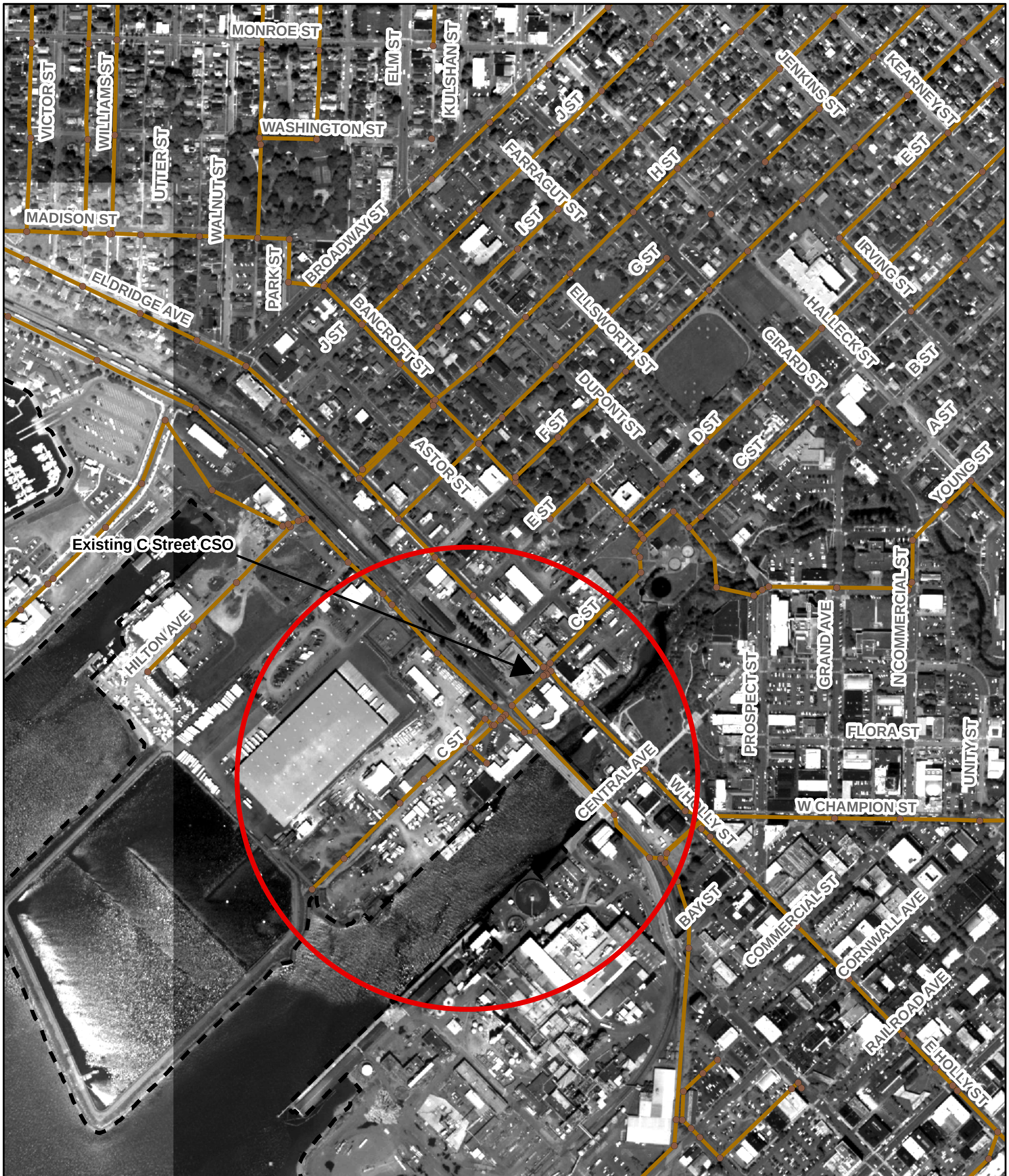
Storage of peak flows is a relatively common practice in the Northwest. The City of Seattle and King County both utilize remote storage in their collection and conveyance systems as part of their overall CSO control strategies. Peak excess flows are captured prior to overflow, and stored during duration of the wet weather event. When flows recede following the event, stored flow is transferred back into the collection system for downstream treatment at the WWTP.

Various storage configurations can be effective for CSO control, depending on the required storage volume, site constraints, and topography. This planning level analysis assumes a 1.7 million gallons (MG) rectangular, off-line storage tank would be used in the vicinity of the C Street CSO location. Based on the LTS modeling described in Chapter 6, a storage basin of this size would control CSOs to baseline levels through year 2016. Additional peak flow reduction improvements would be required beyond year 2016 to control CSOs to their baseline volume levels through year 2026.

The storage basin would be cast-in-place concrete, approximately 20 feet deep. During an event, the basin would fill by gravity, and following the event it would be dewatered by pumping over a 24-hour period. Automated self-cleaning features would include a sloped bottom and spray nozzles located around the basin perimeter. Above grade odor control and electrical facilities would be required at the site.

The cost of remote storage facilities can vary depending on site and subsurface conditions, land use of the surrounding area, and other factors. Cost curve data are typically used to develop storage costs for planning level analysis. For the basin sizes considered for the City, unit costs for remote storage range from $2 to $4 per gallon of tank volume. These unit costs do not include costs for easement and land acquisition, site piping, mitigation, and other such project costs.

There are significant non-cost factors to consider relative to remote storage of excess peak flows. Key advantages and disadvantages of Alternative 1A are summarized in Table 7.1.



Legend

- Modeled Manholes
- Modeled Collection System
- Potential Vicinity for Remote Wet Weather Facility
- Future Sewer Service Zone

N

0 0.1 0.2 Miles

POTENTIAL VICINITY FOR REMOTE WET WEATHER FACILITY

FIGURE 7.8

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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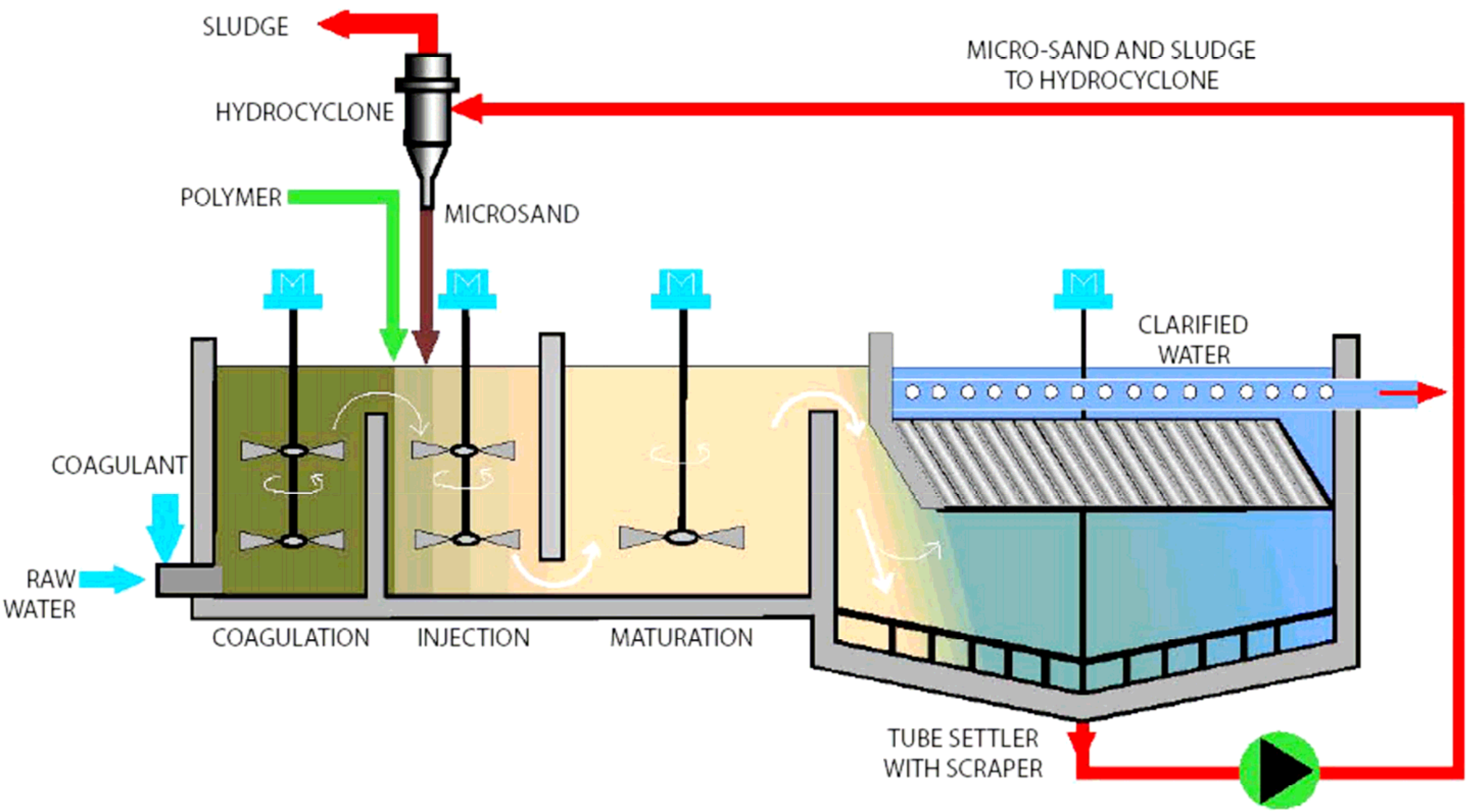
Table 7.1 Alternative 1A - Non-cost Considerations Comprehensive Sewer Plan City of Bellingham	
Advantages	**Disadvantages**
• Relatively low impact on O&M. No treatment process equipment to maintain for infrequent use. • Limited permitting issues (no new discharge required).	• Risk of overtopping storage and/or not being able to empty storage prior to next event. • Limited flexibility for expansion, if tank footprint becomes large.

7.3.2.2 Alternative 1B - Remote HRT and Peak Flow Reduction

HRT processes have proven to provide high quality effluent and equivalent or superior removal efficiencies relative to conventional secondary treatment operating under high flow events. HRT facilities commonly combine high rate clarification with ultraviolet (UV) disinfection to treat peak flows in a limited footprint. High rate clarification processes use chemical and physical treatment to achieve solids removal at very high surface loading rates (SORs). Whereas conventional sedimentation process for wastewater treatment are designed at SORs of approximately one gallon per minute per square foot of clarifier surface area (gpm/sf), high rate clarification processes for CSO treatment can be successfully operated at SORs exceeding 60 gpm/sf.

A process diagram for an Actiflo® high rate clarifier is shown in Figure 7.9 The process consists of chemical stabilization with enhanced settling promoted through the addition of a microsand ballast. Chemical treatment is achieved by adding an aluminum or iron based primary coagulant, and polymer. Once coagulation has occurred, the polymer promotes the agglomeration of the floc and microsand. High-density microsand floc is settled in a clarifier equipped with tube or plate settlers to reduce solids carryover. Clarified effluent is collected in launders located above the settlers, and disinfected. The settled microsand floc (sludge) is continuously pumped through a hydrocyclone to separate the sludge from the microsand particles. In remote wet weather facilities, the sludge is typically discharged back to the conveyance system, and the washed microsand is pumped back into the process for reuse.

UV is the most common disinfection process used for HRTs, as it has a small relative footprint and requires no chemical storage. The level of inactivation that is achieved through UV is a function of the amount UV light received by a microorganism. UV absorbance of wastewater generally decreases continuously with increasing wavelength. Correspondingly, UV transmittance increases. Destruction of *E.coli* using UV disinfection is impacted primarily by the UV transmittance of the clarified effluent. However, constituents such as iron that are strong absorbers of UV light also shield bacteria from exposure, causing poor log reduction of bacteria even when UV transmittance is high. Therefore, aluminum coagulants are required when UV disinfection is used.



ACTIFLO® HIGH RATE CLARIFIER
PROCESS FLOW DIAGRAM

FIGURE 7.9

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

The City of Salem, Oregon performed extensive pilot testing on simulated wet weather flows from January to March of 2001, and from January to March of 2002. The pilot program demonstrated that HRT systems are capable of consistently achieving greater than 85 percent removal of total suspended solids (TSS), and from 50 to 70 percent removal of biochemical oxygen demand (BOD) during periods of dilute influent concentration. Log inactivation of *E.coli* was sufficient to meet limits of 126 colonies per 100 milliliters (ml) on a geometric mean basis, with no samples greater than 406 colonies per 100 ml.

A summary of typical process performance for HRT processes is shown in Table 7.2. Based on these results and subsequent evaluation of wet weather management alternatives, Salem is constructing a remote HRT facility with a first phase capacity of 50 mgd. The City of Bremerton, Washington also has an operational HRT facility treating CSO events up to 25 mgd.

Table 7.2 Typical HRT Treatment Efficiency
Comprehensive Sewer Plan
City of Bellingham

Parameter	HRT Effluent (mg/L)	Percent Removal
TSS	3-5	85-95%
BOD	15-25	55-70%
E.coli	<126[1]	4-Log
Total P	0.07	96.0%
As	<0.002	----
Cd	<0.00005	50.0%
Cr	0.0005	58.3%
Cu	0.005	73.7%
Pb	0.00013	75.5%
Hg	<0.00005	58.3%
Ni	0.00039	22.0%
Ag	<0.0002	92.3%
Zn	<0.005	92.4%

Note:
(1) Colonies per 100 ml.

The 10-mgd HRT process train assumed for this analysis includes fine screens, high-rate clarification, UV disinfection, effluent (or influent) pumping, odor control, chemical feed facilities, and electrical and operations facilities. Preliminary sizing is based on treating design peak flows through the high-rate clarification process at an SOR of 60 gpm/sf. Based on the LTS modeling described in Chapter 6, an HRT of this capacity would control CSOs to baseline levels through year 2016. Additional peak flow reduction improvements would be required beyond year 2016 to control CSOs to their baseline volume levels through year 2026.

The cost of remote HRT facilities varies similarly to storage. For the capacities considered for Bellingham, unit costs for remote HRT range from $0.8 to $1.2 per gallon per day of capacity. These unit costs do not include costs for easement and land acquisition, site piping, mitigation, and other such project costs. There are significant non-cost factors to consider relative to treating excess peak flows with a remote HRT process. Key advantages and disadvantages of Alternative 1B are summarized in Table 7.3.

Table 7.3 Alternative 1B - Non-cost Considerations
Comprehensive Sewer Plan
City of Bellingham

Advantages	Disadvantages
• Flexibility for expansion beyond 10 mgd provided by small footprint of HRT facilities. • Flexibility to increase loading rates for peak flows. • Eliminates risk of not being able to empty storage prior to next event.	• Relatively high impact on O&M. Additional treatment process equipment to maintain for infrequent use. • Permitting issues (requires new discharge permit).

7.3.3 Alternative 2 - Convey All Flow to WWTP

The second alternative to peak flow management is to convey all flow in excess of the CSO to the WWTP. Figure 7.10 shows the conveyance system backbone for the City. There are three components to the primary portion of the conveyance system that must be upgraded to increase the flow from the C Street overflow location to the WWTP. These improvements are described below.

7.3.3.1 Improvements Upstream of the Oak Street Pump Station

The conveyance capacity of the C Street bypass piping from Manhole 2617 to 83303-05 may need to be increased to carry more flow past the CSO weir and on to Oak Street. Refinements in the flow modeling may demonstrate that this improvement is not needed. Costs for this piping improvement are included in this analysis, pending future evaluations during facilities planning. The pipeline in question is 36 inches in diameter and approximately 300 feet long. Constructing a parallel 36-inch diameter pipe would provide sufficient additional conveyance capacity for peak flows generated by the 10-year event.

7.3.3.2 Improvements to Oak Street Pump Station

The capacity of Oak Street will have to be increased in order to pump future peak flows to the WWTP. Oak Street currently has 3 pumps rated for 22 mgd and 2 pumps rated for 10 mgd. This results in a firm capacity of 64 mgd and a total capacity of 86 mgd. Modeling the November 2004 storm for 2026 conditions requires a pumping rate of 70 mgd. The 10-year event in 2026 will require a pumping rate of 80 mgd. Pump station capacity increases are required to convey the peak flows for both storm events.

Legend

- Modeled Lift Station
- Permanent Flow Monitor
- Improvement Required to Increase Flow Past C Street CSO
- Insufficient Conveyance at 72 mgd
- Insufficient Conveyance at 92 mgd

All Sewer Pipes
Pipe Diameter

- 30"
- 36"
- 42"
- 48"
- 60"

Existing Sewer Boundary

Miles: 0 0.2 0.4

PRIMARY INTERCEPTOR PIPING UPGRADES TO INCREASE CONVEYANCE TO WWTP

FIGURE 7.10

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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Replacement of the 10 mgd pumps with 22 mgd pumps would increase the firm capacity to 88 mgd, which is sufficient for both the November 2004 and 10-year design storms in 2026. The pump station was upgraded as part of the 1998 CIP, and space for replacing these pumps was anticipated as a part of that project. Wet well hydraulics at peak flows were not investigated in this analysis, and should be verified.

7.3.3.3 Improvements Downstream of Oak Street Pump Station

The current capacity of the primary interceptor between Oak Street and the WWTP is 60 mgd. Segments of this interceptor will have to be upgraded to accommodate future peak flows generated by both the November 2004 storm and the 10-year event. These segments are highlighted in Figure 7.10. The cost of increasing the interceptor capacity assumes that segment capacity will be increased through the addition of parallel gravity lines. Current pipe segments are properly sized for average dry weather flow (ADWF) conditions. Parallel pipe segments would only be used during wet weather events to maintain velocities during typical flow conditions. To accommodate this requirement, diversion structures with overflow weirs could be constructed at each parallel junction. This also aids in construction, allowing the new junction structure and parallel piping to be installed prior to cutting into the existing pipeline.

To increase the wet weather conveyance from Oak Street to the WWTP, parallel piping was added downstream from manholes where the water level reached within two feet of the manhole rim at the modeled peak flow. Table 7.4 identifies the segments requiring parallel piping and lists the parallel pipe size.

Table 7.4 Segments Requiring Parallel Piping
Comprehensive Sewer Plan
City of Bellingham

Upstream Manhole Number(1)	Downstream Manhole Number(1)	Pipe Length (ft)	Current Pipe Diameter (in)	Parallel Pipe Diameter (in)
27707(2)	T82362-47	162	60	84
T82362-47	27302	1034	60	84
27118(2)	27009	962	60	96
30137(2)	T72022-01	55	60	96
T72022-01	928	611	60	60
26924	T72013-01	522	60	96
27009	27003	726	60	96

Notes:
(1) Manholes numbers starting with T indicate Tee connection.
(2) Manhole rim is less than 2 feet from pipe crown at 72 mgd.

Based on the planning level analysis, the cost to increase conveyance capacity to the WWTP is estimated at approximately $27 million. These upgrades will provide a total conveyance capacity of approximately 93 mgd, which is sufficient to convey year 2026 flows generated by the 10-year storm event. The capacity of the WWTP is currently limited to approximately 72 mgd. Upgrades to the plant's hydraulic capacity and/or wet weather facilities (i.e. storage or HRT) will be required at the plant. These upgrade options are discussed in Chapter 10.

7.4 SUMMARY AND CONCLUSIONS

The collection system was evaluated for two storm events: the November 2004 storm, and the 10-year design storm. The November 2004 storm event is recommended as the basis for identifying the pipe segment lengths that should be upsized. The 10-year storm is the recommended design basis for sizing the diameter of the parallel pipelines for these improvements to accommodate 2026 peak flows.

Flow modeling shows that components of the existing collection cannot convey future flows without risking overflows at manholes and/or at the current CSO. Collection system improvements identified in this Chapter include replacement of smaller pipes and parallel pipelines to increase capacities within the existing sewer basins.

Pipe sizes and preliminary alignments for new collection system service into the currently unsewered portion of the UGA are presented in this Chapter, to estimate future costs for comparison with other peak flow management alternatives. Actual alignments and sizes will be refined as specific projects are developed and areas within the UGA are incorporated into the existing system.

Alternatives for peak flow management are presented in this Chapter include alternatives to manage peak flows remotely near the existing CSO, and an alternative to convey future peak flows to the WWTP. An analysis of plant improvements needed for the full-conveyance alternative is developed in Chapter 10, including a summary and recommended peak flow management alternative based on relative cost and non-cost factors. Several programs are also recommended in Chapter 6 to reduce peak flow response to rainfall.

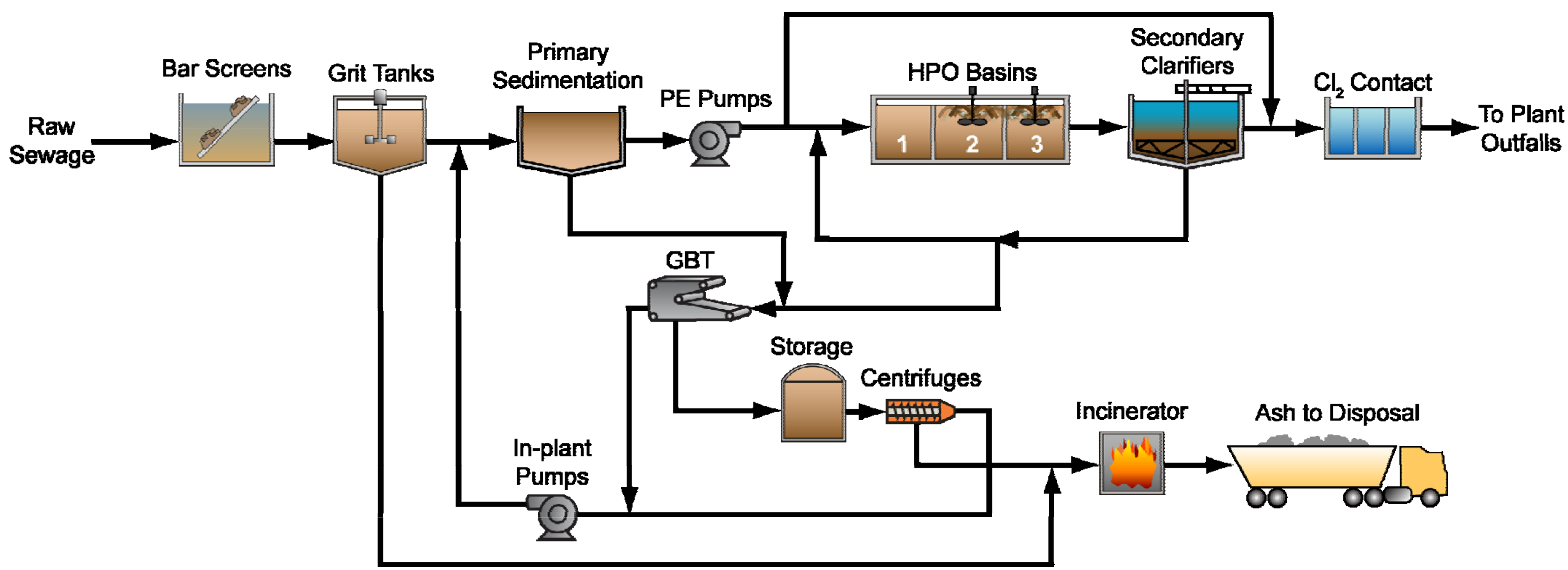
EXISTING TREATMENT FACILITY

8.1 INTRODUCTION

This chapter describes the City of Bellingham's existing Post Point Wastewater Treatment Plant (WWTP). The WWTP provides secondary treatment of wastewater prior to marine discharge in Bellingham Bay. The original WWTP at Post Point was built in 1974 to replace an aging treatment plant near the mouth of Whatcom Creek. The 1974 Post Point plant treated wastewater to primary effluent standards for two decades. A consent decree was issued in 1987 by the U.S. District Court, Western District of Washington to the City, requiring the WWTP to meet secondary treatment by the beginning of 1994.

In 1990, the facility was upgraded to provide full secondary treatment. A schematic of the treatment process is presented in Figure 8.1. The upgrade included the following major components:

- Expansion of administrative building.
- Additional storage building.
- New influent Parshall flumes.
- New mechanically and manually cleaned bar screens.
- New grit cyclones and classifiers.
- New chemical odor control scrubber for grit chamber.
- New primary effluent pumping.
- New pure oxygen activated sludge basins.
- New secondary clarifiers.
- Upgrade of chemical facilities.
- New gravity belt thickener system.
- New centrifuge dewatering system.
- Additional multiple hearth incinerator with odor control.
- New pump stations.



POST POINT WWTP SCHEMATIC

FIGURE 8.1

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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WA\Bellingham\7489A00\Deliverables\Comprehensive Sewer Plan\Fig08_1

8.2 DESIGN CRITERIA

The original design criteria for the WWTP are defined in the WWTP Upgrade Report, as well as in the general drawings from the 1990 design (CH2M HILL 1999). These criteria are summarized in Table 8.1.

Table 8.1 Post Point WWTP Summary Design Data(1)
Comprehensive Sewer Plan
City of Bellingham

Process Unit	Value
PRELIMINARY TREATMENT	
Mechanically Cleaned Bar Screen	
Number	3
Capacity Each	30.0 mgd
Width	6 ft
Manually Cleaned Bar Screen	
Number	2
Capacity Each	20.0 mgd
Width	8 ft
Screenings Press	
Number	2
Capacity Each	27.5 cf/hr
Septage Pumps	
Number	2
Type	Induced flow, recessed impeller
Capacity Each	150 gpm
Grit Chambers	
Number	2
Type	Gravity settling detritors
Capacity Each	> 150 mesh at 18 mgd > 100 mesh at 55 mgd
Dimensions	30-ft diameter
Grit Pumps	
Number	2
Type	Recessed impeller
Capacity Each	200 gpm

Table 8.1 Post Point WWTP Summary Design Data[1]
Comprehensive Sewer Plan
City of Bellingham

Process Unit	**Value**
Grit Cyclones	
Number	2
Capacity Each	200 gpm
Grit Classifiers	
Number	2
Type	Screw conveyers
Dimensions	16-in diameter
Grit Washdown Area Sump Pump	
Number	1
Type	Recessed impeller
Capacity	100 gpm
Odor Control	
System	Single-stage liquid scrubber
Chemicals	Sodium hydroxide, sodium hypochlorite
Scubber	10-ft diameter
Capacity	20,000 cfm (18 air changes/hour)
PRIMARY CLARIFICATION	
Clarifiers	
Number	2
Dimensions	120-ft diameter, 10-ft Side Water Depth
Capacity Each	30 mgd
Primary Sludge Pumps	
Number	2
Type	Piston type
Capacity Each	127 gpm at 55 ft TDH
Primary Scum Pumps	
Number	1
Type	Piston type
Capacity Each	85 gpm
Location	Primary sludge pumping station

Table 8.1 Post Point WWTP Summary Design Data(1)
Comprehensive Sewer Plan
City of Bellingham

Process Unit	Value
PRIMARY EFFLUENT PUMPING	
Pumps	
Number	4
Type	Vertical mixed flow, variable speed
Capacity Each	20 mgd
Maximum Capacity	60 mgd with 3 pumps in operation
SECONDARY TREATMENT	
Oxygen Activated Sludge Basins	
Number	2 basins, 3 stages/basin
Dimensions	150-ft x 50-ft x 15-ft Side Water Depth
Volume	1.68 total million gallons
Detention Time	2 hours at maximum month flow
F/M(2)	0.64
MLSS(2)	2,500 mg/L
Secondary Clarification	
Number	3
Size	120-ft diameter by 14-ft Side Water Depth
Peak Overflow Rate	1,500 gpd/sq ft
Return Activated Sludge Pumps	
Number	4
Type	Centrifugal, variable speed
Maximum Capacity	20.02 mgd with 4 pumps operating
Waste Activated Sludge Pumps	
Number	2
Type	Centrifugal
Capacity Each	400 gpm
Secondary Scum Pumps	
Number	2
Type	Air-operated diaphragm
Capacity Each	85 gpm
Location	Secondary sludge pumping station

Table 8.1 Post Point WWTP Summary Design Data[1]
Comprehensive Sewer Plan
City of Bellingham

Process Unit	**Value**
DISINFECTION	
Chlorinators	
Number	1
Type	V-notch
Capacity	2,000 lb/day
Number	1
Type	V-notch
Capacity	1,000 lb/day
Chlorine Residual Analyzers	
Number	2
Type	In situ, continuous
Chlorine Cylinder Scales	
Number	2
Size	3 cylinders/scale
Capacity	6,000 lb
Number	4
Size	2 cylinders/scale
Capacity	4,000 lb
Chlorine Cylinder Hoist/Trolley	
Number	2
Type	electrical cable hoists with motor operated trolleys
Capacity	2 tons
Chlorine Building Scrubber	
Type	Countercurrent packed tower scrubber
Chemical	Sodium hydroxide
Scrubber size	7-ft diameter
Capacity	60 air changes per hour

Table 8.1 Post Point WWTP Summary Design Data[1]
Comprehensive Sewer Plan
City of Bellingham

Process Unit	Value
FLOW MEASUREMENT AND SAMPLING	
Influent Parshall Flumes	
Number	3
Size	2-ft, 6-in throat
Capacity each	23 mgd
Location	Downstream from mechanical bar screens
Number	1
Size	1-ft, 6-in throat
Capacity Each	16 mgd
Location	Downstream from mechanical bar screens
Effluent Flowmeter	
Number	1
Size	Magnetic drive propeller
Capacity	75 mgd
Location	Upstream from chlorine contact basin
Effluent Parshall Flume	
Size	3-ft throat
Capacity	25 mgd
Location	Downstream from chlorine contact basin
Wastewater Samplers	
Type	Automatic composite samplers
Locations	Influent and effluent channels
Scum Storage	
Tank Capacity	5,400 gallons
Scum Concentrator Feed Pumps	
Number	2
Type	Progressive cavity
Capacity Each	15 gpm
Scum Macerator	
Capacity	400 gpm

Table 8.1	**Post Point WWTP Summary Design Data(1) Comprehensive Sewer Plan City of Bellingham**
Process Unit	**Value**
Scum Concentrator	
Size	36 sq ft
Capacity	1.25 gpm/sq ft
Concentrated Scum Pump	
Number	1
Type	Progressive cavity
Capacity	1.5 gpm
SOLIDS HANDLING	
Gravity Belt Thickening	
Number	2
Size	2 meter
Solids Loading Rate	150 gpm/meter
Thickened Sludge Concentration	5%
Sludge Storage	
Number	1
Type	Mixed
Capacity Each	75,000 gallons
Thickening Blowers	
Number	2
Capacity Each	400 cfm
Sludge Dewatering Centrifuge	
Number	3
Capacity Each	100 gpm
Dewatered Sludge Concentration	25%
Centrifuge Feed Pumps	
Number	3
Capacity Each	120 gpm
Hearth Furnace Incinerator	
Number	2 (1 existing, 1 new)
Size	14-ft, 3-in diameter by 7 hearths
Capacity each	5,400 wet lb/hr at 25% solids

Table 8.1	Post Point WWTP Summary Design Data[1] Comprehensive Sewer Plan City of Bellingham
Process Unit	**Value**
Sludge Cake Pumps	
Number	2
Type	Piston
Polymer System	
Bulk Polymer Storage Tank	4,000 gallons
Polymer Hopper	8 lb/min
Liquid Feed Pump	3 gpm
Transfer Pump	100 gpm
Mix Tank	260 gallons
Feed Tank	260 gallons
Feed Pumps	
Number	5
Type	Variable speed
Capacity	15 gpm
Odor Control	
System	2-stage liquid scrubber
Chemicals	Sodium hydroxide, sodium hypochlorite
Scrubbers	2 at 6-ft diameter
Capacity	8,500 cfs
NONPOTABLE WATER PUMP STATION	
Non-potable Water Pumps	
Number	2
Type	Vertical turbine, variable speed
Capacity Each	1,250 gpm
ONSITE SUBMERSIBLE PUMP STATIONS	
Raw Sewage Station Pumps	
Number	5
Type	Submersible, variable speed
Capacity Each	750 gpm

Table 8.1 Post Point WWTP Summary Design Data(1) Comprehensive Sewer Plan City of Bellingham	
Process Unit	**Value**
In-plant Station Pumps	
Number	3
Type	Submersible, variable speed
Capacity Each	900 gpm
Dewatering Station Pumps	
Number	1
Type	Centrifugal
Capacity Each	2,200 gpm

Note:

1. These data are derived from the Engineering Report, Table 10-1 and from Drawing 10-G-8 and Drawing 10-G-9 of the 1990 Design Drawing Set.
2. F/M = food-to-microorganism ratio, MLSS = mixed liquor suspended solids.

8.3 PLANT COMPONENTS

Each of the major components of the WWTP is briefly described in the following paragraphs.

8.3.1 Influent Bar Screens

Bar screens were installed in the secondary expansion project in 1990. The screens are located in a separate building called the Screenings Facility. There are three mechanical reciprocating rake screens, each 6 feet wide with a nominal capacity of 30 mgd. The screens are constructed from 2-1/2-inch by 3/8-inch stainless steel bars with a spacing of 3/8 inch. In addition to the mechanical screens, there are two manually raked screens, each 8 feet wide with a nominal capacity of 20 mgd. The manual screens are constructed of 2-1/2 inch by 3/8-inch aluminum bars with 1-inch openings.

A Parshall flume is located downstream of each bar screen. There are three 2-foot throat-width flumes for the mechanical bar screens and two 3-foot wide flumes for the manual screens. Bar screens are automatically controlled based on level in the upstream screen channels. Operation of the bar screens is controlled by either water surface differential or time, to initiate a cleaning cycle. Screenings are conveyed to screenings presses for dewatering and storage prior to disposal offsite.

8.3.2 Grit Removal

There are two gravity grit basins, each 30 feet in diameter. The grit basins were built prior to the 1994 expansion, and are gravity fed tanks with a grit collection mechanism. This type of grit removal system is commonly known as a “detritus” tank. New grit dewatering cyclones and grit washers were constructed in the 1994 expansion. The grit pumps that are in service predate the 1994 expansion.

8.3.3 Primary Clarifiers

The WWTP has two 120-foot diameter primary clarifiers originally designed for a peak capacity of 30 mgd each. The primary clarifiers remove settleable solids that would otherwise need to be removed in the secondary process. Conventional design of primary clarifiers is based on selecting an appropriate overflow rate to remove particles in the influent wastewater that have a settling velocity greater than the surface overflow rate (flow divided by surface area). At the original design flow for the WWTP of 60 mgd, the primary clarifiers’ surface overflow rate is 2,653 gallons per day per square foot (gpd/sf), which is reasonable for peak flow conditions.

8.3.4 Primary Effluent Pumps

The primary effluent pumps lift effluent from the primary clarifiers to the high purity oxygen (HPO) activated sludge basins. Design data for the primary effluent pumps are presented in Table 8.1. The pumps were installed as part of the secondary treatment expansion. The design rated capacity of each pump is 11,500 gallons per minute (gpm) or 16.5 mgd. The maximum firm capacity of the pump station would be 66 mgd, with one pump out of service. However, in the City’s Hydraulic Evaluation (Brown and Caldwell 2001), a field test was conducted which indicated that individual pump capacity was 17.6 mgd with the wet well level at an elevation of 16.2 feet. The evaluation estimated individual pump capacity at 18.3 mgd, with the wet well level at its maximum level of 19 feet. Therefore, with four pumps running (one pump out of service) and the wet well at the highest level, the station is reported to have a firm capacity of 73 mgd.

8.3.5 High Purity Oxygen Activated Sludge Process

Major components of the HPO activated sludge process include the HPO basins, the oxygen generation/dissolution system, and the secondary clarifiers. The plant has two HPO basins, each with a volume of approximately 0.84 million gallons (MG). The HPO basins are divided into three equal sized stages. The first stage in each basin originally contained a 40-horspower (hp) constant speed aerator. A recent upgrade project installed new 50-hp motors, new impellers, and variable speed drive controls to permit operation of the first stage in an anaerobic mode by turning down the speed of the impellers. The second stage in each basin originally contained constant speed 30-hp aerators. The recent upgrade project replaced the motors, gearboxes, and impellors in both second stage tanks with new 75-hp higher efficiency units equipped with variable speed drive controls for automatic control of dissolved oxygen concentration. The original 30-hp constant speed third stage impellers were upgraded to provide new 30-hp motors and higher efficiency impellers.

Oxygen is generated on-site using a pressure swing absorption (PSA) system. The PSA system utilizes two compressors to feed compressed air to three adsorbent vessels. The adsorbent vessels use molecular sieves to separate 90 percent pure oxygen from the compressed atmospheric air.

Bypass of the secondary treatment process occurs at an automatic overflow weir when flows exceed approximately 40 mgd. Bypass flow is directed to the chlorine contact basin, blended with secondary effluent, and disinfected prior to discharge.

The plant has three secondary clarifiers, each 120 feet in diameter with a side water depth of 15 feet. At the design peak flow of 40 mgd, the clarifiers have a surface overflow rate of 1,178 gpd/sf. There are four return activated sludge pumps with a combined capacity of 20 mgd. With one pump out of service, the firm capacity is approximately 15 mgd, or 37.5 percent of the design peak secondary flow of 40 mgd. There are two variable speed waste activated sludge pumps, each with a capacity of 400 gpm.

8.3.6 Disinfection

The WWTP uses gas/liquid chlorine for disinfection of wastewater effluent prior to discharge to Bellingham Bay. The chlorine system was upgraded during the 1990 expansion. Two feed channels were added to the existing contact tanks to increase contact time and other minor modifications were made to the contact tanks. New chlorine tank scales and chlorinators were installed in the Chlorine Building and a new chlorine scrubber was installed. The system has the capability for prechlorination, post chlorination, and intermittent chlorination of return activated sludge for sludge bulking control. Internal effluent water systems can also be chlorinated. The effluent from the chlorine contact chamber is dechlorinated with sodium bisulfite prior to final discharge.

8.3.7 Effluent Outfall and Flow Measurement

The WWTP has two outfalls. The main 60-inch diameter effluent outfall discharges to a multi-port diffuser that is approximately 81 feet below the City datum at mean lower low water (MLLW) in Bellingham Bay. The main outfall has a total length of 2,400 feet at an average slope of 23 percent. The second, 54-inch diameter outfall discharges approximately 500 feet from shore into Bellingham Bay, approximately 30 feet below the City datum. The 54-inch outfall is an overflow outfall which begins upstream of the effluent Parshall flume and is used only when flows exceed the capacity of the multiport diffuser. A replacement for this outfall is currently under construction.

Dilution calculations for the main outfall were included in the WWTP Upgrade Report (CH2M HILL 1989). The WWTP Upgrade Report calculated dilution ratios in Bellingham Bay with the main outfall varying from 224:1 for moderate current at 10 mgd to 48:1 at

60 mgd with no current. A recent study for the City determined that the capacity of the two outfalls together under conditions of maximum high tide elevation of 13.3 feet is 71.7 mgd (Brown and Caldwell 2002).

8.3.8 Gravity Belt Sludge Thickeners

Mixed primary and waste activated sludges from the secondary treatment system are pumped to gravity belt thickeners (GBT) for initial dewatering prior to storage and subsequent centrifuge dewatering and incineration. There are two, 2-meter GBTs, each with a design flow rate of 150 gpm. The original plant design called for separate thickening of waste activated sludge (WAS) in the GBT process, but plant staff have found that co-thickening can be achieved at higher loading to the GBT, resulting in a more efficient thickening operation.

8.3.9 Centrifuge Dewatering

Thickened primary and WAS is stored in a 75,000-gallon tank prior to dewatering. Stored solids are dewatered in solid bowl centrifuges prior to incineration. There are three centrifuges, each with a capacity of approximately 100 gpm of thickened sludge. Only one centrifuge is required for normal loadings under current conditions.

8.3.10 Incinerators

There are two multiple hearth incinerators at the WWTP. One unit was in service prior to the 1990 secondary expansion, and a second unit was added in the expansion. The older unit has a capacity of 1,050 pounds per hour (pph) of dry sludge. The newer unit has a capacity of 1,350 pph. The units are typically alternated and operated three to four days per week, 24 hours per day.

8.4 SOLIDS PRODUCTION AND MANAGEMENT

The WWTP separates solids from the influent wastewater in four different stages: the influent bar screens, grit separation, primary clarification, and secondary clarification. The average to maximum day solids production ranges from 30 to 90 ppd for screening, 4,000 to 12,000 ppd for grit, 7,000 to 18,000 ppd for primary sludge and 9,000 to 25,000 ppd for WAS.

8.4.1 Solids Management Program

Screenings are hauled to either the Birch Bay, Cedarville, or Point Roberts transfer stations. Thickened solids (a combination of thickened primary and secondary sludges, and grit), with an average concentration of 6.6 percent (96 percent recovery of solids) are dewatered in solid bowl centrifuges prior to incineration. Cake solids concentrations average 28 percent, with cake recovery averaging 97 percent. The incinerators produce on average 6 cubic yards per day of ash that is stored and hauled weekly to a landfill.

8.5 PRETREATMENT PROGRAM

The City's industrial pretreatment program is conducted by the Department of Ecology. The WWTP Upgrade Report (CH2M Hill 1989) contained a chapter evaluating sources and quantities of industrial waste loads into the WWTP. Based on the City's 1987 industrial sampling program, anticipated industrial loading estimates through the year 2013 were developed. Projected industrial flows amount to 7.4 percent of the total maximum month flow of 20 mgd. The projected maximum 30-day estimate for industrial BOD amounted to 12 percent of the permit limit of 25,530 ppd. The estimate for industrial TSS contribution was 8.4 percent of the design maximum month loading of 27,100 ppd.

8.6 OPERATIONS AND MAINTENANCE (O&M)

The Operations Division of the City's Public Works Department manages operation and maintenance (O&M) of the WWTP and collection system. Approximately 7 operations and 13 maintenance staff are responsible for O&M of the sewer system, pump stations, and plant facilities. In addition to these duties, staff is cross-trained to provide O&M of the water treatment and distribution system.

The plant is fully automated and has a Supervisory Control and Data Acquisition (SCADA) system, which provides operators with information needed to control the facility. The SCADA system is also to monitor and control key pump stations in the collection system, and the water treatment plant and distribution system from Post Point. The degree of automation allows for reduced staffing levels while maintaining a high level of redundancy. State certified plant operators are on duty 24 hours a day at the WWTP to monitor and control the treatment process.

WWTP staff is trained on emergency operational procedures. A Process Safety Management Plan and Emergency Response Plan are on file and the facility, and guide safety procedures and emergency operation. Plant reliability is provided by redundant equipment and backup power provided by two on-site generators. Routine preventative maintenance (PM) and corrective maintenance are performed by City staff.

The City operates a state certified laboratory at the WWTP. The laboratory performs compliance testing for the plant's NPDES permit, and process control testing for each unit process.

TREATMENT PLANT ANALYSIS

9.1 INTRODUCTION

This Chapter analyzes and establishes the capacity of the existing Post Point Wastewater Treatment Plant (WWTP). The design capacity of the WWTP is stipulated in the existing NPDES permit, expressed in terms of the design loadings that may not be exceeded for three consecutive months. Carollo Engineers completed a capacity analysis of the Plant in December 2004 which evaluated, as applicable, the individual capacities of each unit process. A more thorough analysis of the plant was conducted subsequent to the re-rating study as a part of this Comprehensive Sewer Plan (Plan). This analysis is based on a comprehensive modeling approach that considers individual process performance on overall plant performance. The results are consistent with the findings of the 2004 re-rating report, and serve as the basis for recommended upgrades presented in Chapter 10.

9.2 NPDES PERMIT REQUIREMENTS

The design capacity published in the current NPDES permit for the WWTP is expressed in terms of the design loadings that may not be exceeded for three consecutive months. The permit has other requirements including those for effluent toxicity testing and for a Wasteload Assessment in conjunction with the next permit application. The permitted maximum month flow and load values as stipulated in the existing permit are summarized in Table 9.1.

Table 9.1 NPDES Permit Capacity Requirements
Comprehensive Sewer Plan
City of Bellingham

Parameter	Units	Permitted Maximum Month Value[(1)]
Max Month Flow	Million gallons per day (mgd)	20
Biochemical oxygen demand (BOD_5)	Pounds per day (ppd)	25,530
Total suspended solids (TSS)	Pounds per day (ppd)	27,100[(2)]

Notes:
(1) NPDES Permit WA-002374-4, S4 A-B.
(2) The City has requested an increase in the maximum month TSS load to 47,000 ppd.

A re-rating evaluation found that the WWTP had the capacity to treat maximum month BOD and TSS loads of 25,530 and 47,000 ppd, respectively. (Carollo Engineers 2004). Based on these results the City has requested an increase in the maximum month TSS load to 47,000 ppd.

The current permit contains effluent limitations for BOD_5, TSS, fecal coliform, pH, and total and residual chlorine as shown in Table 9.2.

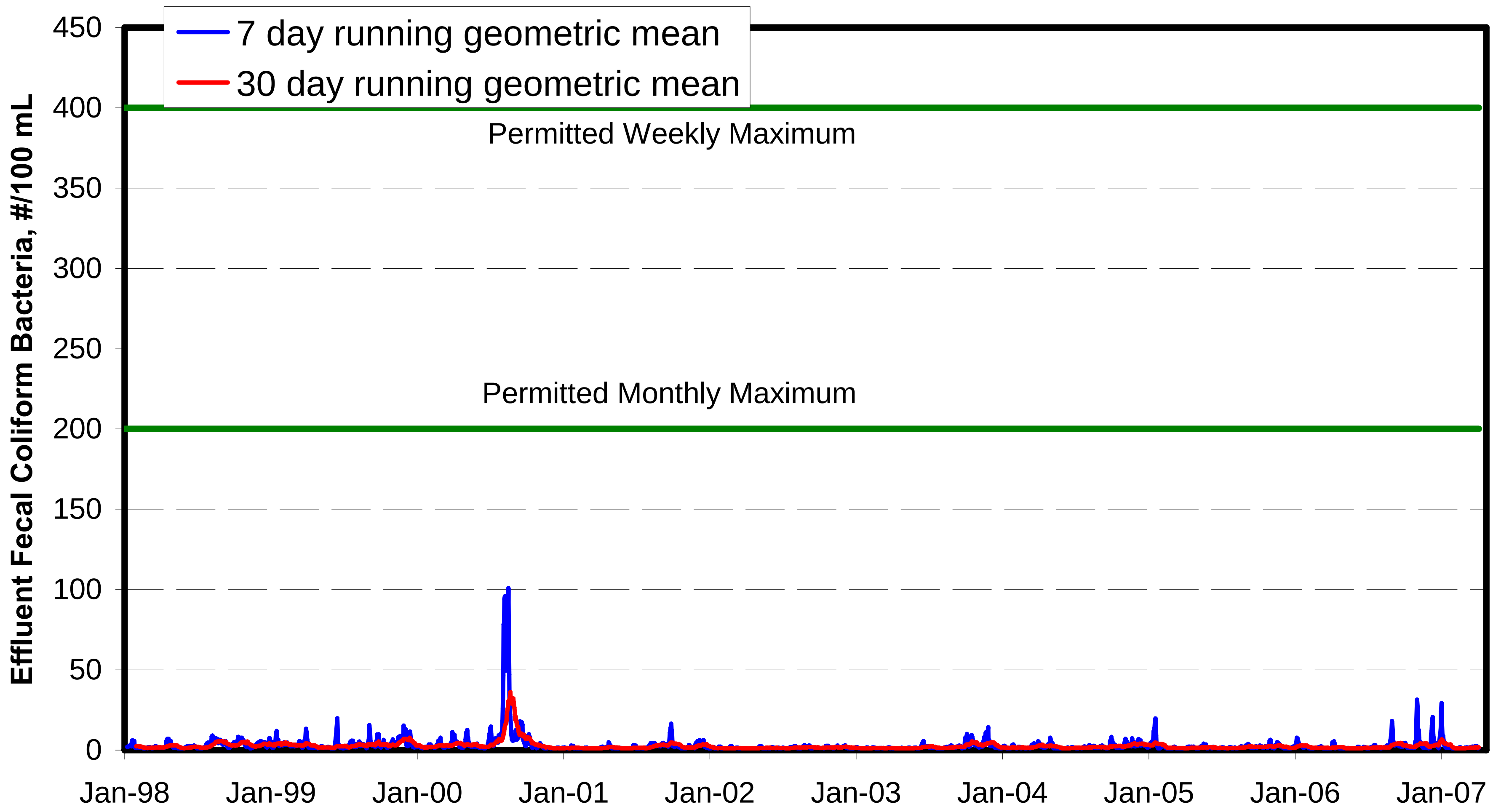
Table 9.2 Current NPDES Permit Limits
Comprehensive Sewer Plan
City of Bellingham

Parameter		Limit	
BOD_5 (1)	Monthly Average	30 mg/L	5004 ppd
	Weekly Average	45 mg/L	7506 ppd
TSS(1)	Monthly Average	30 mg/L	5004 ppd
	Weekly Average	45 mg/L	7506 ppd
Fecal Coliform	Monthly Geometric Mean	200 MPN per 100 mL	
	Weekly Geometric Mean	400 MPN per 100 mL	
pH	Minimum	6	
	Maximum	9	
Total Residual Chlorine	Monthly Average	198 μg/L	33 ppd
	Maximum Day	429 μg/L	NA

Notes:
(1) The average monthly effluent concentration for BOD_5 and TSS shall not exceed 30 mg/L or 15 percent of the respective monthly average influent concentrations, whichever is more stringent except during the “wet weather” months extending from October 1st through May 31st.

9.3 EXISTING PLANT PERFORMANCE

The WWTP produces secondary effluent that is typically well below the current NPDES permit limits. Figures 9.1 through 9.7 present recent plant performance data compared to the NPDES standards for coliform, pH, effluent BOD and TSS. These figures indicate that from 1998 through 2006, the WWTP has not exceeded their permit. Table 9.3 provides a summary of the average secondary effluent quality from 1998 though 2006.



POST POINT PERFORMANCE
EFFLUENT FECAL COLIFORM

FIGURE 9.1

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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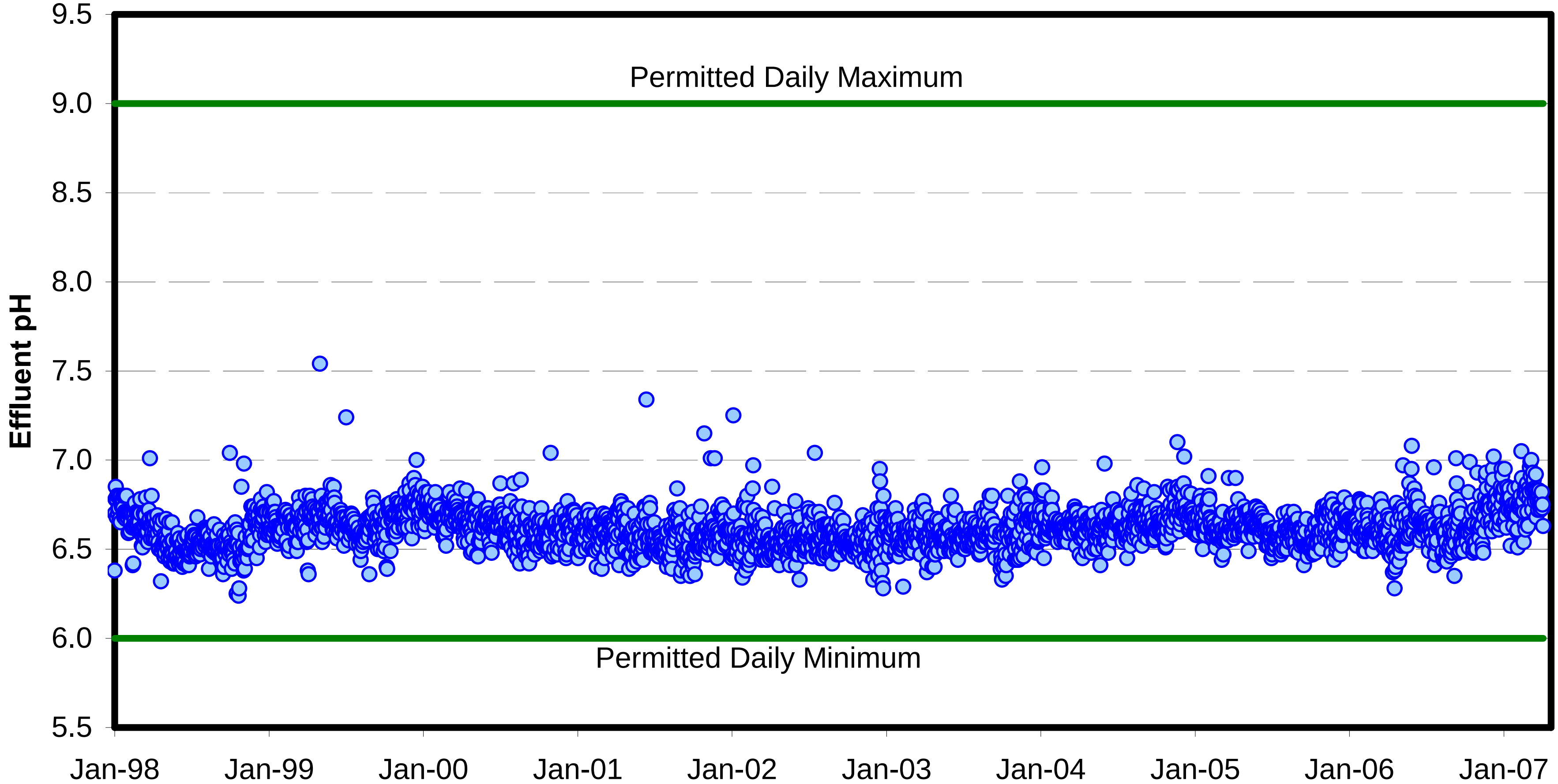
pw://Carollo/Documents/Client/WA/Bellingham/7489A00/Deliverables/Comprehensive Sewer Plan/Fig09_1



POST POINT PERFORMANCE
EFFLUENT pH

FIGURE 9.2

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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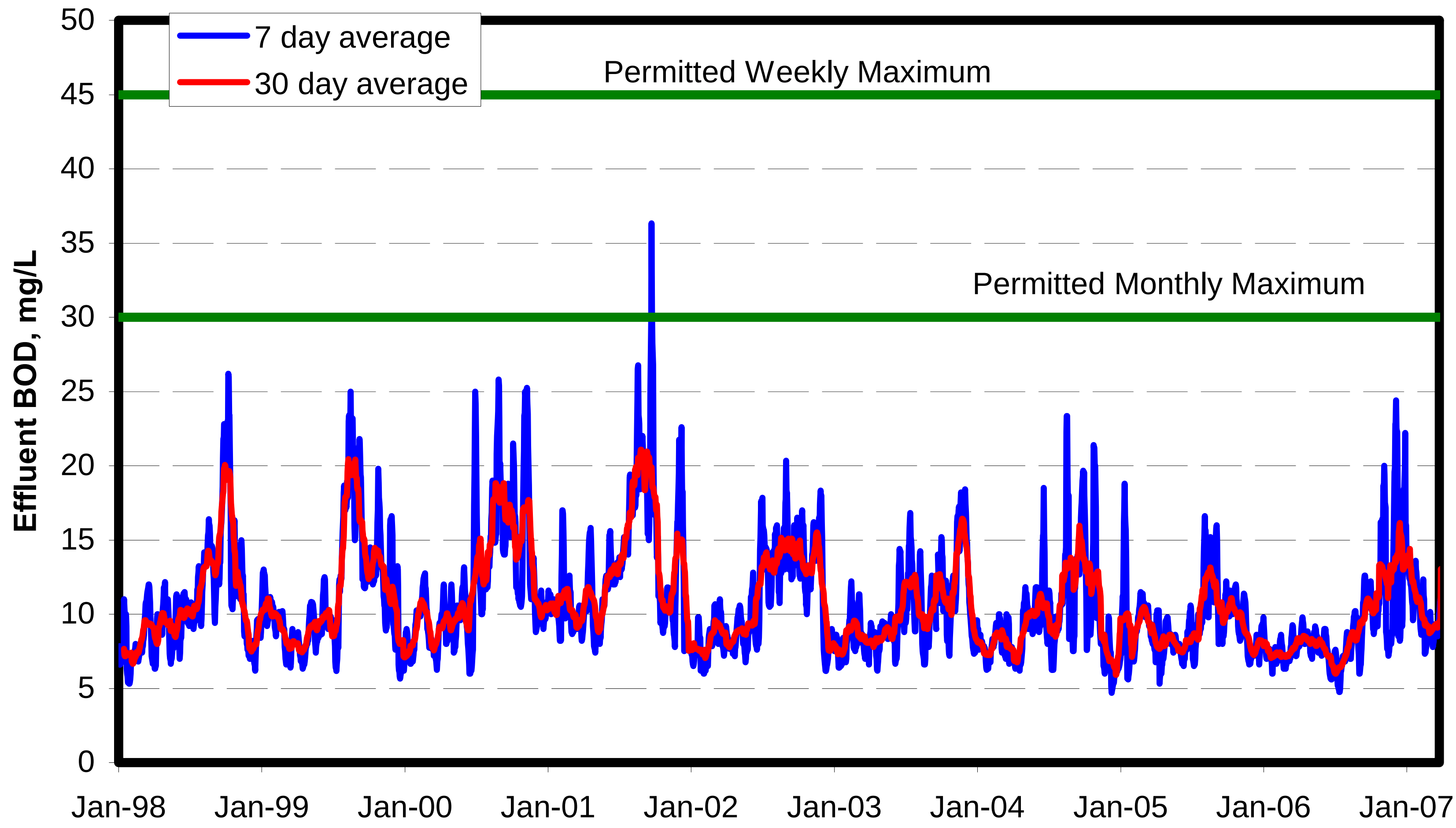
pw://Carollo/Documents/Client/WA/Bellingham/7489A00/Deliverables/Comprehensive Sewer Plan/Fig09_2



POST POINT PERFORMANCE
EFFLUENT BOD CONCENTRATION

FIGURE 9.3

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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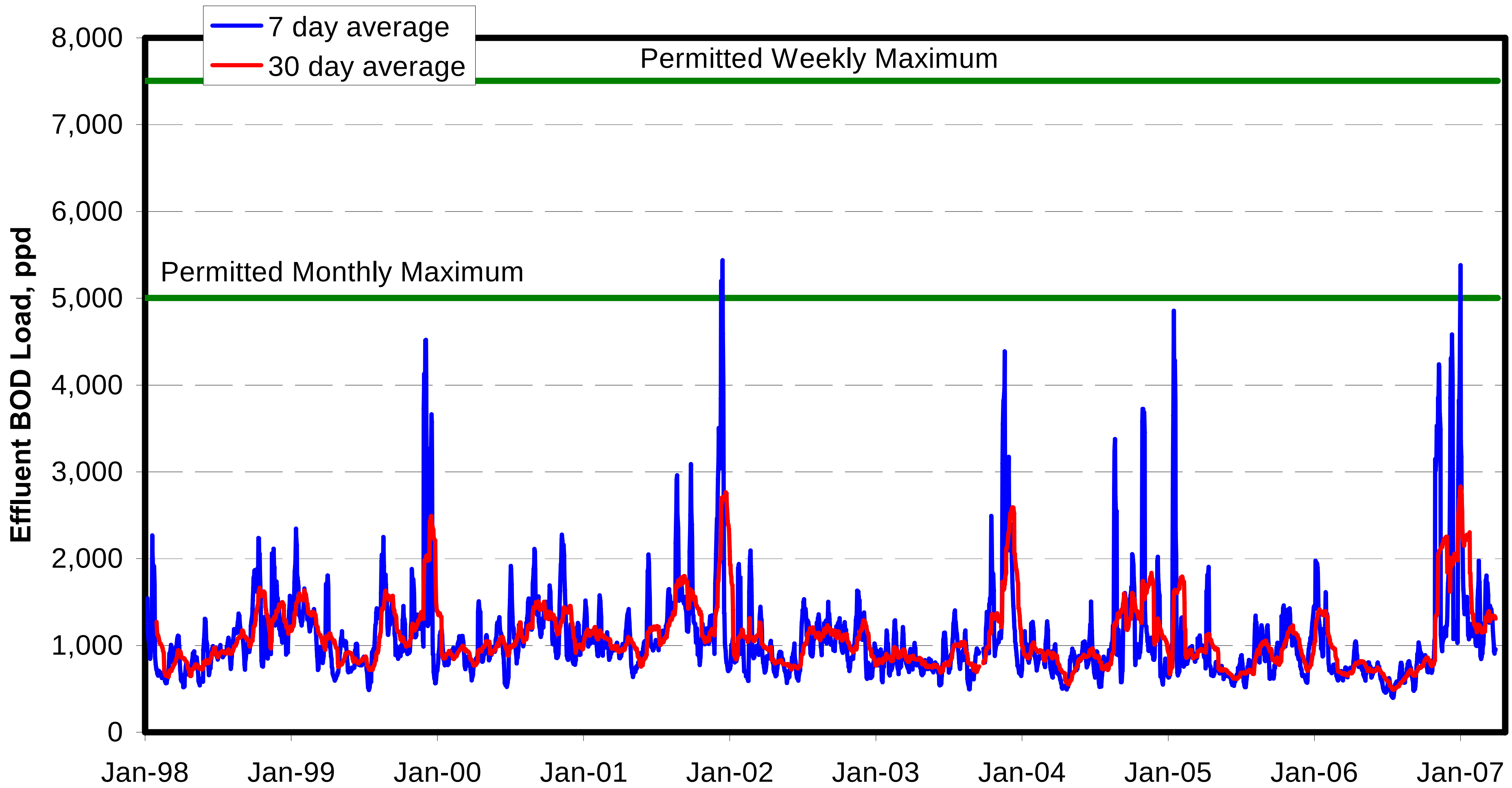
pw://Carollo/Documents/Client/WA/Bellingham/7489A00/Deliverables/Comprehensive Sewer Plan/Fig09_3



POST POINT PERFORMANCE
EFFLUENT BOD LOAD

FIGURE 9.4

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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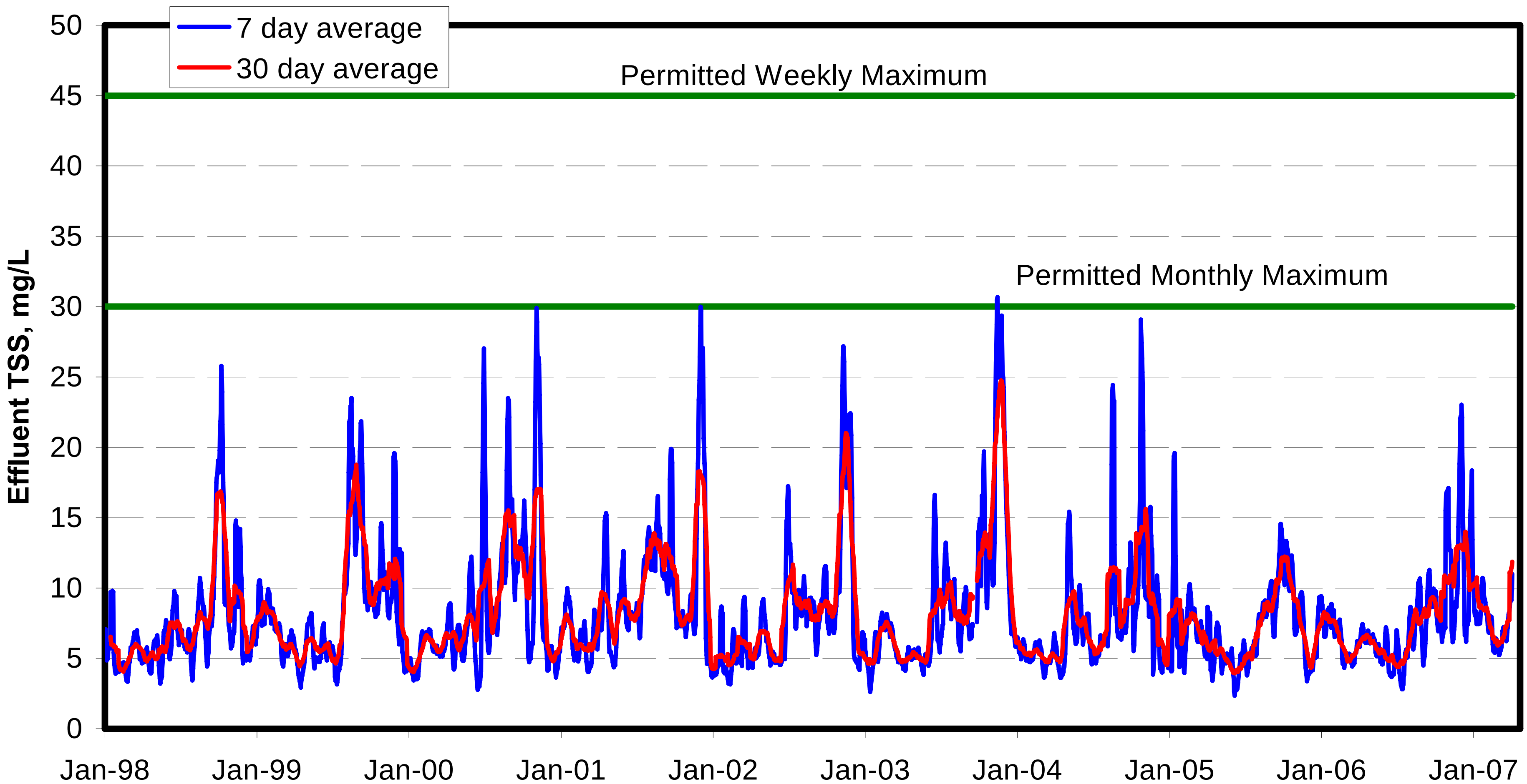

POST POINT PERFORMANCE
EFFLUENT TSS CONCENTRATION

FIGURE 9.5

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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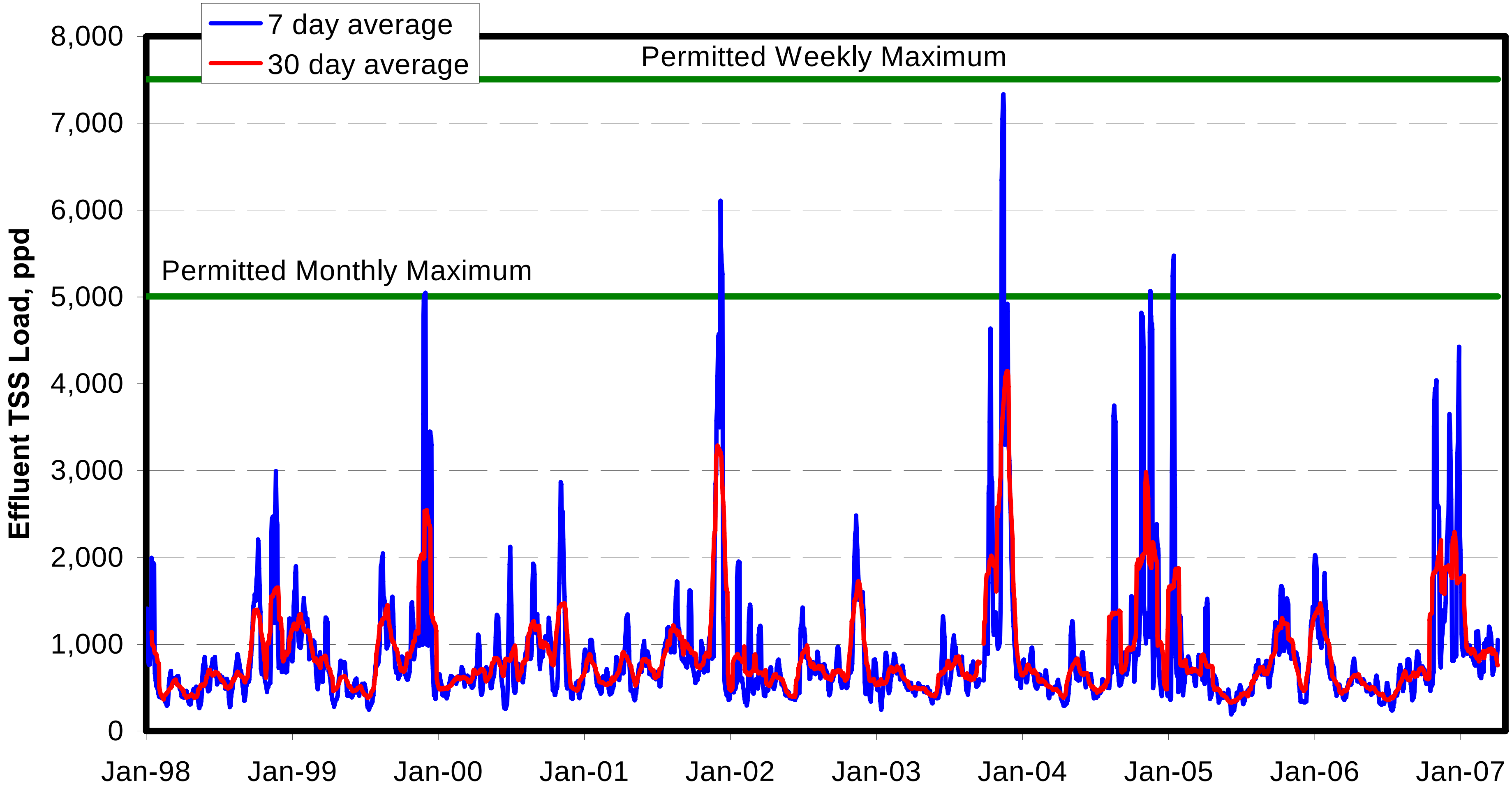
pw://Carollo/Documents/Client/WA/Bellingham/7489A00/Deliverables/Comprehensive Sewer Plan/Fig09_5



POST POINT PERFORMANCE
EFFLUENT TSS LOAD

FIGURE 9.6

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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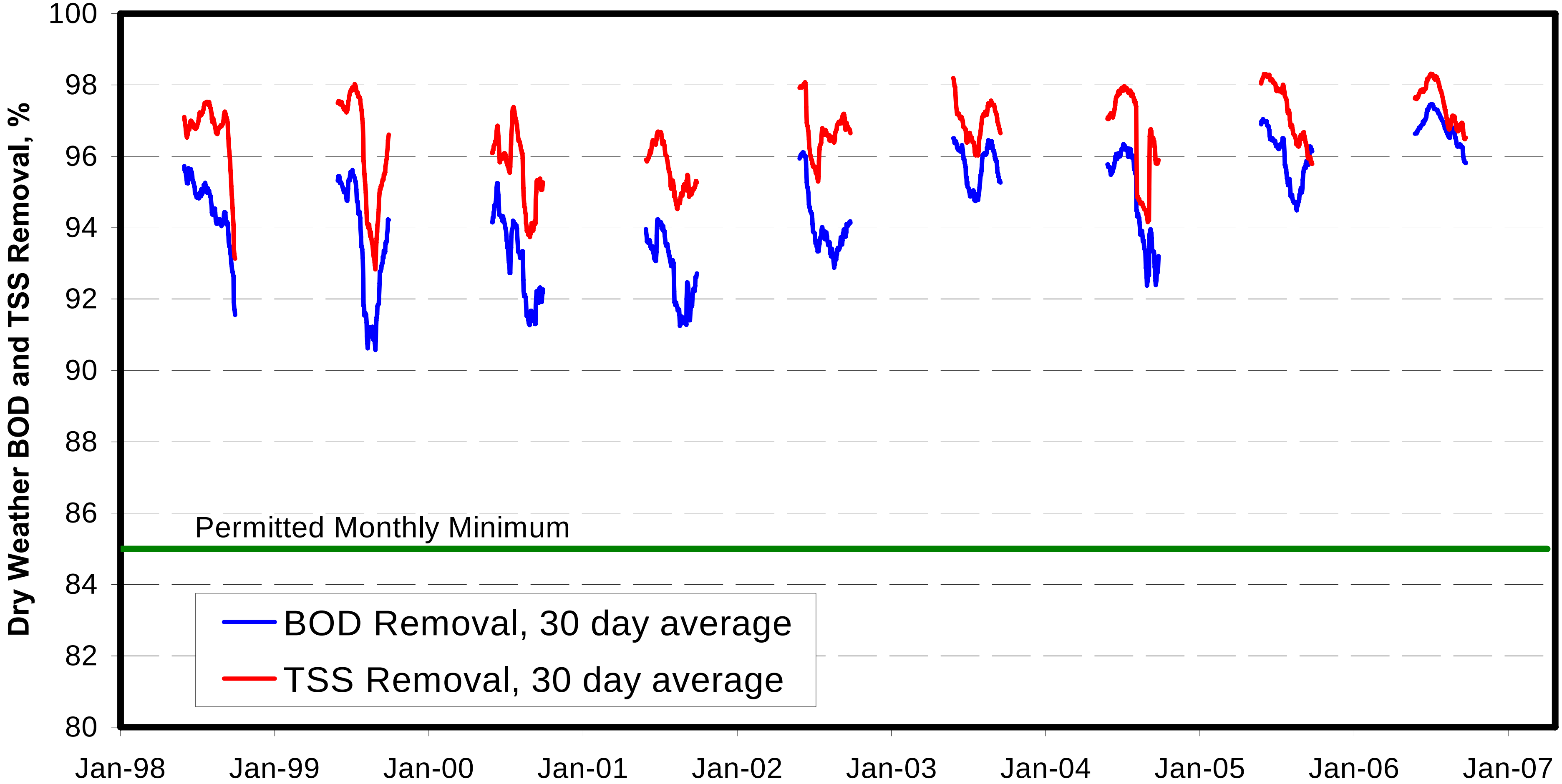
pw://Carollo/Documents/Client/WA/Bellingham/7489A00/Deliverables/Comprehensive Sewer Plan/Fig09_6



POST POINT PERFORMANCE
EFFLUENT BOD AND TSS REMOVALS

FIGURE 9.7

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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pw://Carollo/Documents/Client/WA/Bellingham/7489A00/Deliverables/Comprehensive Sewer Plan/Fig09_7

Table 9.3 Average Secondary Effluent Quality Comprehensive Sewer Plan City of Bellingham				
Parameter	**Average(1)**	**Max Month(2)**	**Max Week(3)**	**Max Day**
BOD				
Concentration, mg/L	11	21	36	53
Load, ppd	1,115	2,767	5,439	12,166
Dry Weather Removal, %	95	91(4)	85(5)	73(6)
TSS				
Concentration, mg/L	8	25	31	84
Load, ppd	883	4,147	7,335	19,505
Dry Weather Removal, %	96	93(4)	86(5)	53(6)
Fecal Coliform, #/100 mL	3(7)	36(8)	101(8)	3,060
pH				
Maximum	6.6	6.8	6.9	7.5
Minimum	6.6	6.5(4)	6.4(5)	6.2(6)

Notes:
(1) Average from 1998 though 2006.
(2) Maximum of the 30 day running average from 1998 though 2006.
(3) Maximum of the 7 day running average from 1998 though 2006.
(4) Values presented are minimum monthly values.
(5) Values presented are minimum weekly values.
(6) Values presented are minimum daily values.
(7) Based on the average of the monthly geometric means.
(8) Based on the geometric mean.

9.4 RELIABILITY REQUIREMENTS

The Washington State Department of Ecology (DOE) maintains requirements for redundancy of treatment processes and equipment, and reliability of electrical power supply. These requirements are presented in the Orange Book, the DOE's guidelines for WWTP design. The reliability guidelines in the Orange Book are derived from Federal standards developed by the U.S. Environmental Protection Agency (EPA).

DOE criteria for designation of wastewater treatment plants are divided into three reliability classes based on the nature of their receiving water. Based on this designation, the Post Point WWTP has a reliability classification of Class II. Corresponding reliability requirements are presented in Table 9.4, based on DOE guidelines, Federal standards, and recommended Carollo criteria. In the capacity analysis, the requirement indicated in the table was used to determine the number of process basins or equipment considered to be out of service.

Table 9.4 Reliability Requirements for Post Point WWTP
Comprehensive Sewer Plan
City of Bellingham

WWTP Component	Requirement	Source
Mechanical Screens	A backup screen designed for mechanical or manual screening must be provided. Passive bypass channel recommended for emergency use.	(1), (2), (3)
Grit Basins	The system must contain components to remove grit and other heavy inorganic solids. All units in service for maximum flow conditions.	(2), (3)
Primary Clarifiers	Units must be sufficient in number and size so that even with the largest-flow-capacity unit out of service, the remaining units will have a design flow capacity of at least 50 percent of the design basin flow. All units in service for peak flow condition.	(1), (2), (3)
Aeration Basins	A backup basin will not be required. At least two equal volume basins must be provided. All units in service for maximum flow and loading conditions.	(1), (2), (3)
Aeration System	A sufficient number of aerators to enable the design oxygen transfer to be maintained with the largest unit out of service. Peaking capacity provided with LOX feed.	(1), (2)
RAS Pumps	A backup pump must be provided for each set of pumps performing the same function.	(1), (2)
WAS Pumps	A backup pump must be provided for each set of pumps performing the same function.	(1), (2)
Secondary Clarifiers	Units must be sufficient in number and size so that even with the largest-flow-capacity unit out of service, the remaining units will have a design flow capacity of at least 50 percent of the design basin flow. All units in service for maximum flow and loading conditions.	(1), (2), (3)
Disinfectant System	Adequate flexibility to allow equipment used for non-disinfection purposes to function as standby units. Equipment sized to provide maximum daily dose with single largest unit out of service.	(1), (2), (3)
Disinfectant Contact Basins	Units must be sufficient in number and size so that even with the largest-flow-capacity unit out of service, the remaining units will have a design flow capacity of at least 50 percent of the design basin flow. All units in service for maximum flow conditions.	(1), (2), (3)
Sludge Thickening and Dewatering	Redundant units provided for equipment maintenance. Ability to thicken and dewater maximum sludge production with all units in service.	(1), (2), (3)
Sludge Incineration	Redundant units provided for equipment maintenance. Ability to incinerate maximum sludge production with all units in service.	(1), (2), (3)

Notes:
(1) *Criteria for Sewage Works Design* (Ecology 2006).
(2) *Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability* (EPA 1974).
(3) Recommended Carollo criteria.
(4) LOX = liquid oxygen, RAS = return activated sludge.

9.5 WWTP CAPACITY EVALUATION

There are two considerations in the evaluation of the overall capacity of the WWTP: 1) process considerations (ability to meet treatment requirements in the NPDES permit); and 2) hydraulic considerations (ability to convey peak flows through the plant). Both of these considerations are addressed in the capacity analysis, with process capacity reported in terms of maximum month flow/load, and hydraulic capacity reported in terms of peak hour flow. Solids treatment systems are not a part of the hydraulic flow scheme, and are expressed only in terms of process capacity.

Process capacities for each liquid and solids treatment system were evaluated using a combination of computer modeling and historical design criteria. Process modeling was calibrated to consider the impact of recent modifications to the HPO process, including conversion of a portion of the existing aeration basins to an anaerobic selector. An important assumption was that maximum month flow and loads can occur simultaneously at the WWTP, which was determined based on the analysis in Chapter 4.

A hydraulic model of the existing WWTP was not developed for the analysis. The most recent hydraulic analysis of the plant was conducted in 2002 (Brown and Caldwell 2002). This evaluation determined the potential for the WWTP to convey a peak hour flow of 72 mgd, which is 18 percent greater than the rated design capacity of 60 mgd. The evaluation identified a series of improvements that would need to be implemented in order to achieve a peak hydraulic capacity of 72 mgd. Those improvements are summarized in Table 9.5. This report assumes that these modifications are in place, and accepts the revised hydraulic capacity of 72 mgd as reported in the 2002 analysis. A more thorough investigation of plant hydraulics is recommended during subsequent phases of planning.

Table 9.5 Conclusions of Hydraulic Evaluation
Comprehensive Sewer Plan
City of Bellingham

Element	Problem Identified	Alternatives Identified	Recommended Solution
Primary clarifier launders	Launders flood because of misdistribution of flow	1. Adjust influent gates 2. Remove grout overlay	1. Adjust influent gates
Primary effluent pump station	Nominal capacity is only 66 mgd	1. Replace pumps or impellers 2. Speed up pumps 3. Use higher wet well level	3. Use higher wet well level

Table 9.5	Conclusions of Hydraulic Evaluation Comprehensive Sewer Plan City of Bellingham		
Element	**Problem Identified**	**Alternatives Identified**	**Recommended Solution**
Secondary process flow control	Flow split is greater than process capacity at peak flow (55 mgd)	Reduce flow to 45 mgd by 1. Raising weir 2. Installing baffle 3. Lowering sluice gate	3. Lower sluice gate
Mixed liquor flow distribution	Weirs submerged at high flow	Raise weirs	No modifications - no adverse process impacts
Secondary clarifiers and effluent piping	Launder submerged over 62 mgd at maximum high tide	1. Additional effluent piping 2. Raise walls 3. Extend scum box height	3. Extend scum box height (project was completed)
Outfall	Capacity of main outfall is less than 71 mgd	Capacity of overflow outfall plus main outfall is 72 mgd	Use both outfalls (expansion of overflow outfall underway)

9.5.1 Preliminary Treatment

Preliminary treatment at the WWTP includes screening and grit removal. Although performance of these systems varies with changing flow, there are no significant process considerations associated with preliminary treatment. Overall capacity of these units is governed by hydraulics.

Hydraulic throughput of a bar screen is typically measured by clear screen velocity, which should not exceed 5 feet per second (ft/sec) under peak conditions. The Re-rating of the Post Point WWTP (2004) includes an analysis of clear screen velocities at various flows. The 5 ft/sec design criteria is not exceeded at 72 mgd. The 2002 hydraulic analysis indicates that the hydraulic capacity of the existing screen channels and grit basins is sufficient to pass 72 mgd. Based on these findings, the rated peak flow capacity of the existing preliminary treatment process is 72 mgd.

9.5.2 Primary Treatment

Primary clarifier performance is typically evaluated in terms of TSS and BOD removal efficiencies, with surface overflow rate (SOR) being the relevant design criteria. Historical removal efficiencies at various SORs are reported in the 2004 re-rating report. In general, greater BOD and TSS removal occurs at lower SOR values, although the correlation between SOR and removal efficiency is somewhat inconsistent.

Selection of a design SOR must consider available capacity of the downstream secondary process. In cases where there is excess available secondary capacity, primary clarifier SOR values can be elevated greater than 3,000 gallons per day per square foot (gpd/sf) without negative impact (Orange Book criteria ranges from 2,000 to 3,000 gpd/sf at peak flow). Secondary process capacity is limited at the Post Point WWTP; therefore achieving higher removal efficiencies in the primarily clarifiers is important. Based on historical performance, a design SOR of 1,000 gpd/sf at maximum month flow yields acceptable BOD and TSS removal, and limits excessive loading to the HPO basins. The corresponding maximum month flow capacity of the two existing clarifiers is 22.6 mgd. The corresponding SOR at existing peak day flow conditions (53 mgd) is approximately 2,300 gpd/sf, which is less than the Orange Book criteria for this process.

The recommended primary clarifier design criteria should be further evaluated during subsequent planning phases, with consideration given to the potential benefits of chemically enhanced primary treatment (CEPT). It is likely that CEPT will increase BOD and TSS removal at higher SOR values, increasing the capacity of the existing primaries beyond 22.6 mgd (maximum month basis).

9.5.3 Secondary Treatment

Secondary treatment at the WWTP is provided by a high purity oxygen (HPO) activated sludge process, that includes three main components: HPO basins, secondary clarifiers, and oxygen generation/dissolution system. All of these components are considered together when rating the capacity of the secondary process.

The Re-rating of the Post Point WWTP Report (2004) based HPO basins and secondary clarifier capacity on conventional design parameters, including volumetric loading for the HPO basins, and peak SOR for the secondary clarifiers. The HPO basins were retrofitted with new mixers in 2007 to improve the efficiency of the oxygen dissolution process. The first stage of the HPO basins was also converted to an anaerobic selector. These modifications have improved oxygen transfer efficiency and sludge settleability.

Process modeling developed for this analysis refines the 2004 ratings based on measured performance and operational history since the secondary modifications were completed. Recent performance demonstrates that the secondary system produces a high quality secondary effluent at an SRT ranging from 2 to 2.5 days. The process was modeled with a 2.3-day SRT, which provided an acceptable clarifier safety factor (1.15) at a maximum month capacity of 25,000 pounds per day (lb/d) and 20 mgd (40 mgd peak flow capacity). At the modeled capacity, the corresponding volumetric loading rate is approximately 83 pounds per day per thousand cubic feet (ppd/kcf). The corresponding peak SOR for the secondary clarifiers is 1,200 gpd/sf.

A pressure swing adsorption (PSA) system provides high purity oxygen for dissolution into the mixed liquor in the HPO basins. The system is rated for a maximum production of 10 tons/day at 90 percent oxygen purity. Operational data indicate that the current system is not capable of consistently producing the rated capacity. The data also show a drop in purity as production increases. The top-end of the measured production ranges from 8.0 to 8.5 tons per day at an oxygen purity between 85 and 90 percent. The City uses supplemental liquid oxygen (LOX) to maintain dissolved oxygen (DO) levels in the HPO basins during peak loads. With supplemental LOX feed and accounting for the upgrades to the mixers completed as a part of the 2006 HPO upgrades, the current oxygen dissolution capacity of the oxygen generation and dissolution system is 20.5 tons/day of oxygen. The corresponding influent BOD capacity of the system is approximately 50,000 lb/d.

9.5.4 Disinfection

The WWTP uses gaseous chlorine for disinfection. The existing chlorinators have a total capacity of 4,000 lb/d, and a firm capacity of 2,000 lb/d. Plant records indicate typical chlorine doses of 3.0 mg/L for disinfection, with a maximum day dose of 3.9 mg/L. At the historical maximum daily dose, the system has reliable capacity to treat up to approximately 62 mgd on a maximum daily basis.

Chlorine solution is dosed around the perimeter of the three existing secondary clarifiers. Chlorinated secondary effluent enters parallel contact basins, with a total volume of approximately 860,000 gallons. Orange Book criteria for chlorine contact time is 20 minutes at peak day. Discounting the contact time that occurs between the clarifier weirs and the contact basin inlet and based on the 20-minute criteria, the existing contact basins have a maximum daily capacity of approximately 62 mgd.

9.5.5 Liquid Stream Capacity Summary

The liquid stream capacity and design criteria of the WWTP components is shown in Table 9.6.

**Table 9.6 Liquid Stream Process Design Criteria
Comprehensive Sewer Plan
City of Bellingham**

Unit Process	Capacity Basis	Limiting Design Criteria	Value	Current Capacity
Influent Screens	Peak Hour Flow	Maximum Clear Velocity	5 ft/sec	72 mgd
Grit Basins	Peak Hour Flow	Hydraulic Capacity	--	72 mgd
Primary Clarifiers	Max Month Flow	SOR	1,000 gpd/sf	23 mgd
Primary Effluent	Peak Hour Flow	Firm Capacity	--	72 mgd

Table 9.6 Liquid Stream Process Design Criteria
Comprehensive Sewer Plan
City of Bellingham

Unit Process	Capacity Basis	Limiting Design Criteria	Value	Current Capacity
Pumping				
HPO Basins	Max Month BOD	SRT	2.3 days	25,000 lb/d BOD
Oxygen System	Max Day BOD	Total Capacity	20.5 tons(1)	50,000 lb/d BOD
Secondary Clarifiers	Max Month BOD	Clarifier Safety Factor	1.15	25,000 lb/d BOD
Disinfection System	Max Day Flow	Firm Capacity	--	62 mgd
Chlorine Contact	Max Day Flow	Contact Time	20 min	62 mgd

Note:
(1) Capacity shown for system includes capacity provided with LOX feed.

9.5.6 Solids Handling Process Capacity

Solids treatment capacity for individual processes was evaluated during the 2004 re-rating report. Table 9.7 summarizes the capacities and design criteria of the solids handling processes.

Table 9.7 Solids Handling Process Design Criteria
Comprehensive Sewer Plan
City of Bellingham

Unit Process	Capacity Basis	Limiting Design Criteria	Value	Current Capacity
Sludge Thickener	Max Month TSS	Solids Loading Rate	1,000 pph/m (1)	46,800 lb/d TSS
Thickened Sludge Pump	Max Month TSS	Firm Capacity	300 gpm (2)	114,700 lb/d TSS
Sludge Dewatering	Max Month TSS	Throughput Capacity	6,000 pph (2)	125,600 lb/d TSS
Incinerators	Max Month TSS	Throughput Capacity	2,400 pph (2)	50,500 lb/d TSS

Notes:
(1) Orange Book Criteria, pph/m = pounds per hour per meter.
(2) Specifications Value.

9.6 WWTP CAPACITY RATING

The capacity of the existing WWTP is summarized in Table 9.8. The WWTP capacity analysis and proposed alternatives are summarized in Chapter 10.

Table 9.8 Existing WWTP Capacity Summary
Comprehensive Sewer Plan
City of Bellingham

Capacity Parameter	Value	Limiting Process
Max Month Flow	20 mgd	Primary/Secondary Capacity
Max Day Flow	62 mgd	Disinfection System
Peak Hour Flow	72 mgd	Plant Hydraulic Capacity
Max Month BOD	25,000 lb/d	Primary/Secondary Capacity
Max Month TSS	47,000 lb/d	Sludge Thickening

RECOMMENDED TREATMENT PLANT IMPROVEMENTS

10.1 INTRODUCTION

This Chapter summarizes improvements to the Post Point Wastewater Treatment Plant (WWTP) that are needed to accommodate future growth in the service area. Current plant capacity and process expansion requirements are summarized in Chapters 8 and 9. Expansion alternatives at the treatment plant to meet future flow and loading conditions are evaluated in this Chapter. Several options for increasing the capacity of the Plant to meet future maximum month flows and loads are included herein.

Alternatives for managing peak wet weather flow are evaluated separately. Various peak flow management alternatives were presented in Chapter 7. One alternative, Alternative 2, involves upgrading the existing collection system to provide full conveyance of future peak flows to the WWTP. A summary of peak flow management alternatives that considers upgrades to both the collection system and the plant is presented in Section 10.4.

10.2 BASIS OF PLANNING

Several preceding evaluations of the existing WWTP form the basis for alternatives presented in this Chapter, including:

- Post Point Wastewater Treatment Plant Hydraulic Evaluation, 2000
- Addendum to the Post Point WWTP Re-rating Study, 2006
- Evaluation of Potential Uses for the Homeport Properties Site, 2006

These documents were used as a starting point to determine process expansion that will be necessary as growth occurs in the service area. Additional basis of planning information is summarized below.

10.2.1 Future Flows and Loads

The evaluation of flows and loads in Chapter 4 serves as the basis for identifying process expansion at the plant that is driven by future growth. Collection system modeling was also developed to quantify future peak flows. Table 10.1 summarizes projected design flows and loads in year 2026.

The future hydraulic capacity needed at the WWTP depends on the recommended peak flow management alternative. If Alternative 1, Remote Peak Flow Management, is selected, future peak flows will be capped at 72 mgd, and excess peak flow will be managed at remote wet weather facilities. If Alternative 2, Conveyance to WWTP, is selected all flow will be conveyed to the plant. In this case, the future peak flow to the WWTP is estimated at 82 mgd.

Table 10.1 Summary of Future Design Flows and Loads
Comprehensive Sewer Plan
City of Bellingham

Flow (mgd)			BOD (lb/d)	TSS (lb/d)
Max Month	Peak Hour(1)	Peak Hour(2)	Max Month	Max Month
34.3	72	82	39,900	45,500

Notes:
(1) Alternative 1, remote peak flow management.
(2) Alternative 2, conveyance to WWTP.

10.2.2 Future NPDES Permit Limits

The current National Pollution Discharge Elimination System (NPDES) permit effluent limits listed in Chapter 9 are under negotiation with the Washington Department of Ecology (DOE). DOE has indicated that average weekly and average monthly percent removals of BOD and TSS listed in the current permit will remain unchanged. The limits on BOD and TSS daily total mass discharge will be increased proportionately based on effluent flows. Nutrient removal will not be included in the permit currently under negotiation and is not envisioned in the planning period. In meetings with the DOE they have indicated that pH and eutrophication of Bellingham Bay could potentially drive the need for nutrient removal. According to the DOE, pH will no longer be a permitted parameter, and there is no evidence of eutrophication in Bellingham Bay.

The proposed future NPDES permit limits form the basis of planning for this evaluation and are listed in Table 10.2.

Table 10.2 Anticipated NPDES Permit Limits
Comprehensive Sewer Plan
City of Bellingham

Parameter(1)	Average Monthly	Average Weekly
Biochemical oxygen demand (5-day) (BOD_5)(2)	30 mg/L - 5004 lbs/day	45 mg/L - 7,506 lbs/day
Total suspended solids (TSS)(2)	30 mg/L - 5,004 lbs/day	45 mg/L - 7,506 lbs/day
Fecal coliform bacteria(3)	200 / 100 mL	400 / 100 mL
Average Monthly	**Maximum Daily**	**Average Monthly**
Total Residual Chlorine	198 µg/L - 33 lbs/day	429 µg/L - 72 lbs/day

Notes:
(1) NPDES permit currently under negotiation.
(2) Seasonal removal percentages have not yet been determined. The total mass discharge limits will be increased in proportion to effluent flows.
(3) Geometric mean.

10.2.3 Liquid Stream Process Capacity Limitations

The capacity of the existing WWTP is summarized in Chapter 9. Table 10.3 shows the capacity of major process units compared to the projected (Year 2026) flows and loads.

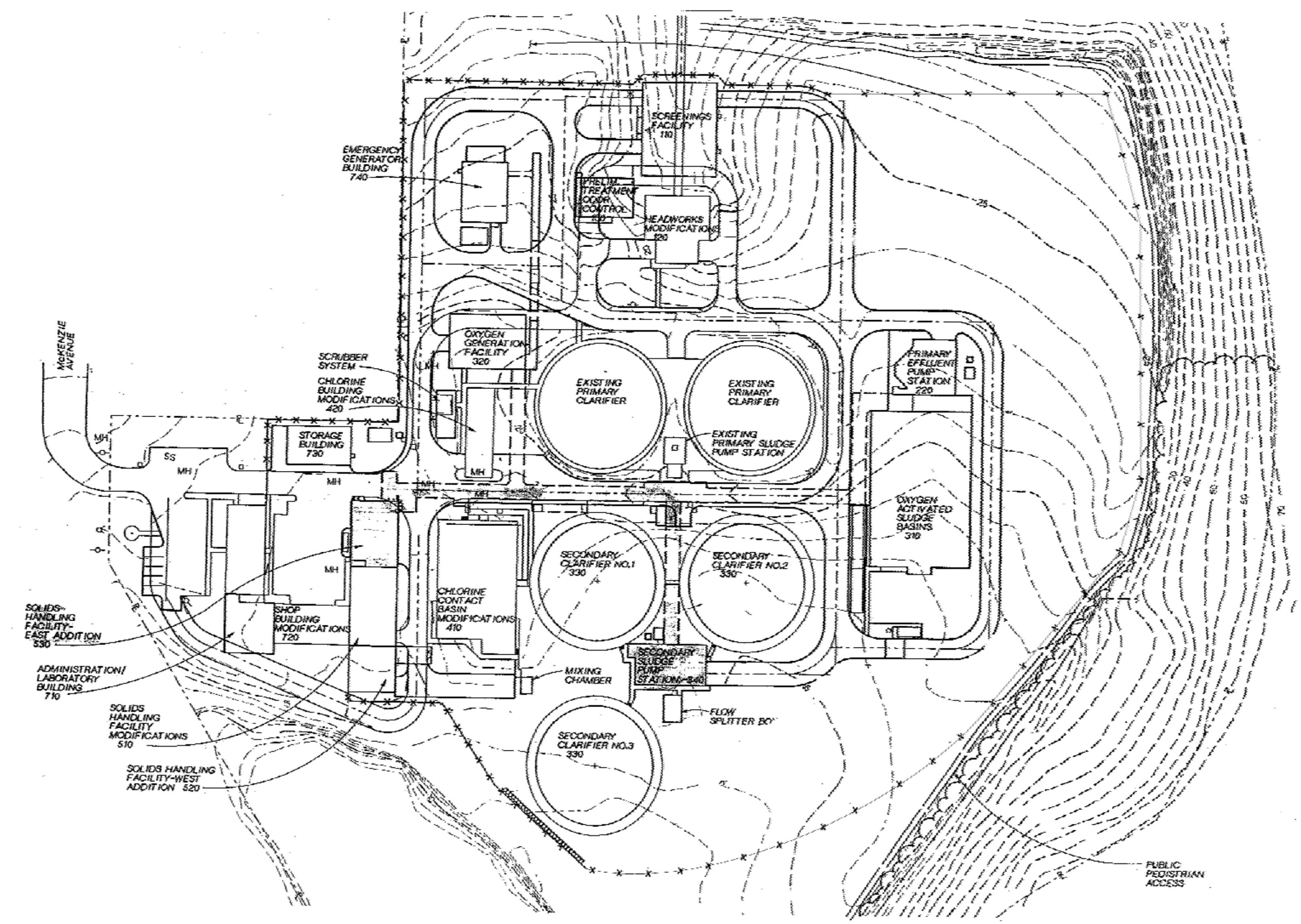
Table 10.3 Liquid Stream Process Design Criteria
Comprehensive Sewer Plan
City of Bellingham

Unit Process	Capacity Basis	Current Capacity	Future Flow/Load
Influent Screens	Peak Hour Flow	72 mgd	72 mgd(1) 82 mgd(2)
Grit Basins	Peak Hour Flow	72 mgd	72 mgd(1) 82 mgd(2)
Primary Clarifiers	Max Month Flow	23 mgd	34.3 mgd
Primary Effluent Pumping	Peak Hour Flow	72 mgd	72 mgd(1) 82 mgd(2)
HPO Basins	Max Month BOD	25,000 lb/d BOD	39,900 lb/d/ BOD
Oxygen System	Max Day BOD	50,000 lb/d BOD(3)	73,000 lb/d BOD
Secondary Clarifiers	Max Month BOD	25,000 lb/d BOD	39,900 lb/d/ BOD
Disinfection System	Max Day Flow	62 mgd	64.2 mgd
Chlorine Contact	Max Day Flow	62 mgd	64.2 mgd
Sludge Thickener	Max Month TSS	46,800 lb/d TSS	45,500 lb/d TSS
Thickened Sludge Pumping	Max Month TSS	114,700 lb/d TSS	45,500 lb/d TSS
Sludge Dewatering	Max Month TSS	125,600 lb/d TSS	45,500 lb/d TSS
Incinerators	Max Month TSS	50,500 lb/d TSS	45,500 lb/d TSS

Notes:
(1) Alternative 1, remote peak flow management.
(2) Alternative 2, conveyance to WWTP.
(3) Includes capacity of PSA and LOX feed.

10.2.4 Site Constraints

The existing WWTP is shown in Figure 10.1. The current site provides limited room for process expansion. The site is bounded on the south by steep slopes leading up to residential property. The City owns land to the south and east of the plant that is currently outside of the existing fence line, the Homeport property, which will likely be needed for future plant expansion. The property west of the existing secondary clarifiers is a sensitive environmental area adjacent to Bellingham Bay, and offers little room for new facilities.



EXISTING POST POINT WWTP SITE PLAN

FIGURE 10.1

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A number of studies have evaluated expansion opportunities on the current site, as well as on an adjacent site recently acquired by the City (Homeport property). The layouts presented in this Chapter focus on expanding the process to meet future maximum month flows and loads within the current site boundary. This will maximize use of existing facilities and minimize flow splitting, yard piping, and the potential need for intermediate pumping.

The Homeport property may be used for construction of future wet weather facilities, if peak flow management Alternative 2 (full conveyance of peak flows to the WWTP) is selected. The site will likely be used if the existing maintenance facilities are expanded or replaced, and may be needed in the future as the capacity of the solids handling processes is increased. The Homeport property would also be needed if future permit limits require nutrient removal or tertiary filtration to meet more stringent BOD/TSS limits, unless the existing secondary process is converted to a membrane bioreactor process.

10.3 UPGRADES REQUIRED FOR MAX MONTH CONDITIONS

There are several options for increasing the capacity of the plant to meet future maximum month flows and loads. Options considered at the planning level are discussed in this section. A fundamental assumption in the analysis is that existing facilities will be used to their fullest extent.

10.3.1 Primary Process Improvements

Installation of a third 120-foot diameter primary clarifier is required to provide future maximum month capacity, and is common to all of the secondary process alternatives being considered. The new clarifier will be needed to limit maximum month BOD/TSS loading to the secondary process. There is space for the primary clarifier to the south of the existing headworks. Effluent from the new clarifier would be connected to the existing primary effluent (PE) pump station, which would normally be used to pump primary effluent from the duty clarifiers into the secondary process.

The recommended primary treatment improvements require modifications to existing yard piping and flow splitting structures. These modifications include a new distribution box downstream of the headworks to split flow between the existing and new clarifiers, and yard piping from the new clarifier to the secondary process. A new PE pump station is not needed to provide maximum month flow capacity. A pump station may or may not be needed for peak flows, depending on which peak flow management alternative is selected. If a peak flow management alternative is selected that increases primary influent flow above 72 mgd, a new PE pump station would be required. Capacity and layout of this pump station are discussed in Section 10.4, which addresses plant improvements for the various peak flow management alternatives.

10.3.2 Secondary Process Improvements

The City has a history of good performance using the existing high purity oxygen (HPO) activated sludge process. Recent improvements to the process include the installation of variable frequency drives (VFDs) on the mixers, and replacement of the current impellers with higher efficiency units. The first stage of the existing HPO tanks was also converted to an anaerobic selector. These improvements have resulted in reduced energy consumed by the oxygen generation system, and provide a means of controlling filamentous organisms to improve sludge settleablity as measured by the sludge volume index (SVI).

Prior to the anaerobic selector being installed, filamentous bulking caused SVIs over 200 under peak loading conditions. The City is currently optimizing process operation with the new selector, and is now seeing SVI values that are typically well below 150. These results suggest that an external anaerobic selector should be included in the secondary process expansion.

Three secondary process options were considered for expanding the plant's future maximum month capacity, including:

- Continued use and expansion of the HPO activated sludge (AS) process.
- Conversion of the existing process to conventional air AS.
- Conversion of the existing process to a membrane bioreactor (MBR) process.

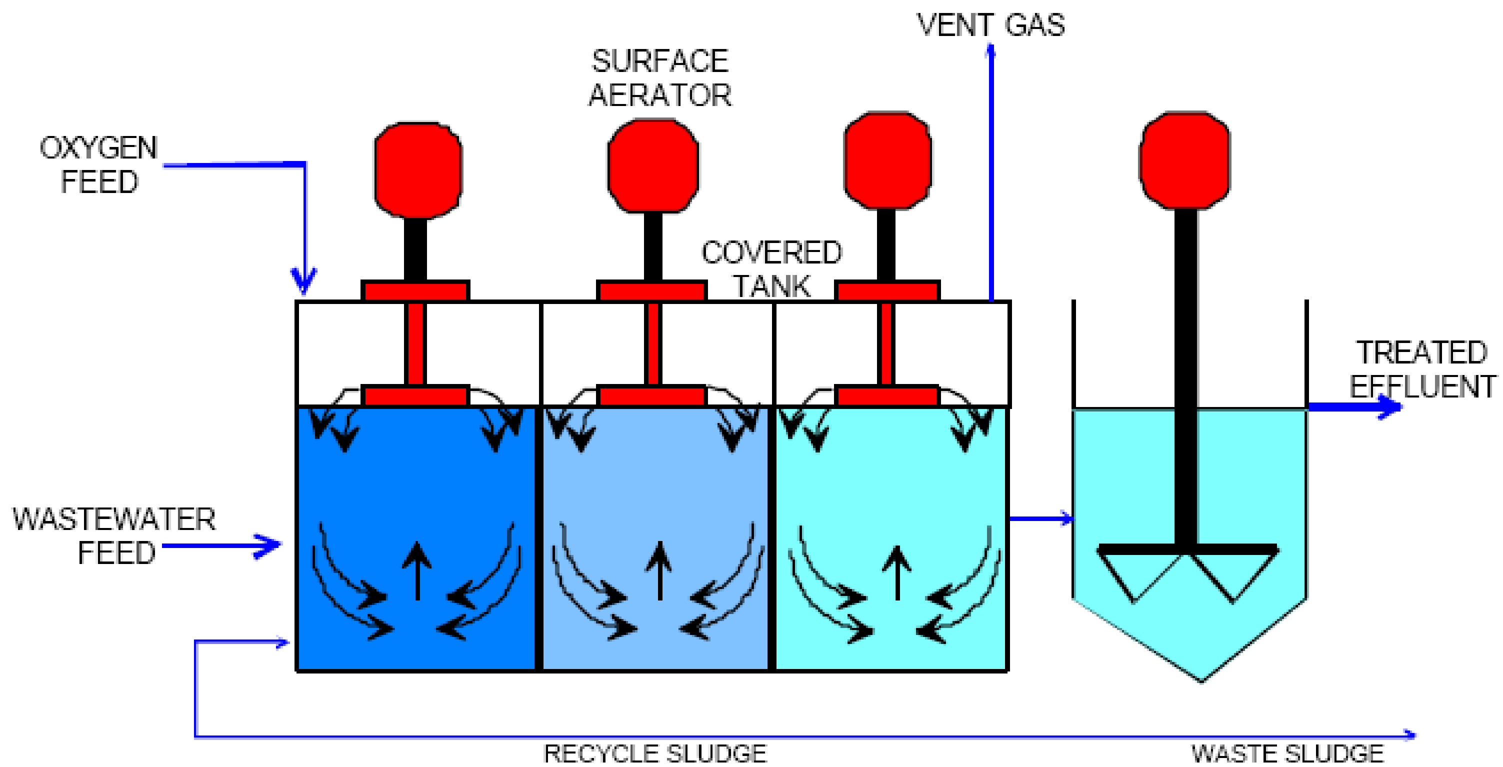
These options are discussed below. A summary of the options and their relative costs is presented at the end of this section.

10.3.2.1 Option 1 - Expansion of the HPO Process

Expanding the current HPO system to meet future loading conditions is the baseline option for secondary process expansion in the prior planning documents. Expansion of the aerobic AS volume is required to meet secondary process design criteria. Without an anaerobic selector, two new secondary clarifiers (for a total of five) are required. If a selector is included in the process, the future maximum month flows and loads can be treated with a total of four clarifiers (one new, three existing).

A process schematic for the HPO process is shown in Figure 10.2. The following improvements are required for the HPO expansion option:

- Two new aeration basins to provide an aerobic volume of 1.7 MG.
- One new 120-foot diameter secondary clarifier and expanded RAS pumping.
- A new 20-ton oxygen generation system to replace the existing system that generates HPO for the process.
- An external anaerobic selector basin upstream of the existing and new HPO basins, sized at 25 percent of the aerobic basin volume (existing and new aerobic basins). The existing anaerobic zone of the current basins will be converted back to aerobic volume.



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HPO PROCESS SCHEMATIC

FIGURE 10.2

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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The improvements also require modifications to the existing yard piping and flow splitting including:

- Modifications to the existing PE pump station to connect the pump station discharge to the new anaerobic selector.
- A new flow splitter to distribute flow from the anaerobic selector to the two existing and two new HPO basins.

There are several advantages to the HPO option. The process expansion fits within the existing plant site. Other advantages and disadvantages are listed in Table 10.4.

Table 10.4 Advantages and Disadvantages of Option 1 - Expansion of the HPO Process
Comprehensive Sewer Plan
City of Bellingham

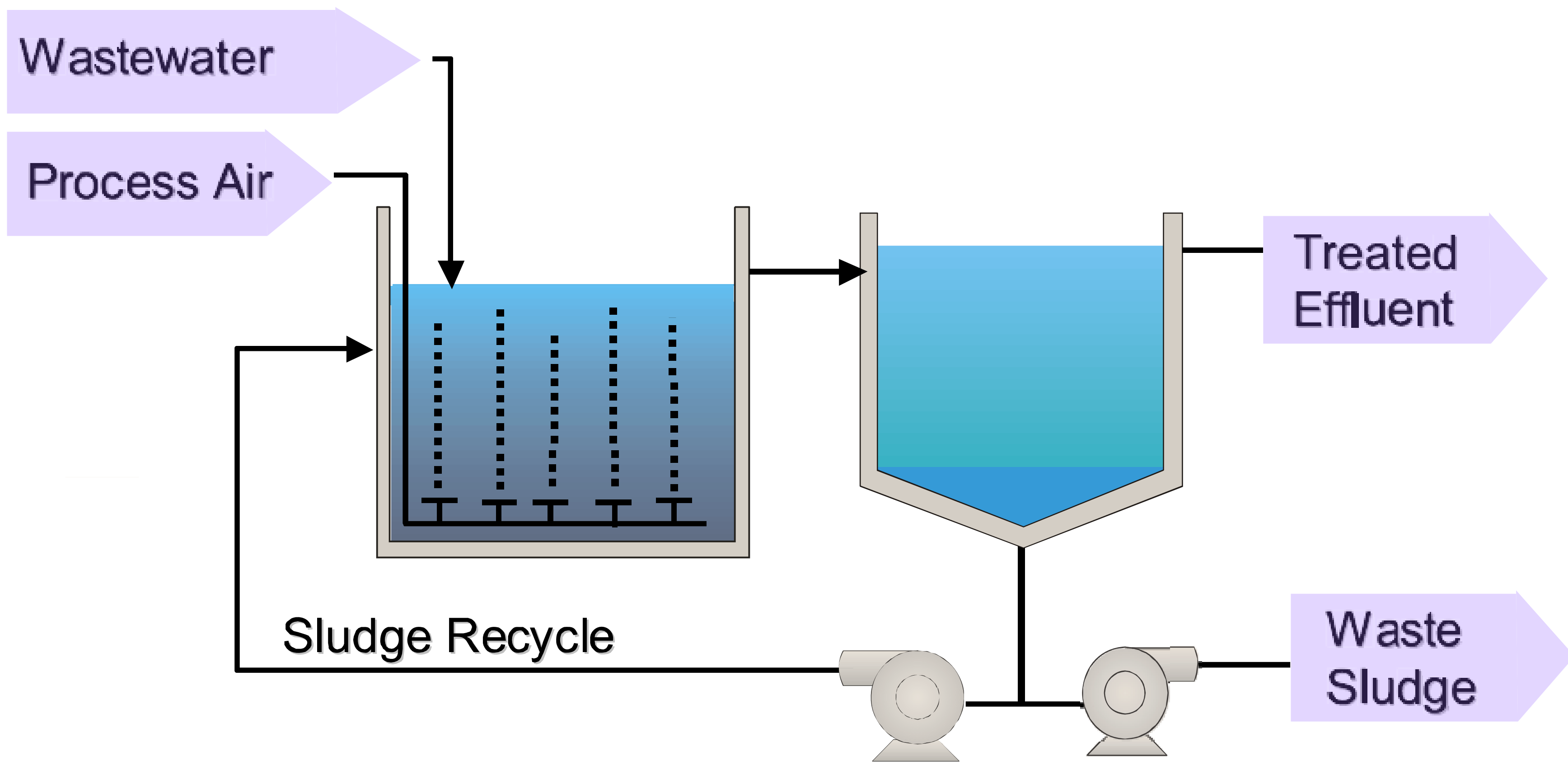
Advantages	Disadvantages
• Relatively low impact on O&M. Uses a technology familiar to operations staff. • Maximizes use of existing facilities. • Relatively easy to construct. Allows “green field” construction of the improvements with continued operation of the existing plant.	• Process not amenable to nitrogen removal, should future permits require nutrient removal.

10.3.2.2 Option 2 - Conversion to Conventional Air AS

The existing HPO system could be converted to conventional air AS, using fine bubble aeration. Five aeration basins (two existing and three new) would be required for this process modification.

Additional aeration basins are required in the AS option due to the reduced oxygen mass-transfer rate of air AS relative to HPO. A process schematic for air AS is shown in Figure 10.3. The following improvements are required to convert the existing HPO process to air AS:

- Three new aeration basins to provide an aerobic volume of 2.5 MG.
- One new 120-foot diameter secondary clarifier and expanded RAS pumping.
- A new aeration system, including replacement of the existing mixers and oxygen generating equipment with blowers and fine bubble diffusers.
- An external anaerobic selector basin upstream of the existing and new aeration basins, sized at 25 percent of the aerobic basin volume (existing and new basins).
- Associated site and yard piping improvements.



AIR AS PROCESS SCHEMATIC

FIGURE 10.3

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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Advantages and disadvantages of this option are listed in Table 10.5.

Table 10.5 Advantages and Disadvantages of Option 2 - Conversion to Conventional Air AS
Comprehensive Sewer Plan
City of Bellingham

Advantages	Disadvantages
• Process more flexible to provide nitrogen removal in the future, though this will require a significant increase in basin volume and aeration capacity.	• Additional aeration basins will not fit on existing site. Requires primary effluent flow split to Homeport and extensive yard piping. • Difficult to construct due to site limitations and the need to replace mixers with a diffused air system. • Requires more aeration basins for future capacity relative to HPO.

10.3.2.3 Option 3 - Conversion to MBR

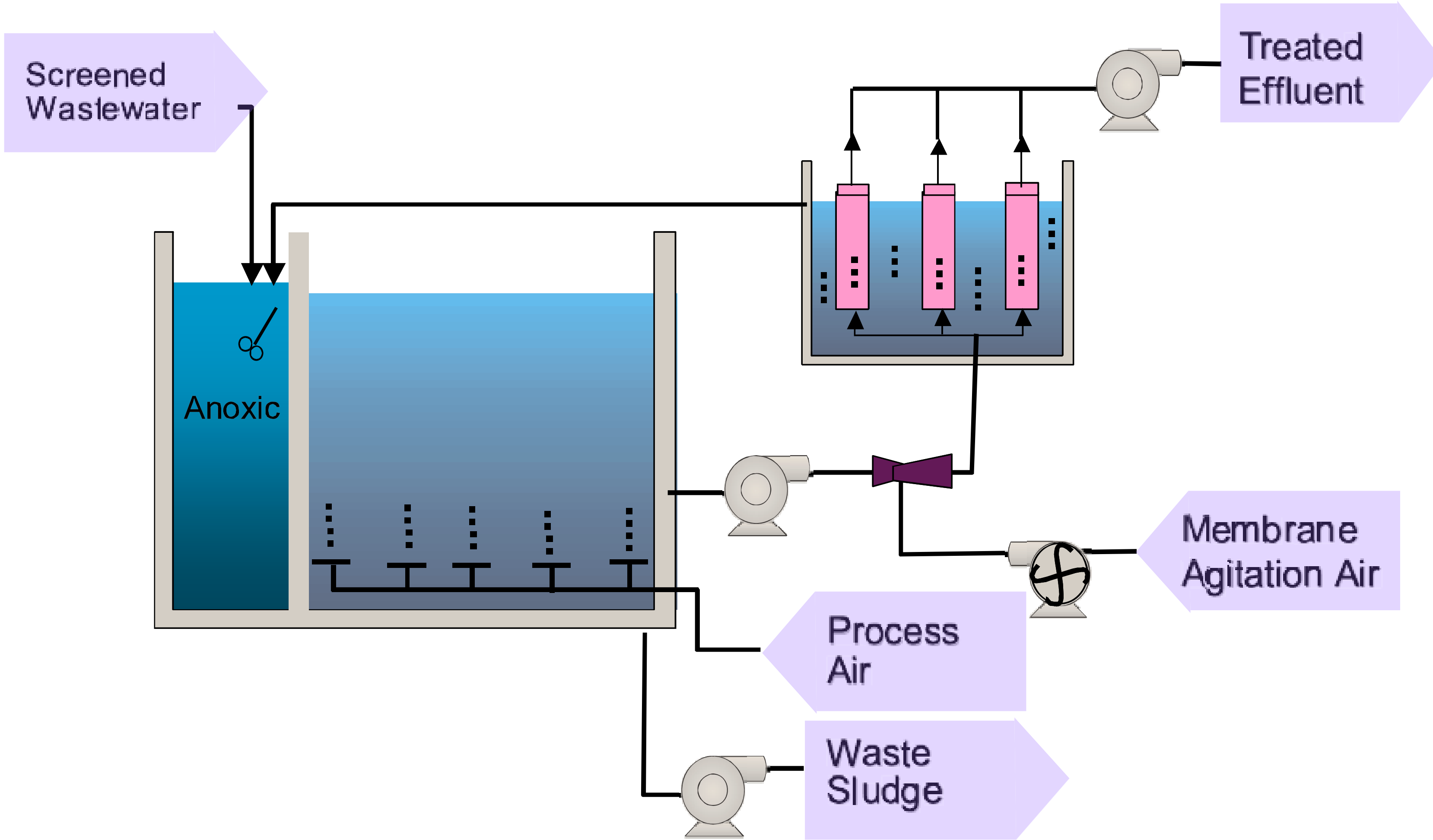
The MBR process uses membrane filtration in lieu of secondary clarification for liquid-solid separation. This method of separation allows the aeration basins to be operated at higher mixed liquor suspended solids (MLSS) than aeration basins requiring secondary clarification and produces an effluent quality meeting Class A reclaimed water standards. In contrast to these process advantages, MBR requires fine screening upstream of the membranes to prevent physical damage to the membranes, and additional blower capacity to provide solids back-transport from the membrane surface. A complete MBR process train consists of fine screening, aeration basins, blowers for aeration basins and membranes, fine bubble diffusers, and membrane bioreactors and tanks. A schematic of the MBR process is shown in Figure 10.4.

The existing HPO process could be converted to an MBR process by retrofitting the existing two basins. A longer solids residence time (SRT) is required for MBR processes, to promote the formation of a filterable floc. Nitrification occurs at the longer SRTs, even if nitrification is not required to meet ammonia or total nitrogen limits in the NPDES permit.

For this option the existing secondary clarifiers would be replaced by membrane tanks for separation of the MLSS. A total volume of 1 MG is required for the membrane tanks, arranged in four trains. Space currently occupied by at least one secondary clarifier may be needed for the membrane tanks.

The following improvements are required to convert the existing HPO process to an MBR system:

- Fine screens (1.0 mm) with capacity for approximately 50 mgd.
- Five new membrane tanks to replace existing secondary clarifiers.



MBR PROCESS SCHEMATIC

FIGURE 10.4

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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- A new aeration system, including replacement of the existing oxygen generation equipment and mixers with blowers and fine bubble diffusers for the aeration tanks and air scour blowers for the membrane bioreactors.
- An external anaerobic selector basin upstream of the aeration basins.
- Associated site and yard piping improvements.

Advantages and disadvantages of this option are listed in Table 10.6.

Table 10.6 Advantages and Disadvantages of Option 3 - Conversion to MBR
Comprehensive Sewer Plan
City of Bellingham

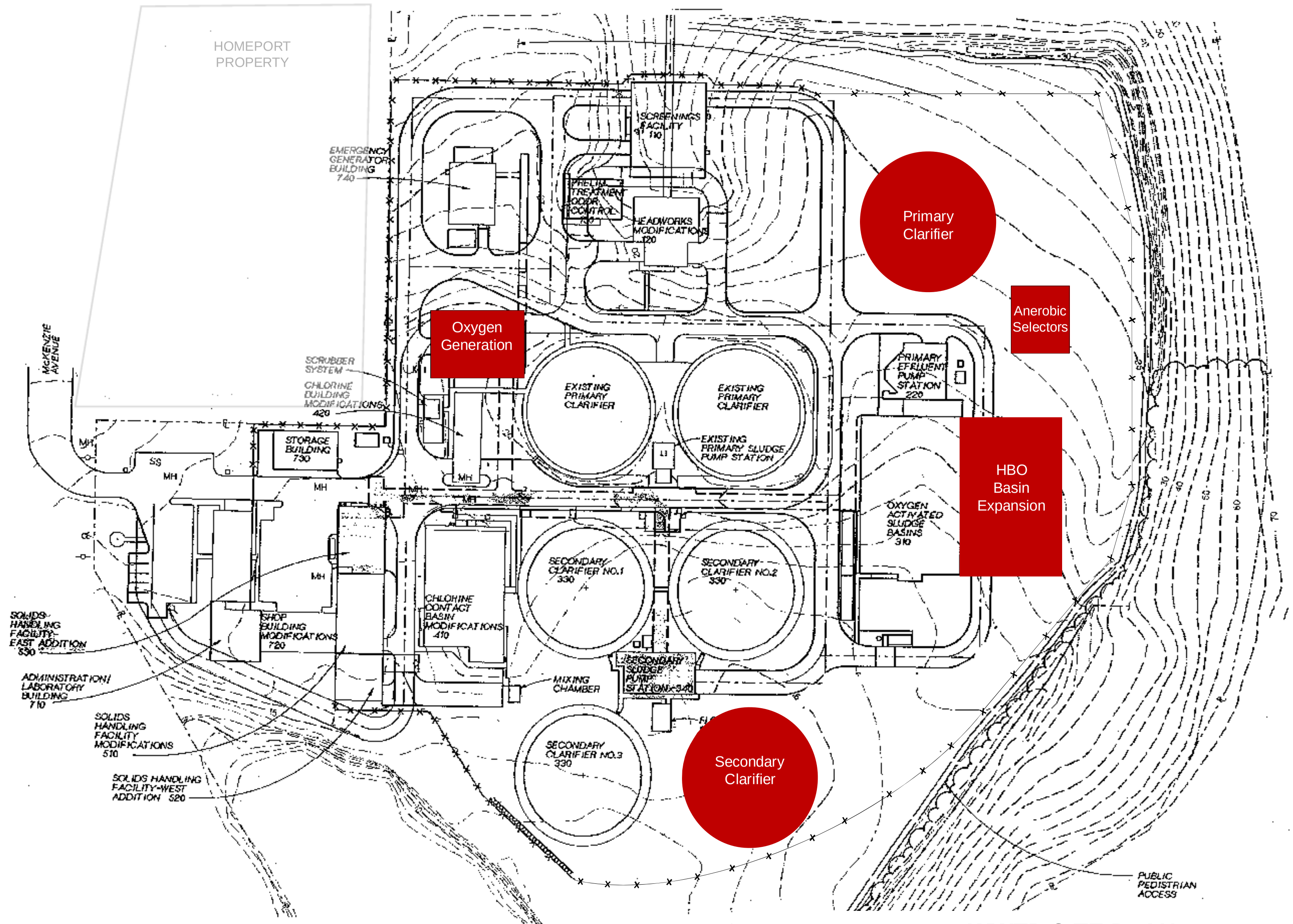
Advantages	Disadvantages
• Process provides nitrogen removal, should future permit limits become more stringent for nutrients. • Process provides Class A effluent in a small footprint, should beneficial reuse of plant effluent be implemented in the future.	• Reduced use of existing facilities, including secondary clarifiers and high purity oxygen mixing system. • MBR processes are expensive to operate, relative to other options.

10.3.2.4 Recommended Secondary Process Improvements

Table 10.7 summarizes the secondary process improvements that were evaluated to provide maximum month capacity through the planning period. Expanding the HPO system as described by Option 1 is recommended. This option has the lowest relative cost of the three options considered, will have a lower operating cost relative to MBR, and is likely the easiest to implement from a constructability standpoint. The HPO process has proven to be effective at the Post Point WWTP, and there are no compelling reasons to convert the plant process at this time. Planning level costs for the HPO expansion are developed in Chapter 11, along with a phasing plant to implement the improvements. A preliminary site plan for expanding the HPO process is shown in Figure 10.5.

Table 10.7 Comparison of Secondary Process Options
Comprehensive Sewer Plan
City of Bellingham

Option	MLSS (mg/L)	Target Aerobic SRT (days)	Total Aeration Basins (New and Existing)	Relative Cost
Option 1 - Expanded HPO	2,000	2	4	1.0
Option 2 - Air AS Conversion	2,000	3	5	1.4
Option 3 - MBR Conversion	8,000	7	2	1.7



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WWTP SITE PLAN, RECOMMENDED HPO EXPANSION OPTION

FIGURE 10.5

CITY OF BELLINGHAM
COMPREHENSIVE SEWER MASTER PLAN

Another option for secondary process improvements not addressed in this Chapter is a hybrid option of the existing HPO system with a phased-in MBR system. The MBR system would consist of one or two aeration basins and required ancillary processes sized to accommodate base flows. Under this scenario, a portion of the flows to the plant would be treated with the new MBR facility with excess flows treated by the existing HPO system. Evaluation of this option is recommended during facilities planning, to identify its relative life-cycle cost and feasibility based on operational issues and constructability.

10.3.2.5 <u>Future Improvements Beyond the Planning Period</u>

The basis of planning defines the anticipated NPDES permit requirements that will be in effect through 2026. Recommended process improvements are sized to meet these requirements. The need to modify or expand the plant processes to meet future permit limits beyond the planning period was briefly evaluated. Two potential permitting issues were considered: future nutrient removal requirements; and future increased percent removal requirements. The purpose of this evaluation was to identify potential process or site impacts that should be considered when implementing the recommended approach. Costs for these potential upgrades are not included in the Capital Improvement Plan (CIP).

10.3.2.5.1 Future Upgrades to Provide Nutrient Removal

As discussed in Section 10.2, it is unlikely that nutrient removal will be required at the Post Point WWTP. If future permits beyond the planning period were to require nutrient removal, HPO AS would not be the preferred secondary process. Operating the AS system in HPO mode reduces system pH, which results in a suppression of nitrification reaction rates. Basin expansion near the pressure swing adsorption (PSA) system would also be difficult given the site constraints.

Future nutrient limits could be achieved by converting the plant to a biological nutrient removal (BNR) process. Under this scenario the existing HPO tanks could be converted to air activated sludge tanks, and retrofitted to provide the necessary anoxic and aerobic zones. The equivalent of approximately six new aeration basins would be needed for conventional BNR for the 2026 loading conditions, requiring expansion onto the Homeport property. Mixed liquor from the BNR process would be settled in conventional secondary clarifiers.

A more favorable option for future nutrient removal would be to convert the HPO tanks to aeration basins for an MBR. Additional tankage for the membranes, blowers for the aeration basins and membranes and fine screening facility would be required, as discussed previously.

10.3.2.5.2 Future Upgrades to Reduce Effluent BOD/TSS

More restrictive limits on effluent BOD/TSS may be required in the future, to reduce mass load or increase percent removal of BOD/TSS. Tertiary filtration would need to be added to the recommended HPO process to meet these limits. Potential tertiary filter options include conventional sand filters, cloth media filters, or membranes. Chemical facilities and staged flocculation would be required based on the selected filtration process.

Tertiary facilities would be sized to filter a portion of the secondary effluent to meet the required permit limits. Given the site constraints adjacent to the secondary clarifiers, it is likely that new filters would be constructed on the Homeport property, necessitating a new filter pump station. Tertiary filters would not be needed if the process were converted to MBR.

10.3.3 Solids Stream Upgrades

The planning level analysis of the plant is focused on liquid stream process upgrades, which will be required early in the planning period. Based on the loading projections in Chapter 4, solids thickening, dewatering, and incineration processes have sufficient capacity through the planning period. New solids facilities may be desirable due to the condition and performance of existing facilities. Figure 10.6 shows a potential site layout for the future solids facilities. The layout assumes that existing administration, lab, and maintenance buildings would be replaced with new buildings on the Homeport site to make room for the solids process expansion. The cost for these facilities is not included in the WWTP improvements through the planning period.

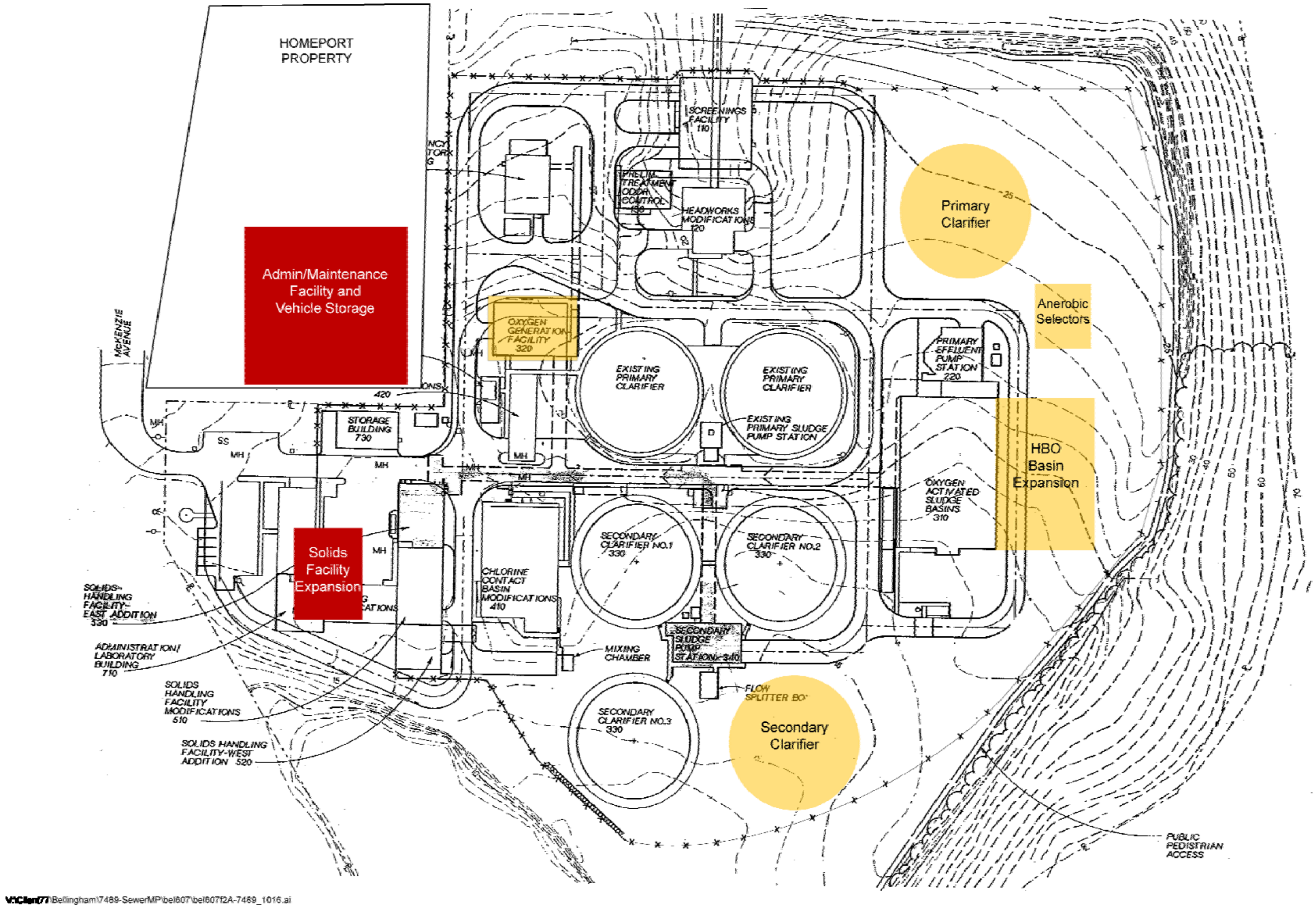
10.3.4 Recommended Maximum Month Upgrades

The capacity of the WWTP was evaluated to determine the upgrades required to meet projected 2026 maximum month flows and loads, and a modeled peak hour flow of 82 mgd. The hydraulic capacity of the plant is limited to approximately 72 mgd. Upgrades to increase hydraulic capacity are not required, as the recommended approach to peak flow management is remote storage, which caps peak flow to the WWTP at 72 mgd. Projected maximum month BOD and TSS loads are 39,900 lb/day and 45,500 lb/day respectively. Process analysis indicates that the existing primary and secondary processes must be updated to provide capacity for future growth.

A new 120-foot primary clarifier and expansion of secondary system are required to meet future flows and loads. Three options for secondary expansion were evaluated, including expanded HPO, conversion to air AS, and conversion to MBR. The expanded HPO option is recommended based on its lower relative cost and other operational and site factors. Preliminary sizing indicates the need for a new anaerobic selector, two new aeration basins, and a new 120-foot secondary clarifier. A new 20-ton PSA system will also be needed to replace the existing system. The expanded HPO alternative should be refined during facilities planning, and compared to potential hybrid alternatives incorporating a combination of HPO and MBR processes.

10.4 UPGRADES REQUIRED FOR PEAK FLOWS

Two alternatives for managing peak wet weather flows were presented in Chapter 7. For Alternative 1, peak flows would be managed remotely in the collection system by reducing peak flows through collection system improvements and constructing either storage or high rate treatment (HRT) facilities near the combined sewer overflow (CSO) location. For this



POTENTIAL SITE PLAN, FUTURE SOLIDS EXPANSION

FIGURE 10.6

CITY OF BELLINGHAM
COMPREHENSIVE SEWER MASTER PLAN

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alternative, peak flow to the plant would be capped at 72 mgd, and no additional plant improvements (beyond those recommended for maximum month capacity) are needed. For Alternative 2, the capacity of the collection system would be increased to convey peak flows to the plant. Storage or HRT may be needed at the plant site for this alternative, as discussed in the following sections.

The same assumptions for storage and HRT that were presented in Chapter 7 are valid for wet weather facilities considered under Alternative 2. Siting wet weather facilities at the plant site offers some key advantages over the remote alternative, including:

- The City currently owns property adjacent to the existing WWTP that is well suited for either storage or HRT.
- Access to facilities adjacent to the plant site would be immediate, reducing staff response time during an event, and improving efficiency of routine operation and maintenance (O&M) procedures.
- Wet weather facilities located at the plant site would not require the aesthetic design features that would be needed if the facilities were constructed in a waterfront area to be developed in the future.

Subsets to Alternative 2 are presented in the following sections. Alternatives 2A and 2B assume that the hydraulic capacity of the plant would not be increased beyond its current capacity of 72 mgd. For these alternatives, peak flows in excess of 72 mgd would be stored or treated through an HRT process upstream of the existing bar screens. Alternative 2C assumes that the hydraulic capacity of the plant would be increased to 85 mgd, matching the process capacity provided by the primary and secondary improvements that are driven by future maximum month flows and loads.

10.4.1 Future Peak Flows

Chapter 6 describes the modeling assumptions that were used to generate future peak flows. Long Term Simulation (LTS) modeling was used as the design basis for determining excess capacity required to control CSOs. The modeling showed the need for an additional 10 mgd of conveyance and treatment capacity to control CSOs through year 2016, yielding a future peak flow of 82 mgd. If storage were used in lieu of increasing treatment capacity, a 1.7 MG tank would be required. For both of these alternatives, additional collection system improvements would be required beyond year 2016 to control CSO volume to baseline conditions.

For alternatives presented below, plant capacity, storage, and/or HRT facilities are sized for a peak flow of 82 mgd. Consideration should be given to future expansion of plant capacity or wet weather facilities, as further expansion may be needed to provide additional storage or treatment capacity at the plant if the capacity of facilities sized based on LTS modeling is exceeded within the planning period.

10.4.2 Peak Wet Weather Process Capacity

The hydraulic capacity of the WWTP is currently 72 mgd. Peak flow process capacity will be gained by constructing the improvements needed to meet future maximum month flow and loading conditions. The capacity of the primary and secondary process train following the recommended maximum month improvements is 55 mgd. Combined with the 30 mgd of split flow that is currently blended with secondary effluent when flows exceed secondary capacity, the recommended improvements will provide a process capacity of 85 mgd. This is greater than the future peak flow capacity needed to limit CSOs to an average of one event per year (82 mgd). There are several plant processes that are designed based on hydraulic criteria that will need to be upsized in order to provide a peak flow capacity of 85 mgd. These modifications, which would eliminate the need for storage of HRT facilities, are discussed for Alternative 2C.

10.4.3 Comparative Cost Development

Costs are developed in this Chapter primarily to allow comparison of peak flow management alternatives. Comparative costs will be used as the basis of selecting the recommended alternative. Once this alternative has been established, more detailed costs and sequencing plans will be developed for the CIP.

10.4.4 Alternative 2A - Store Peak Flow Greater Than 72 mgd

Peak flows would be stored upstream of the existing bar screens under Alternative 2A. The same storage volume required for Alternative 1A, 1.7 MG, is needed for Alternative 2A. The Homeport property is the most likely location for construction of the storage facility. Figure 10.7 shows how the footprint of a 1.7 MG storage basin could fit on the site.

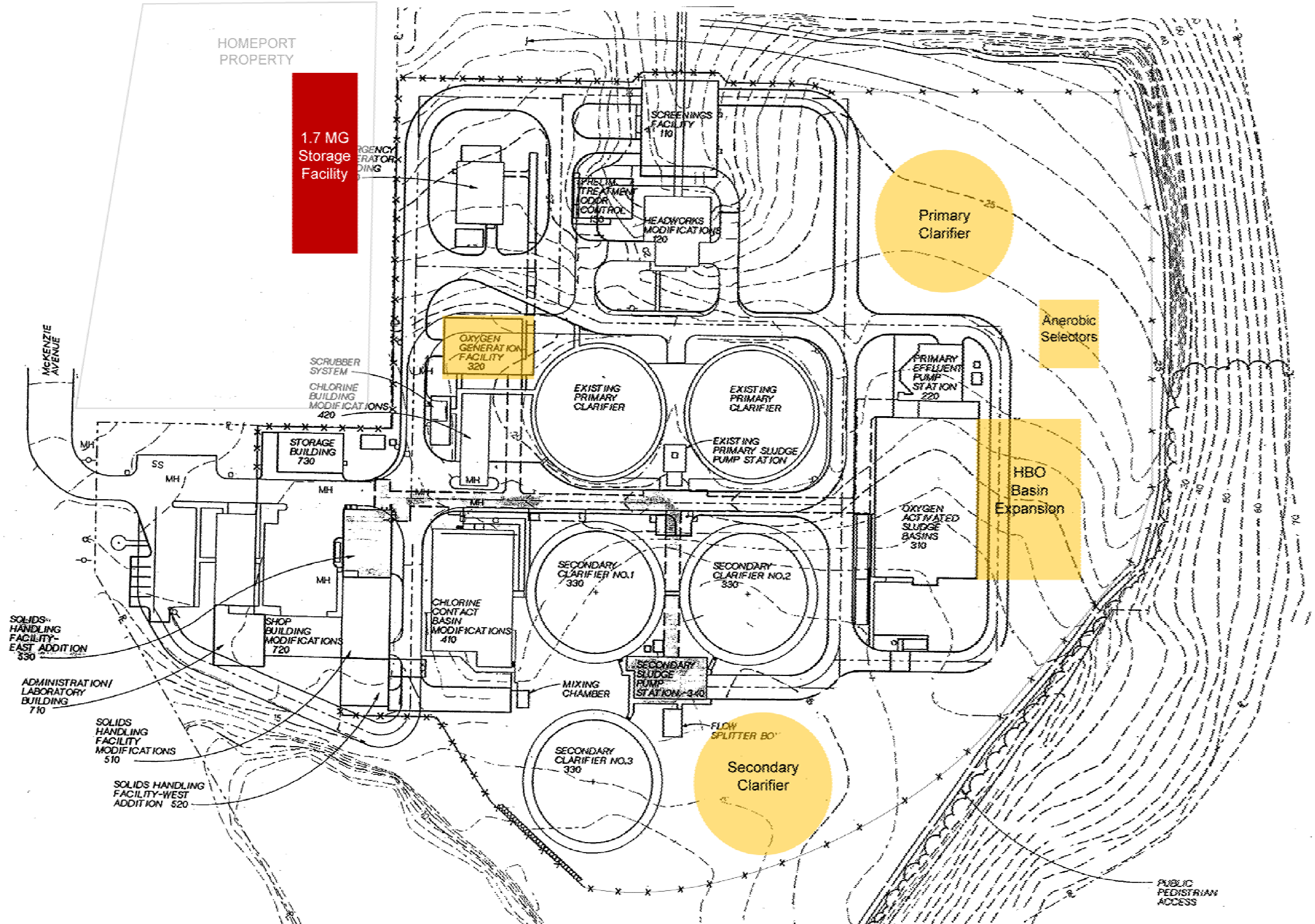
Non-cost factors to consider relative to storing excess peak flows at the WWTP are summarized in Table 10.8.

Table 10.8 Advantages and Disadvantages of Alternative 2A
Comprehensive Sewer Plan
City of Bellingham

Advantages	Disadvantages
• Relatively low impact on O&M. No treatment process equipment to maintain for infrequent use.	• Risk of overtopping storage and/or not being able to empty storage prior to next event. • Limited flexibility for expansion, if tank footprint becomes large.

10.4.5 Alternative 2B - HRT for Peak Flow Greater Than 72 mgd

Peak flows would be split treated through an HRT process for Alternative 2B. The flow split would occur upstream of the existing bar screens. The same HRT capacity for Alternative 1B, 10 mgd, is needed for Alternative 2B. The Homeport property is the most likely location for construction of the facility. Figure 10.8 shows how the footprint of a 10-mgd HRT facility could fit on the site.



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ALTERNATIVE 2A SITE PLAN, WWTP STORAGE

FIGURE 10.7

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COMPREHENSIVE SEWER MASTER PLAN

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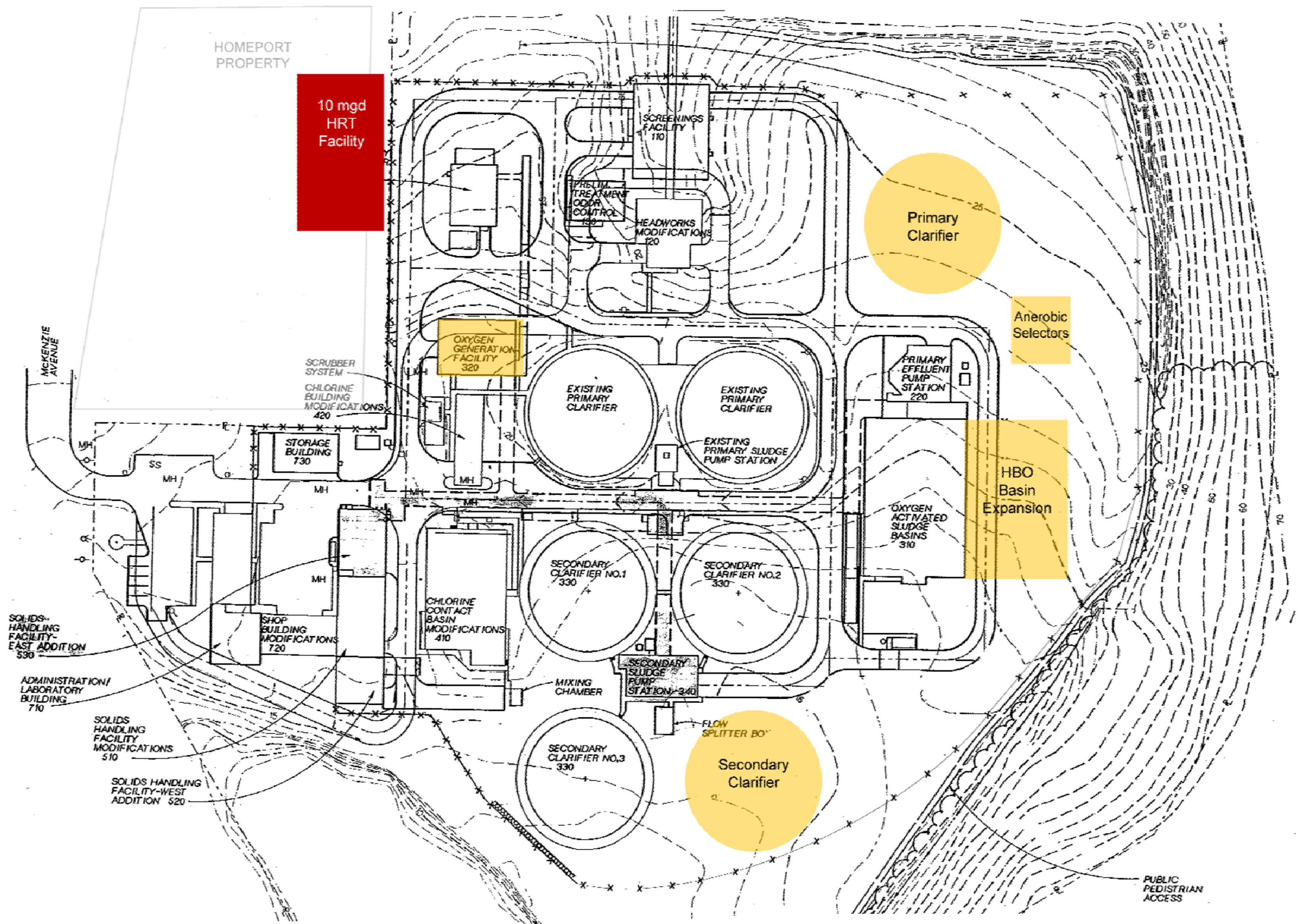

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ALTERNATIVE 2B SITE PLAN, WWTP HRT

FIGURE 10.8

CITY OF BELLINGHAM
COMPREHENSIVE SEWER MASTER PLAN

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Non-cost factors to consider, relative to treating excess peak flows with an HRT process at the WWTP, are summarized in Table 10.9.

Table 10.9 Advantages and Disadvantages of Alternative 2B Comprehensive Sewer Plan City of Bellingham	
Advantages	**Disadvantages**
• Flexibility for expansion beyond 10 mgd provided by small footprint of HRT facilities • Flexibility to increase loading rates for peak flows. • Eliminates risk of not being able to empty storage prior to next event.	• Relatively high impact on O&M. Additional treatment process equipment to maintain for infrequent use.

10.4.6 Alternative 2C - Increase Plant Hydraulic Capacity to 85 mgd

Alternative 2C assumes the plant capacity will be increased to 85 mgd. The following improvements are required:

10.4.6.1 Influent Screening

The current screening facility includes five channels. Mechanically cleaned screens are installed in three of the channels, each with a capacity of approximately 25 mgd. Manually cleaned trash racks are installed in the remaining two channels. Replacing one of the trash racks with a fourth bar screen will provide a firm screening capacity of 75 mgd, and a total screening capacity of 100 mgd. Replacing the second trash rack with a fifth bar screen is recommended to provide firm capacity for 85 mgd, provided that an alternate location for passive bypass can be found.

10.4.6.2 Grit Removal

The existing bar screens were constructed over the top of the original influent channel feeding the grit basins. The existing channel was demolished and upsized during these improvements, but the dimensions of the channel feeding the grit basin were not increased. The channel constriction is a bottleneck that limits flow to the existing grit basins to 72 mgd.

Peak flows over 72 mgd could be bypassed around the existing grit basin to eliminate the need to expand this process. The potential impact on downstream plant processes should be fully explored if this option is selected. For planning purposes, a new grit basin is recommended to provide 85 mgd of hydraulic capacity through the plant. The existing basins are original, and improvements in grit removal technology have been developed to improve process performance.

The layout and size of the new grit basin should be determined during Facilities Planning Phase, if this alternative is selected. One option would be to size the grit basin for maximum dry weather flows, such that the new basin could be used alone to provide more effective grit removal during the majority of the year. For this option, the two existing grit basins would be brought into service as flows exceeded the new basin design capacity.

Comparative costs developed for evaluation of peak flow management alternatives assume a new 30-foot diameter vortex grit basin is constructed south of the existing grit building, complete with new grit pumps, cyclones, and classifier.

10.4.6.3 Primary Effluent Pumping

A new primary clarifier is needed to provide future maximum month capacity. The capacity of the existing PE pump station is approximately 72 mgd. A new PE pump station will be required if the overall plant capacity is increased to 85 mgd. An economical option for the new pump station would be to install a submersible station designed for limited use during peak flows. The existing pump station would be used year-round, with the peak PE pump station used when flow exceeds 72 mgd.

10.4.6.4 Chlorine Contact Basin

The volume of the existing chlorine contact basin provides approximately 20 minutes of contact time at a future maximum day flow of 64.2 mgd. The contact time at a peak hour flow of 82 mgd is approximately 14 min. Contact times for chlorination systems are established as guidelines to provide reliability, limit the potential for short circuiting, and reduce chlorine consumption on an annual basis. The actual design basis for the chlorine disinfection system is the product of residual chlorine concentration (C) and contact time (t), and is referred to as Ct. The existing chlorination system has sufficient capacity to provide the appropriate Ct at a peak hour flow of 82 mgd. The existing dechlorination system is used to limit chlorine residual in the disinfected effluent.

Although expansion of the process is not required from a capacity standpoint, alternatives to continued chlorine disinfection should be explored during Facilities Planning Phase. The current system uses ton cylinders of chlorine gas, which present a potential safety hazard to the plant staff and the neighboring population. The loop control of gaseous chlorination/dechlorination systems is also more complicated and difficult to tune relative to other options. Two common alternatives to gaseous chlorine are UV and liquid (hypochlorite) disinfection. While these improvements may ultimately be recommended, they are not required for capacity. Therefore, costs to convert the existing system to one of these two alternatives are not included in the comparative analysis.

10.4.6.5 Summary of WWTP Improvements

The capacity of the WWTP can be increased to 82 mgd by making the following improvements to hydraulically limited processes, which are needed in addition to the primary and secondary process expansion for maximum month conditions:

- At least one additional bar screen. Two additional screens are recommended if an acceptable passive bypass can be provided.

- One additional grit basin. The recommended design criterion is maximum dry weather flow, such that the basin can be used for year-round effective grit removal.
- A PE pump station with a firm 28 mgd capacity.
- Associated yard piping and site improvements.

Figure 10.9 shows the hydraulic improvements that would be required at the plant site.

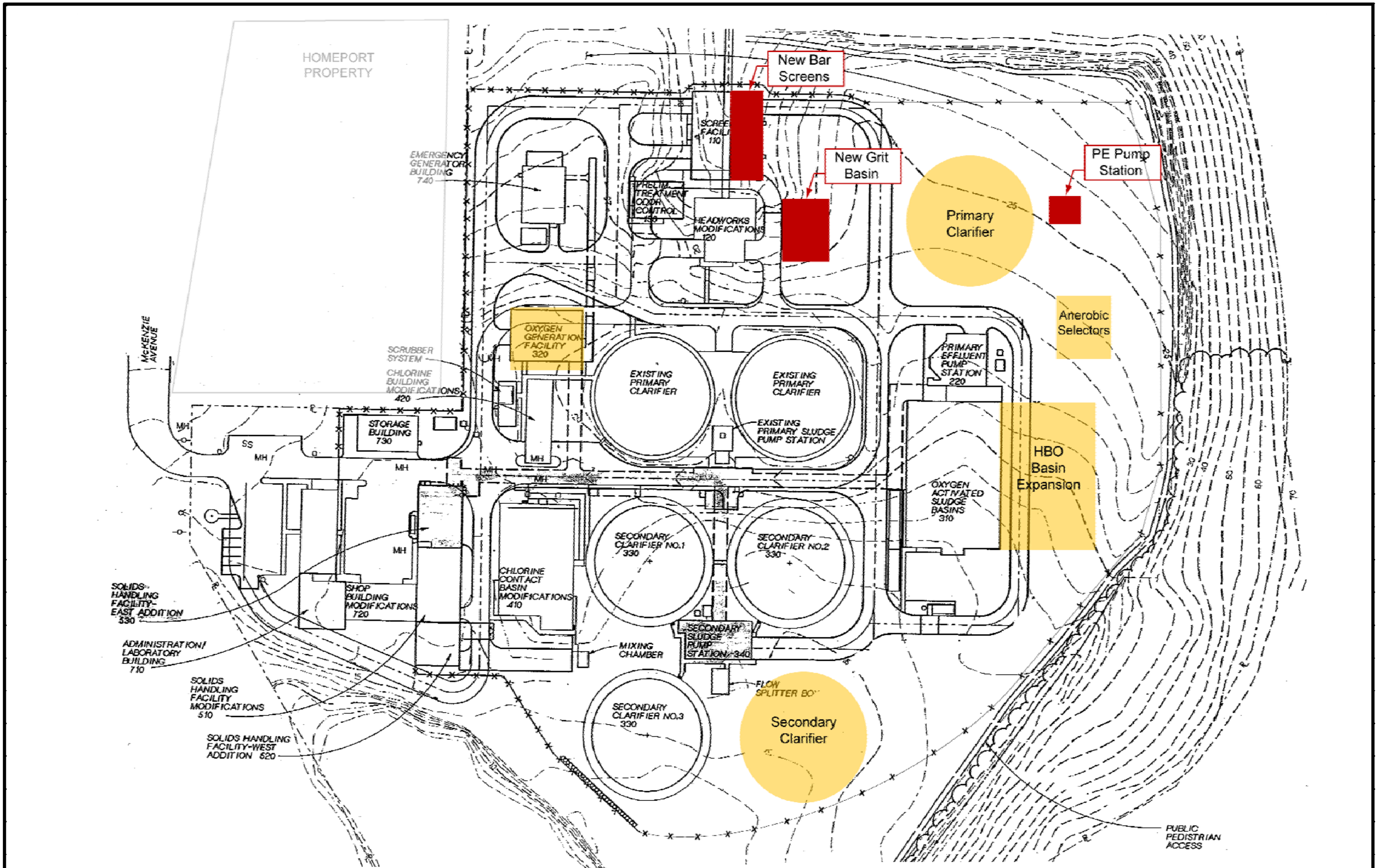
10.4.7 Recommended Peak Flow Management Alternative

Table 10.10 summarizes the relative costs of the peak flow management alternatives that were evaluated. The table shows that Alternative 1, managing peak flows near the existing C Street CSO structure, is much more cost effective than Alternative 2, increasing the capacity of the Oak Street Pump Station and the downstream interceptor, and providing peak flow storage or capacity at the WWTP. Storage (Alternative 1A) is the recommended remote peak flow management alternative, and has the following advantages over HRT:

- <u>Cost Effectiveness.</u> The remote storage facility has a lower capital cost, and will likely have a lower life cycle cost than HRT.
- <u>O&M Impacts.</u> A remote HRT facility would require a high level of attention by City staff. Routine O&M of the HRT facility would be necessary to keep it ready for operation when needed.
- <u>Reliability.</u> Storage facilities provide a relatively simple approach to peak flow management compared to HRT, which requires operation of process equipment including screening, chemical feed, sludge collection/pumping, and UV systems for reliable performance.
- <u>NPDES Permitting Issues.</u> There is precedence in Washington and Oregon for permitting the discharge of HRT facilities treating CSOs and sanitary sewer overflows (SSO). However, storage facilities do not require modifications to the City's existing NPDES permit, as peak flow is captured and ultimately treated through the WWTP.

Table 10.10 Relative Cost Comparison of Peak Flow Management Alternatives
Comprehensive Sewer Plan
City of Bellingham

Alternative	Description	Relative Cost
1A	Remote Storage	1.0
1B	Remote HRT	1.3
2A	Conveyance and Peak Flow	2.9
2B	Conveyance and HRT for Peak Flows	3.1
2C	Conveyance & WWTP Expansion	3.1



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WWTP HYDRAULIC CAPACITY UPGRADES

FIGURE 10.9

CITY OF BELLINGHAM
COMPREHENSIVE SEWER MASTER PLAN

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10.5 RECOMMENDATIONS TO REDUCE BOD LOADING

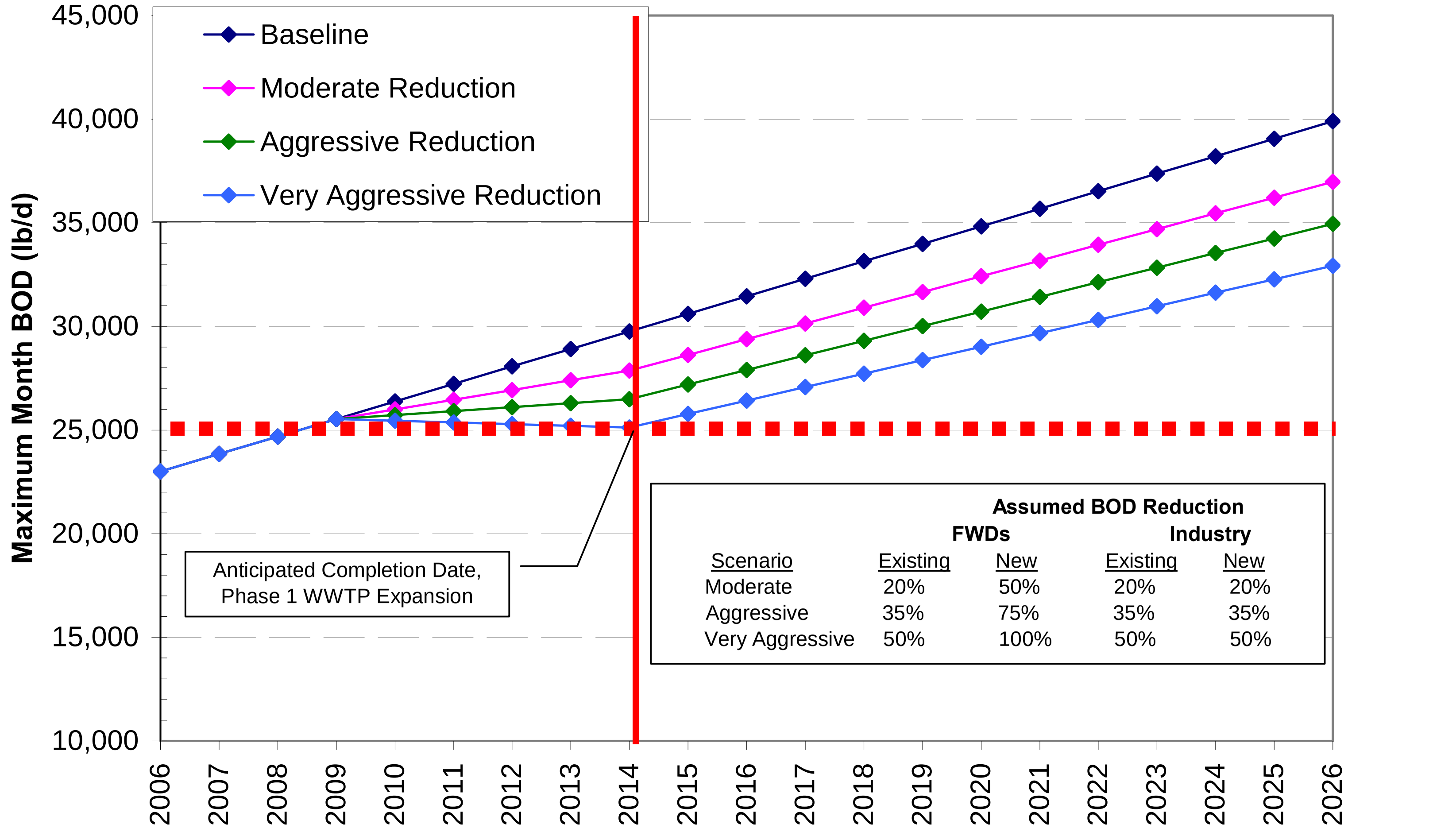
As discussed in Chapter 4, there are opportunities to reduce the amount of BOD entering the City's collection system. A preliminary evaluation of three load reduction scenarios was completed to determine potential impacts on existing and future capacity needs at the WWTP. The tables below summarize the assumptions used for the preliminary evaluation:

Scenario 1 - Moderate Reduction	
Total BOD Source	**Assumed Level of BOD Reduction**
Existing FWDs	Reduced by 20 percent over a five-year period, starting in 2010.
New FWDs	Reduced by 50 percent, starting in 2010.
Existing Industry	Reduced by 20 percent over a five-year period, starting in 2010.
New Industry	Reduced by 20 percent, starting in 2010.
Note: FWDs are assumed to contribute to BOD loads in 75 percent of current and future residences.	

Scenario 2 - Aggressive Reduction	
Total BOD Source	**Assumed Level of BOD Reduction**
Existing FWDs	Reduced by 35 percent over a five-year period, starting in 2010.
New FWDs	Reduced by 75 percent, starting in 2010.
Existing Industry	Reduced by 35 percent over a five-year period, starting in 2010.
New Industry	Reduced by 35 percent, starting in 2010.
Note: FWDs are assumed to contribute to BOD loads in 75 percent of current and future residences.	

Scenario 3 - Very Aggressive Reduction	
Total BOD Source	**Assumed Level of BOD Reduction**
Existing FWDs	Reduced by 50 percent over a five-year period, starting in 2010.
New FWDs	Reduced by 100 percent, starting in 2010.
Existing Industry	Reduced by 50 percent over a five-year period, starting in 2010.
New Industry	Reduced by 50 percent, starting in 2010.
Note: FWDs are assumed to contribute to BOD loads in 75 percent of current and future residences.	

Figure 10.10 shows the potential impact on future maximum month BOD load for each scenario as compared to the “baseline” projections. As shown by the figure, Scenario 1 could provide the equivalent of up to three years of population growth, offsetting future WWTP expansion. If Scenario 3 were implemented according to the assumptions listed above, up to eight years of equivalent population growth could be provided.



POTENTIAL REDUCTIONS IN MAX MONTH BOD

FIGURE 10.10

CITY OF BELLINGHAM
COMPREHENSIVE SEWER MASTER PLAN

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CAPITAL IMPROVEMENTS PLAN

11.1 INTRODUCTION

This Chapter summarizes the Capital Improvement Plan (CIP) for the City of Bellingham's (City) Comprehensive Sewer Plan (Plan). Estimated capital costs and phasing plans are presented for projects that are required to meet current and future capacity limitations at the Post Point Wastewater Treatment Plant (WWTP) and in the wastewater collection system. Project phasing is developed between 2008 and the end of the planning period in 2026.

11.2 BACKGROUND

Improvement projects presented in this Chapter are defined by two categories: collection system improvements developed in Chapter 7, and WWTP improvements developed in Chapter 10. Flow modeling identified the need for improvements in the collection system to accommodate future peak flows. Improvements at the WWTP to meet future maximum month flows and loads are also required.

Prior analysis of peak flow management alternatives identified remote storage and peak flow reduction as the preferred alternative for limiting Combined Sewer Overflows (CSOs) to regulatory limits. Implementing this strategy will cap peak flows conveyed to the WWTP at approximately 72 mgd. The primary and secondary process improvements required at the WWTP are driven by future maximum month or peak day design criteria.

11.3 OVERALL CIP PROJECT SUMMARY

11.3.1 WWTP Improvement Projects

Chapter 10 presents an evaluation of WWTP alternatives to meet future maximum month flows and loads. Expansion of the existing High Purity Oxygen (HPO) activated sludge system is recommended. Process improvements required to implement the expanded HPO alternative are summarized below.

11.3.1.1 <u>Preliminary Treatment</u>

The existing bar screens and grit facilities have sufficient peak flow capacity for 72 mgd. No improvements to the headworks are required at the WWTP.

11.3.1.2 <u>Primary Treatment</u>

A third primary clarifier is required to meet future maximum month flow and loading conditions. Implementing Chemically Enhanced Primary Treatment (CEPT) to reduce peak loads may defer or eliminate the need for the third primary. Evaluation of this option is recommended during facilities planning. Costs and phasing plans included in this CIP include the construction of Primary Clarifier No. 3, a primary sludge pump station for the third clarifier, and associated yard piping and flow splitting structures.

11.3.1.3 Secondary Treatment

Expansion of the existing high purity oxygen (HPO) system to provide sufficient capacity for year 2026 flows and loads includes the following elements:

- Modifications to the existing primary effluent pump station and HPO basin inlet structure.
- An external anaerobic selector and flow splitting structure.
- Two additional HPO basins.
- A fourth secondary clarifier and associated return activated sludge (RAS)/waste activated sludge (WAS) pump station.
- Replacement and expansion of the existing Pressure Swing Adsorption (PSA) oxygen generation system.

11.3.1.4 Tertiary Treatment

Based on the current NPDES basis of planning, there are no tertiary facilities required within the planning period.

11.3.1.5 Disinfection

The existing disinfection system has adequate capacity for the future peak and maximum day flows. Costs for expanding the existing facility are not included in this CIP. Options for improving the existing system may be explored during the Facilities Planning Phase, to address operations and maintenance (O&M) and safety issues associated with the current gaseous chlorination system.

11.3.1.6 Solids Stream Processes

There are no near-term capacity limitations in the sludge thickening and incineration processes. Costs for expanding or replacing these processes are not included in this CIP. The condition and performance of the existing thickening and dewatering units, and the incinerators may drive their replacement prior to the end of the planning period in 2026. Further evaluation of the need and timing for these improvements is recommended during Facilities Planning Phase.

11.3.2 Collection System

An evaluation of collection system improvements to accommodate future growth and meet peak capacity requirements is presented in Chapter 7. The analysis indicates the need for changes to the conveyance system to handle peak flows. Recommended improvements in the collection system include a combination of peak flow reduction and remote peak flow storage to control CSOs, as well as upgrades to selected pipes within the system over the planning period to increase their capacity.

11.3.2.1 Peak Flow Management

A phased combination of remote storage and peak flow reduction is recommended to control CSOs to the regulatory limit. The initial phase of the CSO control program is storage near the vicinity of the existing CSO outfall. An I/I study is also included in the CIP, to better define subsequent peak flow reduction projects.

11.3.2.2 Collection System Improvements

Capacity limitations in collection system piping and pump stations were identified by the peak flow modeling analysis. Improvements to correct these deficiencies are presented in the CIP based on the following prioritization:

- Priority 1:
  Priority 1 elements were determined to be currently "deficient" under the selected design storm conditions. These pipes or pump stations are primarily the lower portion of collection sewers and interceptors, and present the highest risk of causing an uncontrolled overflow.

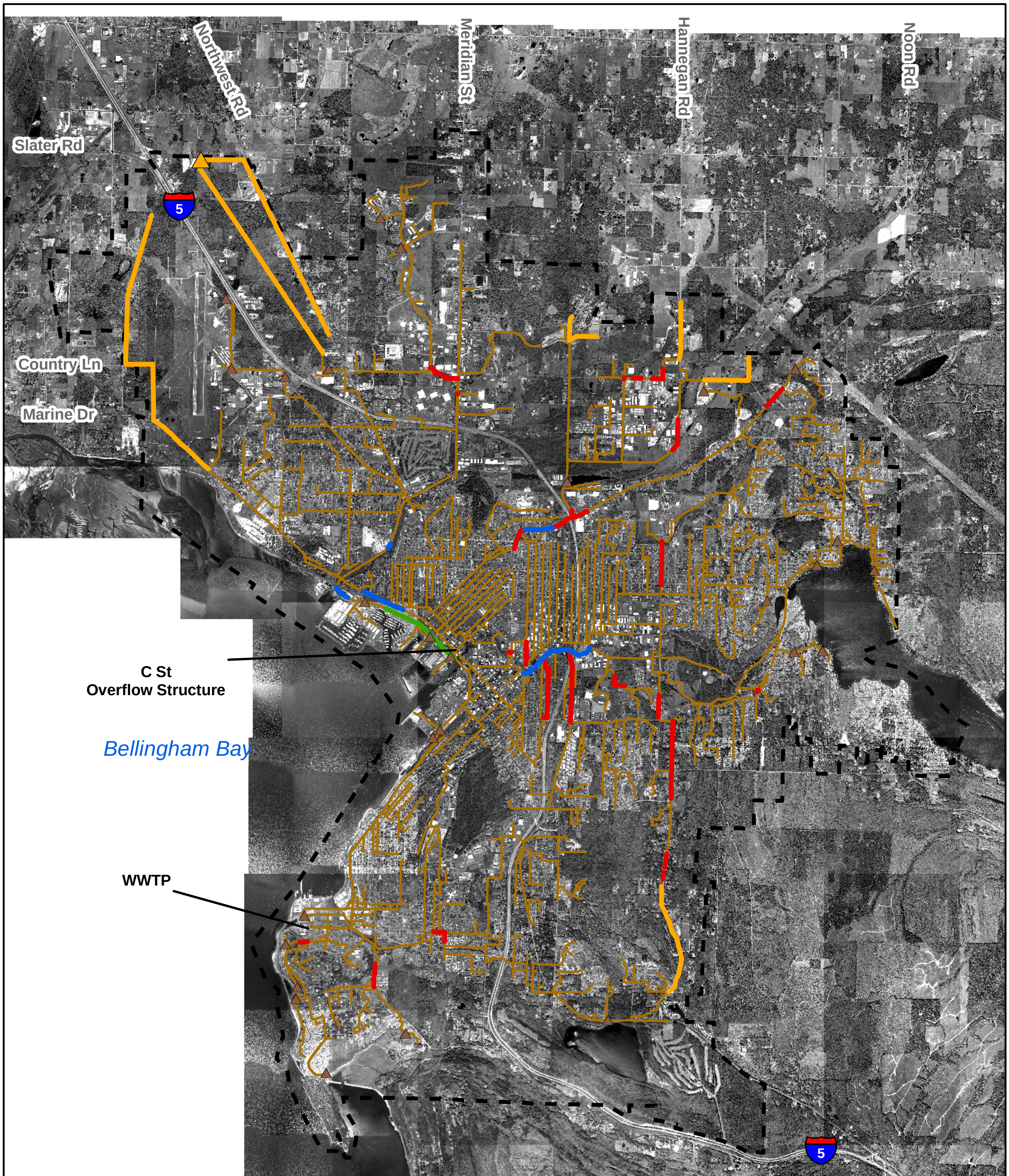
- Priority 2:
  Priority 2 elements are defined as large pipes in the collection system that are "deficient" near the middle of the planning period (Year 2016) under the selected design storm conditions. Selected smaller diameter pipes are also rated as Priority 2, if they present a risk of uncontrolled overflow prior to Year 2016.

- Priority 3:
  Priority 3 elements are defined as pipes in the collection system that are "deficient" near the end of the planning period (Year 2026) under the selected design storm conditions.

The recommended improvements for all three priority categories are shown in Figure 11.1. Project costs assume pipe segments that are capacity limited and smaller than 16 inches in diameter will be replaced with larger diameter segments. Parallel pipe installation is assumed to increase the conveyance capacity of larger pipes (greater than 16 inches) and interceptor sewers.

The recommended piping improvements will reduce the risk of an uncontrolled overflow in the collection system by increasing conveyance capacity. The projects were prioritized based on when they will be needed. Priority 1 projects are required in the near term to address potential current problems. Priority 2 and 3 projects are based on the projected future growth within the current system limits, and incorporation of the Urban Growth Areas (UGAs) into the system.

The hydraulic grade line (HGL) in pipe segments near the CSO location is established by the elevation of the existing overflow weir. Additional Priority 1 improvements are



Legend

- Modeled Lift Station
- New Lift Station to Serve UGA
- Modeled Collection System
- Roeder Street Interceptor
- New Sewers to Serve UGA
- New Parallel Pipes
- Replacement Pipes
- Future Sewer Service Area

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RECOMMENDED COLLECTION SYSTEM CONVEYANCE IMPROVEMENTS

FIGURE 11.1

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COMPREHENSIVE SEWER PLAN

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recommended to mitigate overflow risk near the CSO, particularly along the Roeder Avenue pipeline beyond simply increasing existing pipe segment capacity. Many of the manholes along Roeder Avenue are at risk of overflowing during peak flow events. To increase capacity through this segment, planning level costs assume that the Roeder lift station will be replaced with a new pump station and force main discharging at a point near the CSO. Excess flow from this pump station would be stored or treated at the proposed peak flow management facility. The gravity interceptor downstream from the lift station would continue to carry flow from the downstream connections along the line. Even with the addition of a new pump station and force main, the HGL along Roeder Avenue and near the CSO will be close to the manhole rim elevations. Modifications to the existing CSO structure or manholes in this area should be evaluated during Facilities Planning Phase, to further reduce the risk of an uncontrolled overflow in this area.

11.4 BASIS OF ESTIMATED COST

Preliminary cost estimates are presented in this Chapter for the required WWTP and collection system improvements. The expected level of accuracy for the cost estimates is “Class 4,” with an expected accuracy range of within 30 percent over the estimate to 15 percent under the estimate. Estimated project costs represent July 2007 dollars consistent with the 20-cities Engineering News-Record (ENR) value of 7959, adjusted for the Seattle, Washington region. The following assumptions and markups are used to develop construction and total project costs:

- A 30 percent contingency is applied to the subtotal of direct construction costs for each element.
- A 15 percent markup for General Conditions (GC) is applied to the construction cost subtotal.
- A 10 percent markup for Contractor’s overhead and profit (OH&P) is applied to the construction and GC cost subtotal.
- A 7.75 percent markup for Washington State sales tax is applied to calculate the total estimated construction cost.
- A 20 percent markup for Engineering, Legal, and Administration (ELA) is applied to the total estimated construction cost.
- A 12 percent markup for Owner’s cost is applied to the total estimated construction cost.
- Total estimated project cost is calculated by adding construction, ELA, and Owner’s costs.

The implementation schedule for each project is based on a conventional project delivery, and includes a design phase, bid period, and a construction/start-up period. Durations of each period are adjusted to reflect the magnitude of the project. Construction and start-up periods range from 1.5 to 3 years, and assume a construction contractor's ability to perform approximately $2.5 million per month of construction work under peak conditions. Final implementation schedules for each project developed during subsequent planning should include a review of the proposed CIP schedules, with adjustments made to account for project sequencing, equipment procurement, and facility commissioning times.

Costs for each project are based on July 2007 dollars. Costs are adjusted to their mid-point of construction date and value for determination of the CIP. An annual inflation rate of five percent is used to calculate mid-point construction costs. Design, construction, and construction services costs are applied over the total project duration using a standard S-Curve approach for project costs, as summarized in Table 11.1. This approach distributes percentages of project cost over the duration of the project, taking into account lower percentage spending at the beginning and end of projects, and increased spending in the middle.

11.5 PROJECT PHASING PLAN

Project phasing plans were developed for improvements to the WWTP and collection system using the priority basis defined previously, and to meet capacity triggers presented in the following sections.

11.5.1 WWTP Project Phasing

Project phasing for WWTP improvements was selected to provide the required capacity based on projected growth in the City and UGA. Chapter 4 presents a range of growth projections for flows and loads, based on two assumptions for the percentages of connected service area population relative to overall population estimates. The more conservative projections assume that by 2026, 100 percent of the City and UGA population will be sewered. The less conservative projections assume a constant sewered percentage of the City and UGA. Project timing is less affected by the range of projected growth early in the CIP. Future project triggers assume the need to supply the required maximum month capacity to meet the highest projected growth predictions.

Table 11.1 Standard S-Curves for Project Costs
Comprehensive Sewer Plan
City of Bellingham

Project Duration (Quarters)	Proportion of Project Costs Spent in Quarter													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**Total**
1	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
2	30%	70%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
3	10%	45%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
4	10%	35%	35%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
5	1%	9%	35%	35%	20%	0%	0%	0%	0%	0%	0%	0%	0%	100%
6	1%	1%	8%	35%	35%	20%	0%	0%	0%	0%	0%	0%	0%	100%
7	1%	2%	7%	20%	30%	25%	15%	0%	0%	0%	0%	0%	0%	100%
8	1%	2%	7%	10%	15%	25%	25%	15%	0%	0%	0%	0%	0%	100%
9	1%	2%	5%	7%	10%	15%	25%	20%	15%	0%	0%	0%	0%	100%
10	1%	1%	2%	5%	7%	12%	15%	22%	20%	15%	0%	0%	0%	100%
11	0.6%	1%	2%	3%	5%	8%	12%	16%	19%	19%	14%	0%	0%	100%
12	0.5%	1%	1%	2%	4%	6%	9%	13%	16%	18%	17%	13%	0%	100%
13	0.4%	1%	1%	2%	3%	5%	7%	10%	13%	15%	16%	16%	12%	100%

11.5.1.1 Phase 1 WWTP Improvements

The recommended improvements summarized in Section 3.1 are implemented in two phases. Phase 1 is shown in Figure 11.2, and includes the following project elements:

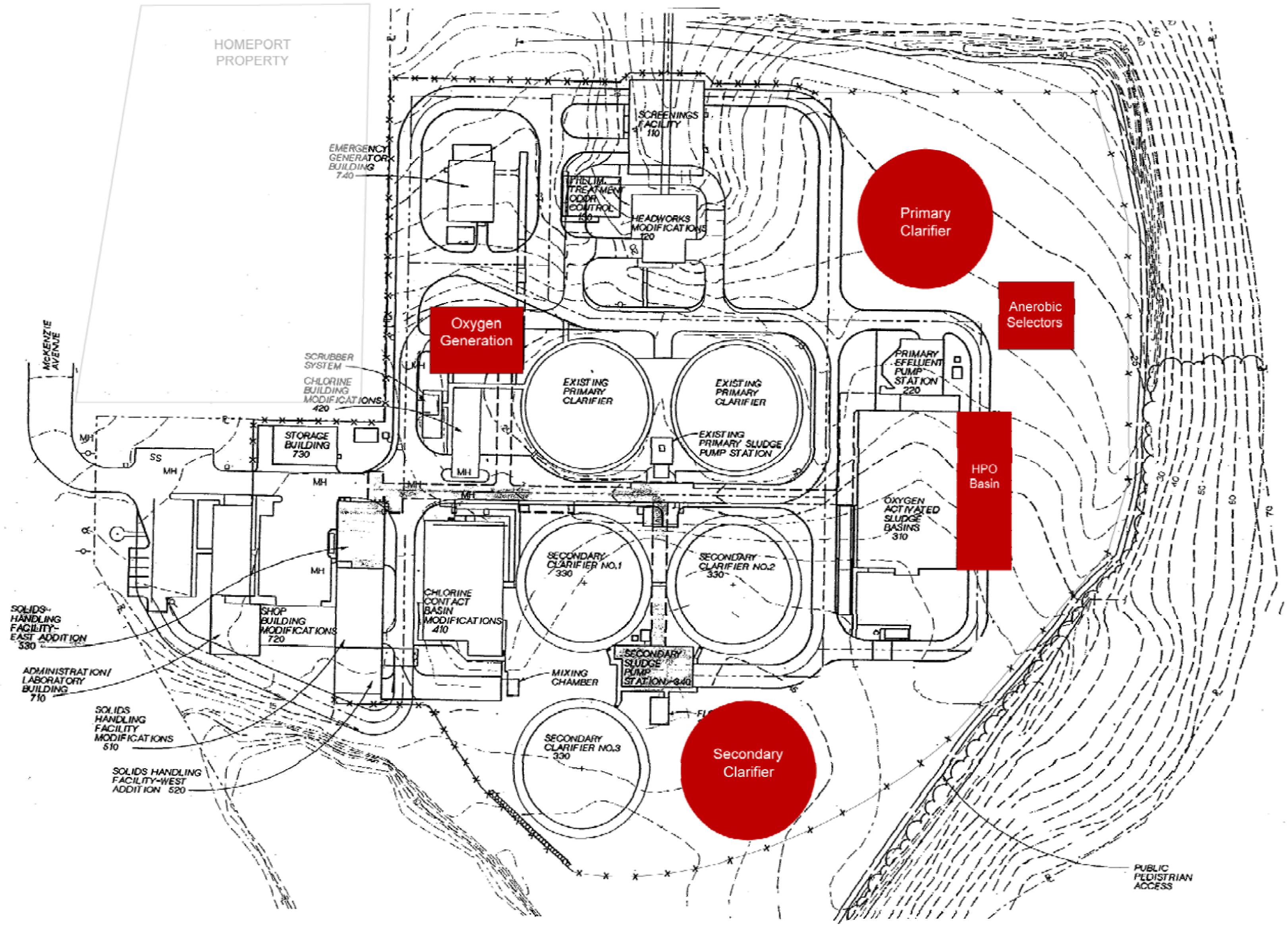
- Primary Clarifier No. 3 and associated sludge pump station.
- Modifications to the existing primary effluent pump station and HPO basin inlet structure.
- An external anaerobic selector and flow splitting structure.
- HPO Basin No. 3.
- Secondary Clarifier No. 4 and associated RAS/WAS pump station.
- Replacement and expansion of the existing Pressure Swing Adsorption (PSA) oxygen generation system.

The estimated construction and total project cost for the Phase 1 improvements is presented in Table 11.2.

Table 11.2 WWTP Phase 1 Improvements
Comprehensive Sewer Plan
City of Bellingham

Project		Cost
Primary Clarifier Improvements		$6,330,000
HPO Aeration Basin No. 3		$15,610,000
Secondary Clarifier Improvements		$7,440,000
Sitework and Yard Piping		$4,410,000
Total Estimated Construction Cost (07/07)		**$33,790,000**
Engineering Legal and Administration Fees	20%	$6,760,000
Owner's Cost	12%	$4,060,000
Total Estimated Project Cost		**$44,610,000**

Figure 11.3 shows the range of future biochemical oxygen demand (BOD) loading to the WWTP developed in Chapter 4. The current maximum month BOD capacity of the facility (25,000 lb/d) is plotted on the figure, and shows the need for expansion of the facility during the first five years of the CIP. The implementation plan for Phase 1 improvements to the WWTP assumes an 18-month design phase starting in the first quarter of 2009, and a 36-month construction phase starting in the fourth quarter of 2010.



PHASE 1 - WWTP IMPROVEMENTS

FIGURE 11.2

CITY OF BELLINGHAM
COMPREHENSIVE SEWER MASTER PLAN

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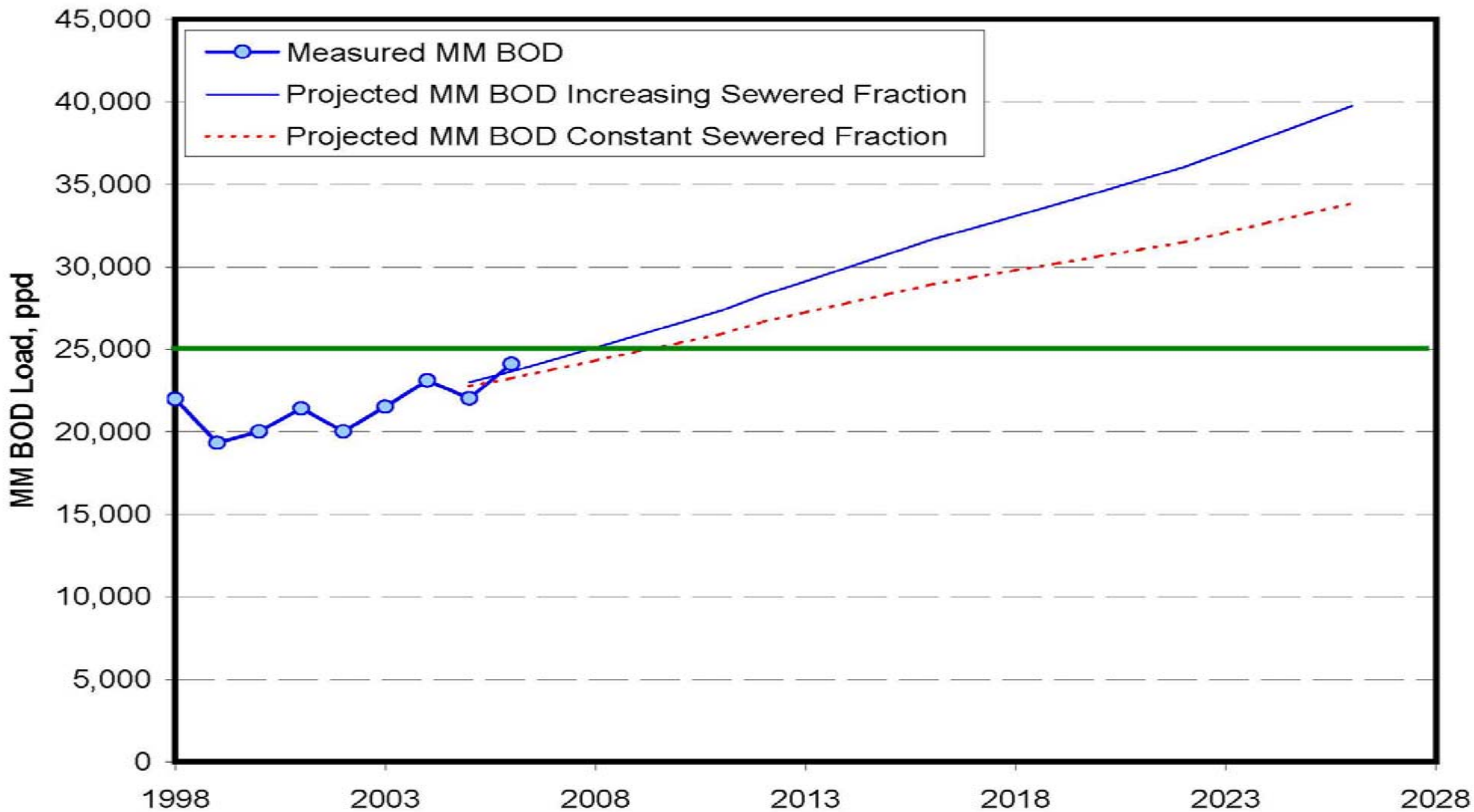

PROJECTED MAXIMUM MONTH BOD LOADS

FIGURE 11.3

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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11.5.1.2 Phase 2 WWTP Improvements

Phase 2 of the WWTP improvements includes construction of HPO Aeration Basin No. 4. With Phase 1 complete, the trigger for Phase 2 is beyond the year 2020, and will be impacted by the actual rate of growth in the sewered population. The CIP assumes a design start date in the first quarter of 2020, and a 24-month construction period starting in the second quarter of 2021. Estimated Phase 2 construction costs are shown in Table 11.3.

Table 11.3 WWTP Phase 2 Improvements
Comprehensive Sewer Plan
City of Bellingham

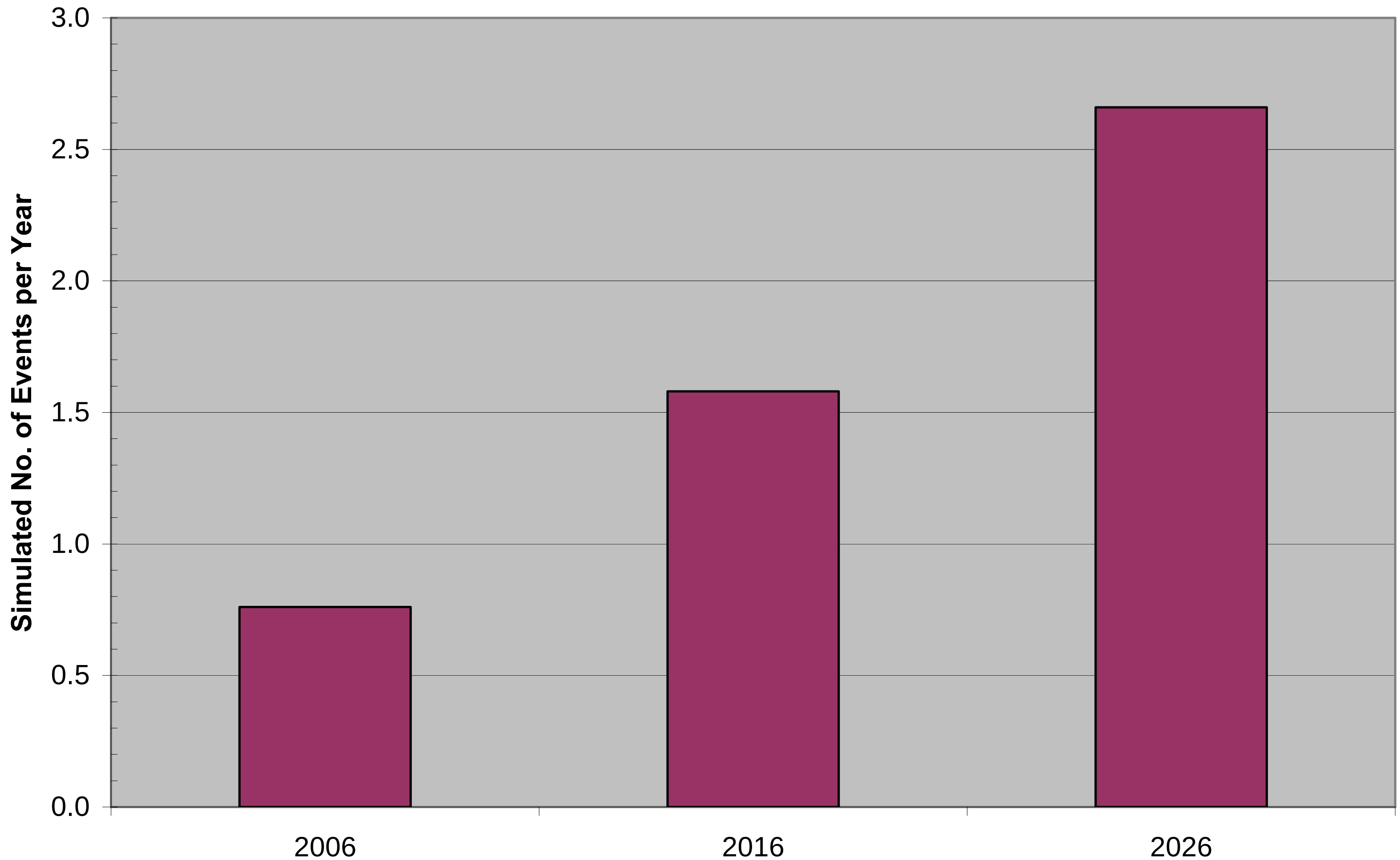
Project		Cost
HPO Aeration Basin Improvements		$5,230,000
Sitework and Yard Piping		780,000
Total Estimated Construction Cost (07/07)		**$6,010,000**
Engineering Legal and Administration Fees	20%	$1,200,000
Owner's Cost	12%	$720,000
Total Estimated Project Cost		**$7,930,000**

11.5.2 Collection System Project Phasing

Phasing of collection system improvements is driven by project priority and the need to control CSO events to meet regulatory limits. Figure 11.4 summarizes the expected number of CSO events per year based on existing system capacity, as simulated by the Long Term Simulation (LTS) modeling completed as a part of this Plan. The figure shows that, by Year 2016, growth in the system is expected to cause 1.58 events per year. To reduce the number of uncontrolled CSOs, a phased approach to CSO control is recommended, with the initial phase consisting of a peak flow storage facility completed prior to year 2016. The cost estimates in this CIP assume the project will be completed in a single phase.

11.5.2.1 Peak Flow Management Facility

Remote peak flow storage or treatment is a priority project in the collection system. The cost estimates and phasing plan for this facility are based on constructing a 1.7 million gallon (MG) storage facility. The benefits of storage versus treatment may be further defined and evaluated during facilities planning. Additional refinement of the storage volume size is recommended during subsequent design phases, to maximize the effect of storage on CSO control and identify the most cost effective volume and storage configuration to fit on the remote site. The phasing of this facility is driven by future development of the waterfront area near the existing C Street overflow, which is the proposed location for the facility. The storage facility must be completed by Year 2011 in



SUMMARY OF EXPECTED CSO EVENTS PER YEAR

FIGURE 11.4

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

order to be coordinated with other regional projects in the area. The CIP assumes a design start date in the first quarter of 2009, and a 20-month construction period starting in the second quarter of 2010. With this schedule, the facility would be operational by December 2011. Estimated costs for the peak flow management facility are shown in Table 11.4.

Table 11.4 Peak Flow Management Facility
Comprehensive Sewer Plan
City of Bellingham

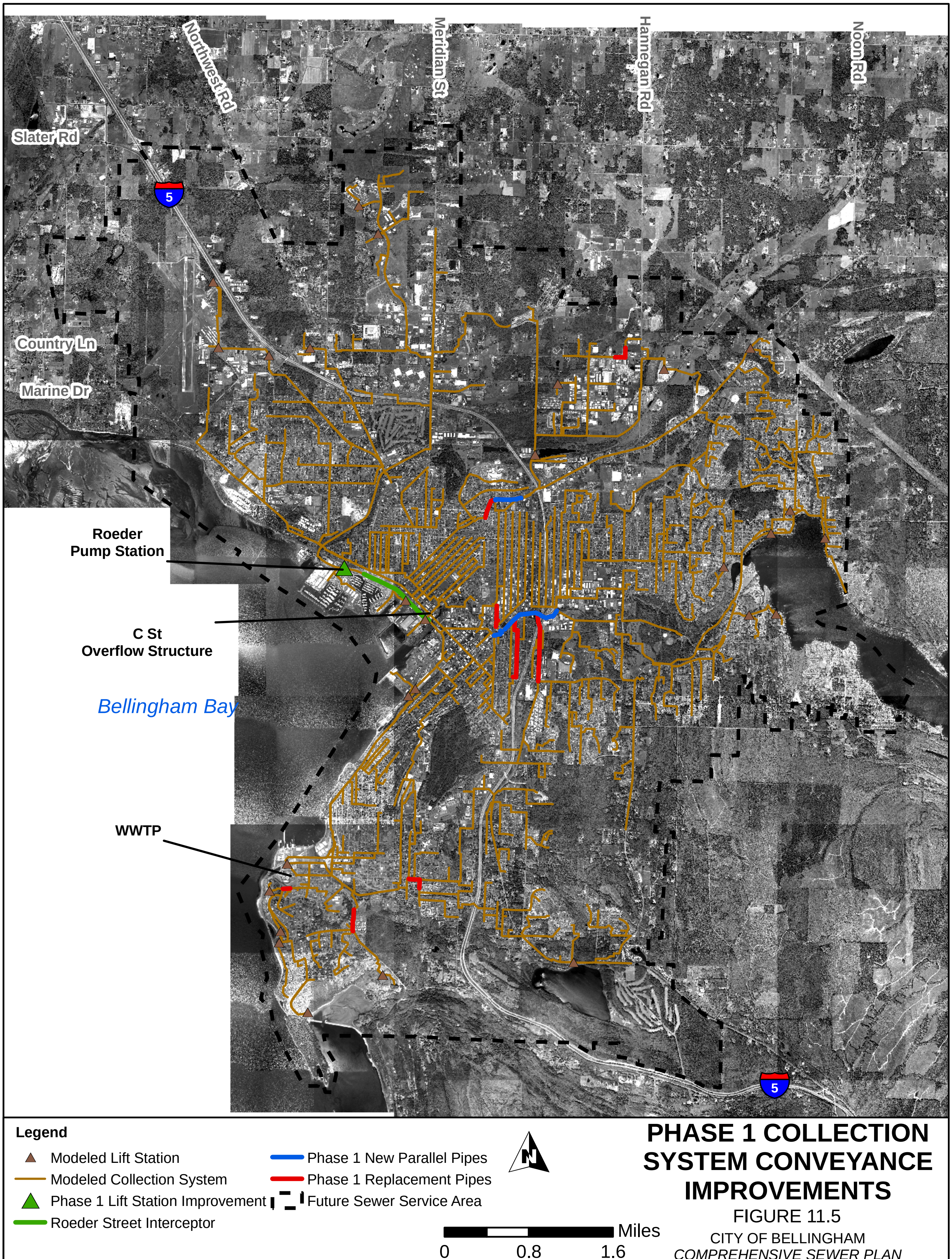
Project		Cost
Piping/CSO Modifications		$3,620,000
Storage Facility		$14,430,000
Geotech/Dewatering Allowance		$1,450,000
Total Estimated Construction Cost (07/07)		**$19,500,000**
ROW/Land Acquisition		$2,500,000
Engineering Legal and Administration Fees	20%	$3,900,000
Owner's Cost	12%	$2,340,000
Total Estimated Project Cost		**$28,240,000**

11.5.2.2 Peak Flow Reduction

The City of Bellingham is committed to ongoing peak flow reduction through selected annual I/I control and storm water separation projects. In addition to the improvements listed in this CIP, the City's financial plan includes an annual budget (summarized in Table 12.4) to fund these projects. The CIP includes an I/I study to better target and improve the cost effectiveness and performance of future peak flow reduction projects. The type of collection system improvement projects that the City should pursue to reduce peak flows, their expected impact in reducing peak flows, and their associated capital cost should be revised to reflect the outcome of this study. A capital cost of $2 million is included in the CIP to fund the study beginning in year 2012.

11.5.2.3 Priority 1 Collection System Improvements

The Priority 1 improvements address potential problems in the system for 2005 flow conditions. Many segments currently operate near capacity. The improvements are focused on lowering the hydraulic grade line in manholes where water levels approach the rim elevation, risking an uncontrolled overflow. The estimated costs of the improvements are summarized in Table 11.5. Figure 11.5 shows the locations of these improvements throughout the system. The segments are summarized in Appendix K.



PHASE 1 COLLECTION SYSTEM CONVEYANCE IMPROVEMENTS

FIGURE 11.5

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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Table 11.5 Priority 1 Collection System Improvements Comprehensive Sewer Plan City of Bellingham		
Project		**Cost**
Replace Segments		$1,660,000
Parallel Segments		$1,340,000
Roeder Pump Station and Force Main		$6,590,000
Total Estimated Construction Cost (07/07)		**$9,590,000**
Engineering Legal and Administration Fees	20%	$1,920,000
Owner's Cost	12%	$1,150,000
Total Estimated Project Cost		**$12,660,000**

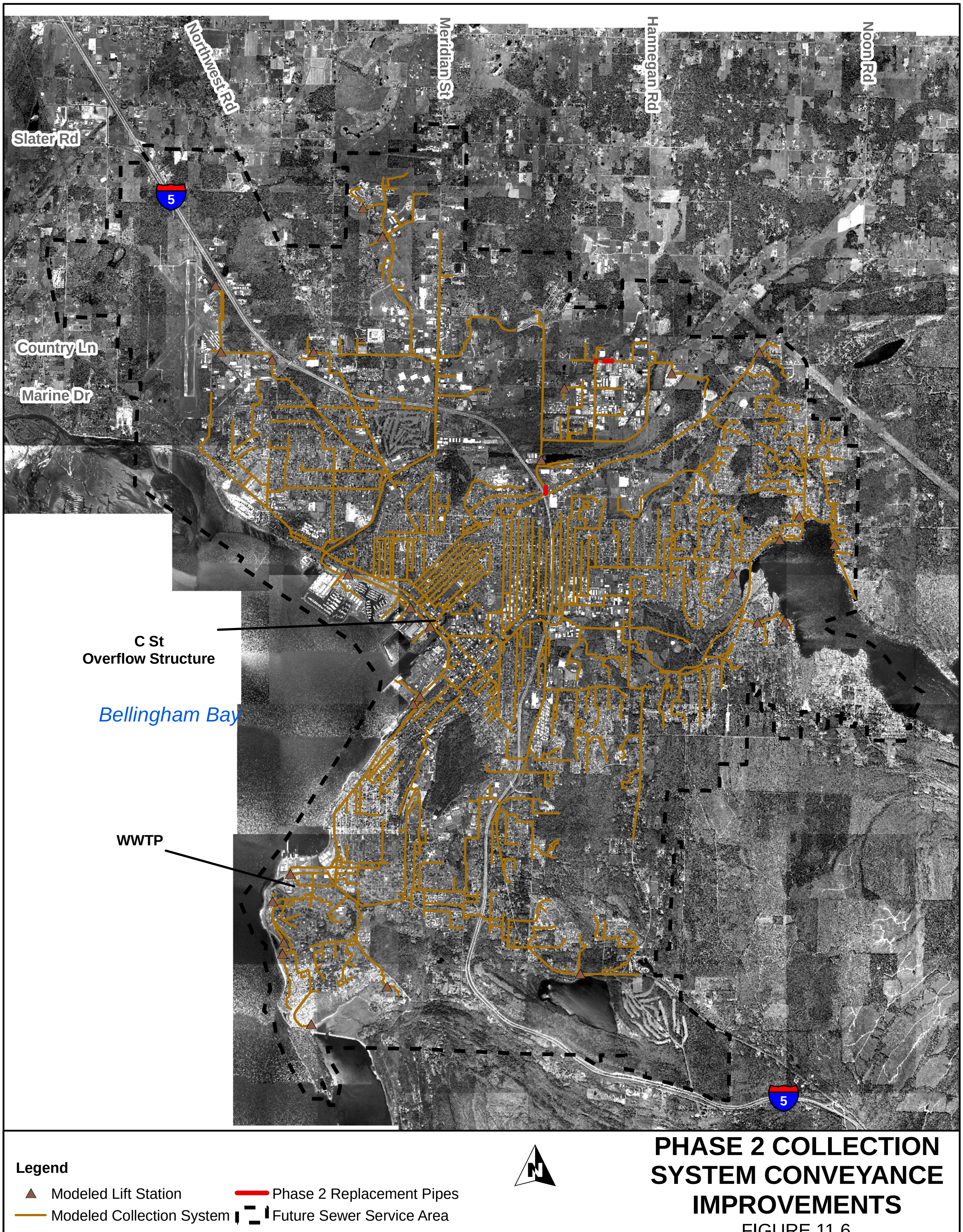
11.5.2.4 Priority 2 Collection System Improvements

The Priority 2 improvements address flow constrictions within the collection system that are smaller segments and at less risk of causing an overflow under current conditions. Table 11.6 summarizes the cost of these improvements. The location of the segments is shown in Figure 11.6. The segments are summarized in Appendix K.

Table 11.6 Priority 2 Collection System Improvements Comprehensive Sewer Plan City of Bellingham		
Project		**Cost**
Replacement Piping		$740,000
Total Estimated Construction Cost (07/07)		**$740,000**
Engineering Legal and Administration Fees	20%	$150,000
Owner's Cost	12%	$90,000
Total Estimated Project Cost		**$980,000**

11.5.2.5 Priority 3 Collection System Improvements

The Priority 3 improvements are pipe replacement projects and parallel pipes for segments with insufficient capacity near the end of the planning period. Priority 3 improvements also



PHASE 2 COLLECTION SYSTEM CONVEYANCE IMPROVEMENTS

FIGURE 11.6

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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include expansion of the collection system into currently unsewered areas as growth occurs. The costs for the Priority 3 improvements are summarized in Table 11.7. The location of these improvements is shown in Figure 11.7. The segments are summarized in Appendix K.

Table 11.7 Priority 3 Collection System Improvements
Comprehensive Sewer Plan
City of Bellingham

Project		Cost
Replace Segments		$2,360,000
Parallel Segments		$1,010,000
Expansion into Unsewered Areas		8,400,000
Total Estimated Construction Cost (07/07)		**$11,770,000**
Engineering Legal and Administration Fees	20%	$2,350,000
Owner's Cost	12%	$1,410,000
Total Estimated Project Cost		**$15,530,000**

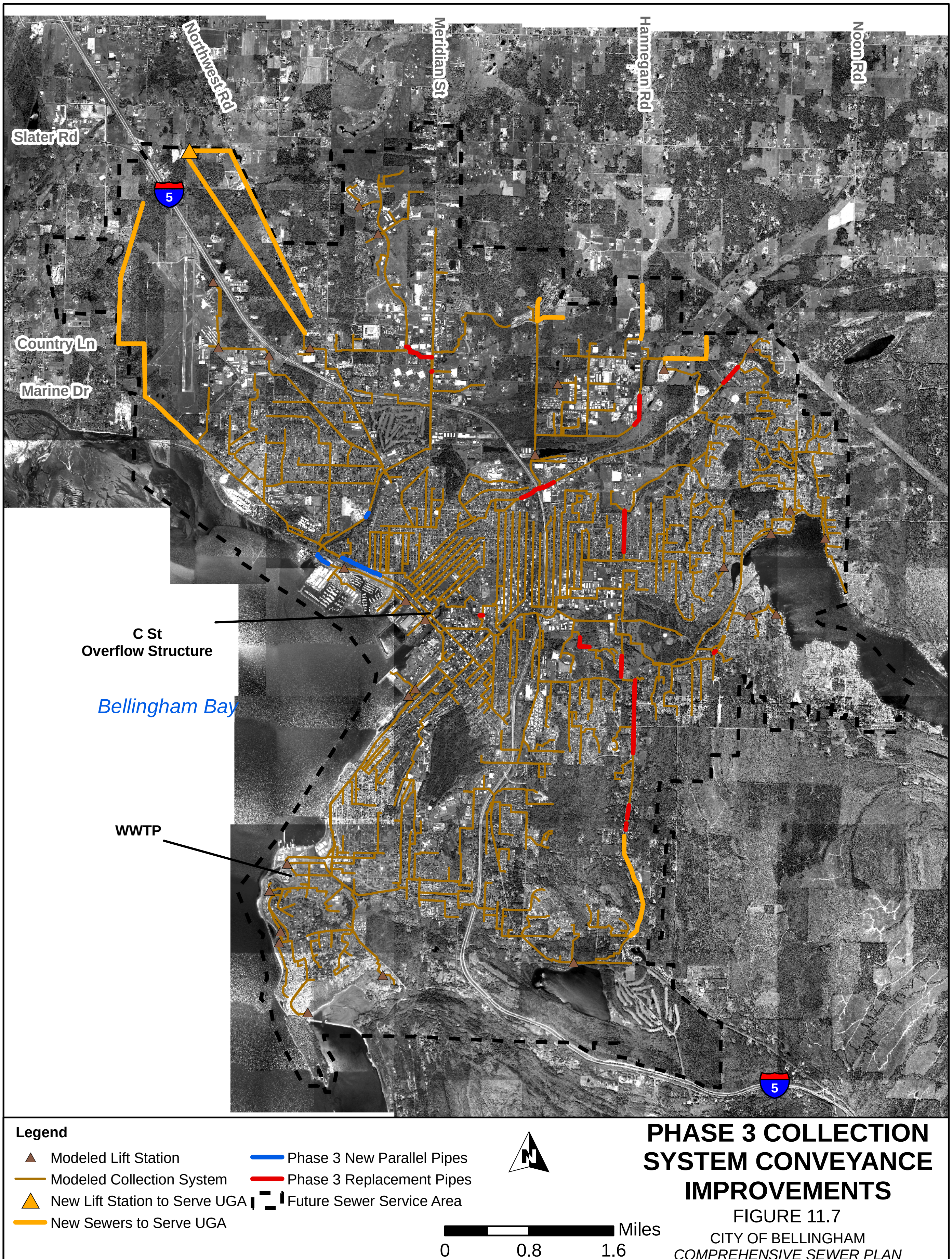
11.6 CAPITAL IMPROVEMENT PLAN

Table 11.8 summarizes the estimated total project costs for the improvements recommended in this CIP. Figure 11.8 presents the capital expenditures by year in escalated dollars throughout the planning period. Figure 11.9 presents the cumulative capital expenditures for the planning period in escalated dollars. Appendix K includes a more detailed cost breakdown of collection system piping and pump station projects.

Table 11.8 CIP Summary
Comprehensive Sewer Plan
City of Bellingham

Project	Mid-Point Year(1)	Total Project Cost(2)
Remote Wet Weather Facility	2011	$ 28.2 Million
I/I Study	2012	$ 2.0 Million
WWTP Phase 1 Improvements	2012	$ 44.6 Million
Priority 1 Collection System Improvements	2014	$ 12.7 Million
Priority 2 Collection System Improvements	2016	$ 1.0 Million
WWTP Phase 2 Improvements	2022	$ 7.9 Million
Priority 3 Collection System Improvements	2025	$ 15.5 Million

Notes:
(1) Assumed mid-point of construction.
(2) Estimated total project cost, July 2007 dollars.



PHASE 3 COLLECTION SYSTEM CONVEYANCE IMPROVEMENTS

FIGURE 11.7

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

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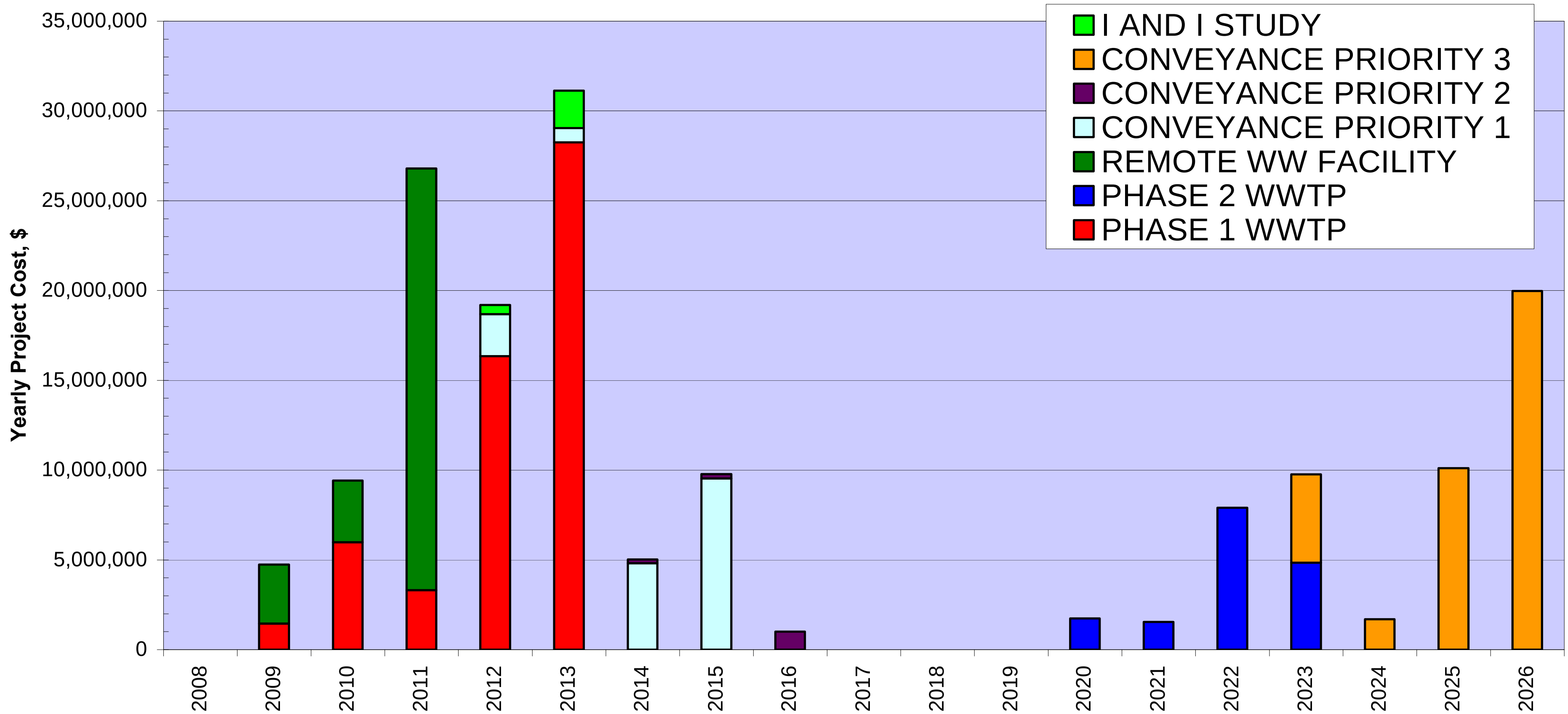

ANNUAL CAPITAL EXPENDITURES

FIGURE 11.8

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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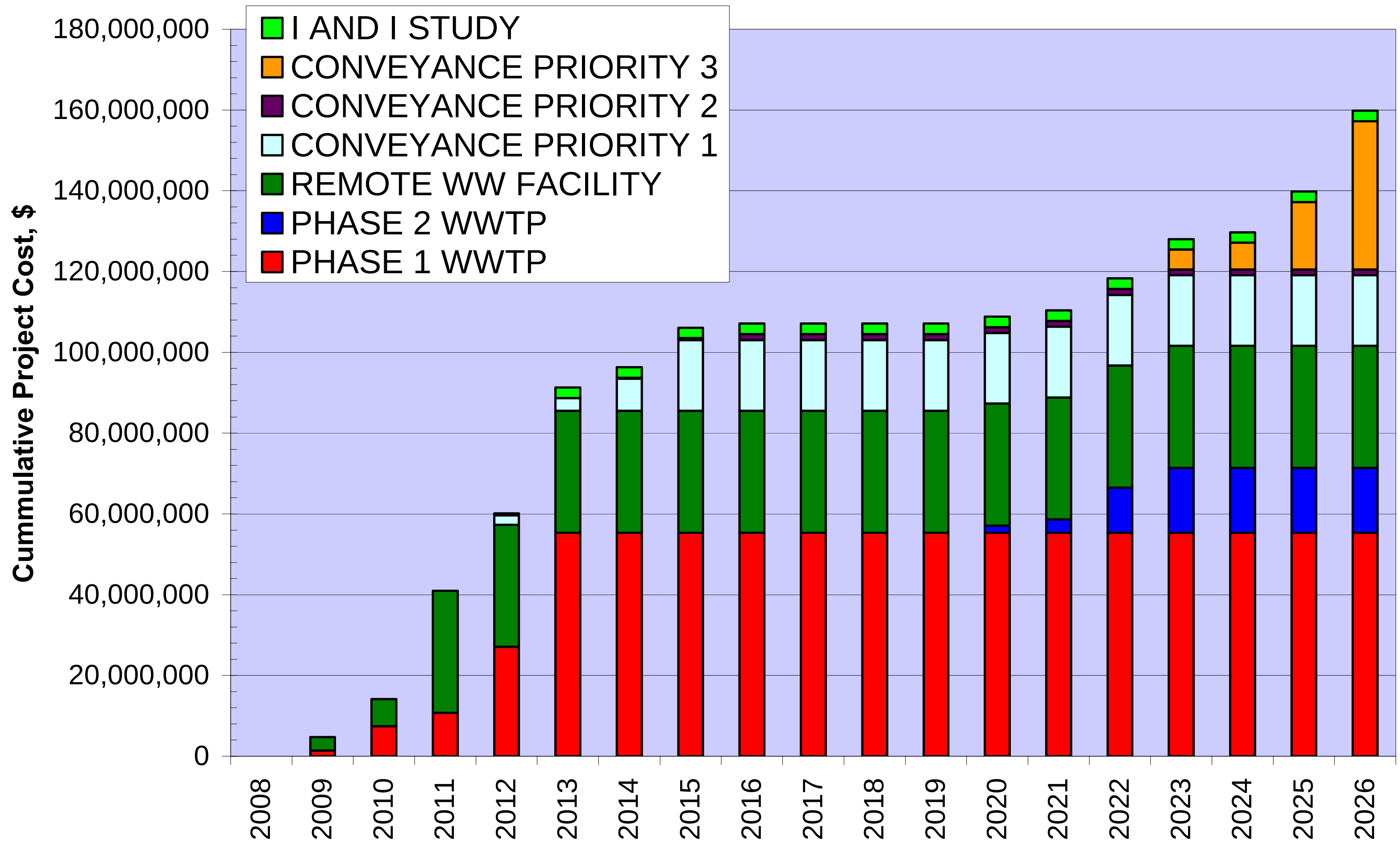

CUMULATIVE CAPITAL EXPENDITURES

FIGURE 11.9

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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FINANCIAL PLAN

12.1 INTRODUCTION

The objective of the financial plan is to identify the total cost of providing wastewater service and to provide a financial program that allows the wastewater utility to remain financially viable during execution of the Capital Improvement Program (CIP) identified in Chapter 11. This viability analysis considers the historical (past) financial condition of the utility, the sufficiency of current revenues to meet current and future financial and policy obligations and the financial impact to rates and charges of executing the CIP. The plan defines a financial strategy that is projected to fully fund the wastewater program.

12.2 PAST FINANCIAL PERFORMANCE

This section includes a historical summary of financial performance as reported by the City on the Statement of Revenues, Expenses and Changes in Fund Equity, and the Statement of Net Assets, specific to the wastewater utility. These statements indicate the City has realized strong historical financial performance.

12.2.1 Comparative Financial Statements

Table 12.1 shows a consolidated Statement of Revenues and Expenses and Changes in Fund Net Assets from 2001 through 2006. This table shows that operating revenues, and specifically rates, have not increased as quickly as operating expenses. Thus, operating income and net earnings have declined, although they remain positive. Capital assets have increased during this period, while cash and investments have declined as projects are funded. In general, this history portrays a financially healthy utility with declining margins, suggesting that rate increases will be necessary as new capital projects are undertaken.

Table 12.1 Statement of Revenues, Expenses and Changes in Fund Net Assets Comprehensive Sewer Plan City of Bellingham

	2001	2002	2003	2004	2005	2006
Operating Revenues						
Sales of Merchandise	$ -	$ -	$ -	$ -	$ -	$13,489,470
less: Cost of Goods Sold	-	-	-	-	-	-
Customer Sales & Service Fees	11,378,936	12,001,853	12,214,416	12,651,889	13,185,739	-
Other Charges for Service	642,664	744,525	621,083	667,251	777,198	757,057
Rents, Parking & Concessions	29,070	30,620	39,763	51,575	44,600	-
Trust Contributions	-	-	-	-	-	-
Other Operating Revenue	3,946	4,585	43,686	35,751	3,236	19,865
Total operating revenues	$12,054,616	$12,781,582	$12,918,948	$13,406,466	$14,010,773	$14,266,392
Operating Expenses						
General Operations	4,559,194	4,907,719	4,126,812	4,356,084	4,808,548	5,417,741
General administration operations	1,584,423	1,594,335	1,477,358	1,461,613	1,719,724	2,098,796
Contracted processing and operations		-	432,128	459,199	542,932	550,090
Maintenance		-	-	-	-	-
Depreciation	1,756,167	1,837,482	1,880,978	1,988,200	2,086,897	2,320,504
Property, excise & business taxes	1,268,921	1,323,355	1,629,698	1,614,552	1,732,172	1,798,671
Payments to claiments and beneficiaries	-	-	-	-	-	-
Total operating expenses	9,168,706	9,662,892	9,546,974	9,879,648	10,890,273	12,185,802
Operating income (loss)	2,885,910	3,118,690	3,371,974	3,526,818	3,120,500	2,080,590
Nonoperating revenues (expenses):						
External operating subsidies	-	-	-	-	-	3,661
Operating assessments and tax levies	-	-	-	-	-	-
Insurance recoveries	-	-	-	-	-	-
Investment interest	1,380,330	1,020,399	836,916	330,008	537,292	729,844
Net incr(decr) in fair value of investments	266,443	(83,555)	(243,507)	(201,088)	(32,806)	180,463
Interest expense and related charges	(999,695)	(804,317)	(735,819)	(729,679)	(549,075)	(477,518)
Gain (loss) on sale of capital assets		(2,133)	-	-	-	(1,988)
Other non-operating revenues	72,812	95,310	-	184,245	65,715	111,196
Other non-operating expenses		(129,289)	(129,291)	(58,993)	(85,453)	(85,453)
Total non-operating revenue (expense)	719,890	96,416	(271,701)	(475,506)	(64,326)	460,205
Income (loss) before contributions and transfe	3,605,800	3,215,106	3,100,273	3,051,312	3,056,174	2,540,795
Capital contribution	772,096	920,604	3,486,664	1,182,509	417,515	723,100
Prior Period Adjustment	850,387		(18,873)	-	-	
Transfers in	164,767	4,101	44,344	9,398	-	-
Transfers out	-	(175,423)	(50,000)	(163,654)	(740,000)	(1,251,790)
Change in net assets	5,393,050	3,964,388	6,562,408	4,079,565	2,733,689	2,012,105
Net assets - beginning	69,128,869	74,521,920	78,486,308	85,048,716	89,128,280	91,861,969
Net assets- ending	$74,521,919	$78,486,307	$85,048,716	$89,128,280	$91,861,969	$93,874,074

12.2.1.1 <u>Findings and Trends</u>

- Through the combination of customer growth and periodic rate increases, sewer rate revenue has been increasing at a rate sufficient to fund annual operating expenses including depreciation expense, though operating cost increases are outpacing rate revenue increases.

- Although operating income has been positive, it is worth noting that connection charge revenues are included in the revenue line item for “Other Charges for Service.” Without these connection charge revenues, the trend indicates that current rates will become inadequate to continue to fund depreciation expense. To avoid eroding net income, and to keep pace with inflation, future rate increases appear necessary.

Table 12.2 is the statement of net assets. The statement includes fund asset information regarding earned and contributed original net value of assets. Total Net Assets, represents total assets minus total liabilities

12.2.1.2 <u>Findings and Trends</u>

- The current ratio (current assets divided by current liabilities) declined from about 9:1 to 6:1 with use of the utility’s cash and investments. A ratio of 2:1 or higher is considered very good in terms of healthy liquidity.

- It appears the City issued a bond for $17,855,000 in 2001 and has not issued additional bonds through 2006 as the non-current bonds payable line has steadily declined and the current bonds payable line first contained a value in 2002, which has been steadily increasing as is the trend in a level repayment structure.

- Net assets have steadily been increasing after the 2001 reporting change to contributed capital.

Table 12.2 Statement of Net Assets
Comprehensive Sewer Plan
City of Bellingham

	2001	2002	2003	2004	2005	2006
ASSETS						
Current Assets:						
Cash and cash equivalents	$ 1,280,759	$ 818,181	$ 866,466	$ 1,137,291	$ 746,891	$ 5,174,469
Deposits with fiscal agents	15,000		10,000			
Investments	15,732,593	15,700,024	13,910,278	11,989,041	14,698,838	8,960,004
Receivable (net of uncollectibles allowance)	640,162	853,663	806,810	721,028	738,095	708,993
Interfund receivables	945,005	4,798,745	4,484,214	2,597,024	1,675,459	846,840
Inetrest receivable	367,763					
Due from other governmental units	574	514				
Inventories		-	-	-	-	-
Prepaid Items		-	-	-	-	-
Total current assets	18,981,856	22,171,127	20,077,768	16,444,384	17,859,283	15,690,306
Noncurrent assets:						
Restricted cash and cash equavalents	$ 1,221,872	$ 300,306	$ 382,815	$ 509,484	$ 249,246	$ 1,277,465
Restricted investments	6,852,797	5,762,548	6,145,729	5,370,858	4,905,180	2,212,033
Notes and contracts receivable			-	-	-	-
Deferred charges	872,800	765,924	659,048	589,619	476,502	363,384
Capital assets (net of accumulated depreciation)						
Land	849,001	849,001	905,030	905,030	905,030	3,915,498
Buildings	39,198,782	38,262,651	37,245,053	36,227,456	43,872,028	43,064,271
Improvements	23,856,390	24,736,179	27,746,304	31,550,966	33,152,678	33,422,190
Machinery & equipment	329,356	676,074	1,960,953	1,873,007	1,842,518	2,186,172
Construction in progress	1,059,172	2,425,322	6,978,258	9,876,942	1,233,826	2,562,387
Total non-current assets	74,240,170	73,778,005	82,023,190	86,903,362	86,637,008	89,003,400
Total assets	$ 93,222,026	$ 95,949,132	$ 102,100,958	$ 103,347,746	$ 104,496,291	$ 104,693,706
LIABILITIES						
Current liabilities:						
Accounts payable	$ 102,749	$ 363,176	$ 1,438,893	$ 211,310	$ 580,083	$ 357,867
Accrued wages and benefits			540,016	101,103	116,324	122,514
Interfund payables	185,770	158,071	82,229	40,096	-	-
Other accrued liabilities	466,335	450,621	15,862	285,664	18,857	195,886
Matured long-term liabilities	15,000		10,000			
Retainage payable	6,354	15,136				
Deposits payable	9,665	15,443				
Current portion:						
Bonds payable						
(net of unamortized premium/discount)		1,505,000	1,585,000	1,665,000	1,742,800	1,807,800
Compensated absences		-	-	147,357	151,826	157,625
Other long-term liabilities		23,447	23,447	23,447	23,447	23,447
Total current liabilities	785,873	2,530,894	3,695,447	2,473,977	2,633,337	2,665,139
Noncurrent liabilities:						
Bonds payable						
(net of unamortized premium/discount)	17,855,000	14,719,986	13,157,399	11,556,091	9,825,490	8,017,689
Unamortized Disc on Rev Bonds (DR)	(207,427)					
Compensated absences	32,187	36,598	35,264	48,714	58,258	43,014
Other long-term liabilities	234,474	187,579	164,132	140,684	117,237	93,790
Total non-current liabilities	17,914,234	14,944,163	13,356,795	11,745,488	10,000,985	8,154,493
Total liabilities	18,700,107	17,475,057	17,052,242	14,219,465	12,634,322	10,819,632
Net assets						
Contributed capital	53,862,858					
Invested in capital assets, net of related debt	20,659,062	50,513,215	59,905,621	78,604,270	69,297,106	75,207,792
Restricted for debt service		2,184,576	2,184,576	1,379,000	1,163,500	1,939,673
Restricted		-	-	-	-	1,549,825
Unrestricted		25,788,517	22,958,519	9,145,011	21,401,363	15,176,784
Total net assets	$ 93,222,026	$ 78,486,308	$ 85,048,716	$ 89,128,281	$ 91,861,969	$ 93,874,074

12.3 FINANCIAL PLAN

The City of Bellingham sewer utility is an enterprise that is responsible to fund all of its related costs. It is not dependent on general tax revenues or general fund resources. The primary source of funding for the sewer utility is derived from ongoing charges for service (monthly rates), with additional revenues coming from miscellaneous fees, investment earnings and from system development charges imposed on new development. The City controls the level of user charges by ordinance, and, subject to statutory authority, can adjust user charges as needed to meet financial objectives.

The financial plan can only provide a qualified assurance of financial feasibility if it considers the "total system" costs of providing wastewater service – both operating and capital. To meet these objectives, the following elements are completed.

1. Capital Funding Plan – Identifies the total CIP obligations for the planning period. The plan defines a strategy for funding the CIP including an analysis of available resources from rate revenues, existing reserves, general facilities charges, debt financing, and any special resources that may be readily available (e.g., grants, developer contributions, etc.). The capital funding plan impacts the financial plan through the use of debt financing (resulting in annual debt service) and the assumed rate revenue resources available for capital funding.
2. Financial Forecast – Identifies future annual non-capital costs associated with the operation, maintenance, and administration of the wastewater system. Included in the financial plan is a reserve analysis that Forecasts cash flow and fund balance activity along with testing for satisfaction of actual or recommended minimum fund balance policies. The financial plan ultimately evaluates the sufficiency of utility revenues in meeting all obligations, including cash uses such as operating expenses, debt service, capital outlays, and reserve contributions, as well as any coverage requirements associated with long-term debt and identifies the future adjustments required to fully fund all utility obligations the projection period.

12.3.1 Capital Funding Plan

The capital improvement program developed for this plan totals nearly $160 million over 20 years. Roughly $71 million is related to the WWTP improvements, $86 million is related to the collection system improvements, $2.6 million to the I&I Study and an additional $33 million is attributable to $4 million of budgeted capital in fiscal year 2008 and funding capacity for the wastewater system repair and replacement program over the forecast period. The annual funding capacity is determined from the City's policy, which specifies funding for an amount that is equal to depreciation expense less debt principal. Most of the funds from this program will be focused on the inflow and infiltration control program. A summary of the CIP is provided in Table 12.3. It should be noted that the CIP figures shown are inflated at 5 percent to the midpoint of project timing.

Table 12.3 CIP Summary Comprehensive Sewer Plan City of Bellingham			
Project	Total Project Cost (2007 Dollars)	Mid-Point Year(1)	Total Project Cost (Escalated to Midpoint)
Remote Wet Weather Facility	$ 28.2 Million	2011	$ 30.2 Million
WWTP Phase 1 Improvements	$ 44.6 Million	2012	$ 55.3 Million
I and I Study	$ 2.0 Million	2012	$ 2.6 Million
Priority 1 Collection System Improvements	$ 12.7 Million	2014	$ 17.5 Million
Priority 2 Collection System Improvements	$ 1.0 Million	2016	$ 1.5 Million
WWTP Phase 2 Improvments	$ 7.9 Million	2022	$ 16.0 Million
Priority 3 Collection System Improvements	$ 15.5 Million	2025	$ 36.7 Million
Total	$111.9 Million		$159.8 Million

Notes:
(1) Assumed mid-point of construction.

The development of the capital funding plan requires that all capital be evaluated on an annual basis. Table 12.4 provides the annual detail associated with the CIP outlined in this plan and that will be used to determine annual funding obligations in the financial forecast.

Table 12.4 Summary of 20 Year Capital Improvement Program (Inflated $)
Comprehensive Sewer Plan
City of Bellingham

	WWTP Phase 1&2 Improvements	Collection System Improvements**	I&I Study	Total Cost	I&I Improvements	Total All CIP
2008	$0	$0	$0	$0	$4,000,000	$4,000,000
2009	1,450,000	3,290,000	0	4,740,000	1,113,545	$5,853,545
2010	5,990,000	3,430,000	0	9,420,000	1,286,248	$10,706,248
2011	3,320,000	23,470,000	0	26,790,000	1,624,366	$28,414,366
2012	16,340,000	2,340,000	520,000	19,200,000	1,606,181	$20,806,181
2013	28,250,000	800,000	2,080,000	31,130,000	1,837,734	$32,967,734
Subtotal						**$102,748,074**
2014	0	5,020,000	0	5,020,000	2,005,349	$7,025,349
2015	0	9,780,000	0	9,780,000	1,973,758	$11,753,758
2016	0	1,010,000	0	1,010,000	1,837,108	$2,847,108
2017	0	0	0	0	1,752,657	$1,752,657
2018	0	0	0	0	1,648,540	$1,648,540
2019	0	0	0	0	1,533,990	$1,533,990
2020	1,740,000	0	0	1,740,000	1,408,298	$3,148,298
2021	1,540,000	0	0	1,540,000	1,328,710	$2,868,710
2022	7,900,000	0	0	7,900,000	1,230,918	$9,130,918
2023	4,850,000	4,910,000	0	9,760,000	1,332,628	$11,092,628
2024	0	1,690,000	0	1,690,000	1,372,631	$3,062,631
2025	0	10,100,000	0	10,100,000	1,207,723	$11,307,723
2026	0	19,980,000	0	19,980,000	1,111,061	$21,091,061
2027			0	0	1,097,957	$1,097,957
2028			0	0	1,000,000	$1,000,000
Total	**$71,380,000**	**$85,820,000**	**$2,600,000**	**$159,800,000**	**$33,309,401**	**$193,109,401**

*** collection system includes: remote wet weather facility and priority 1, 2, 3 collection system improvements*

A capital funding plan is developed to determine the total resources available to meet the CIP needs and if new debt financing will be required. The capital funding strategy developed to fund the CIP identified in this plan assumes the following priority: 1) system development charges (SDC), 2) annual transfers of rate-funded capital (system reinvestment funding) or excess cash (above minimum balance targets) from the operating fund 3) existing cash reserves including interest and 4) revenue bonds. A summary of the 6-year and 20-year capital funding plan is summarized in Table 12.5.

Table 12.5 6-Year (Detailed) and 20-Year (Summary) Capital Financing Plan
Comprehensive Sewer Plan
City of Bellingham

	2008	2009	2010	2011	2012	2013	Total 2008-2013	Total 20 Year
Total Escalated Capital Projects	**$ 4,000,000**	**$ 5,853,545**	**$ 10,706,248**	**$ 28,414,366**	**$ 20,806,181**	**$ 32,967,734**	**$ 102,748,074**	**$ 193,109,401**
Funding Sources:								
System Development Charges	$ 1,765,000	$ 3,970,327	$ 3,981,498	$ 3,992,239	$ 4,002,572	$ 4,351,468	$ 22,063,104	$ 67,423,356
System Reinvestment Funding	1,113,545	1,286,248	1,624,366	1,606,181	1,837,734	1,952,514	9,420,588	19,395,898
Existing Reserves	1,121,455	596,970	5,100,384	7,057,744	377,510	966,313	15,220,376	44,550,464
Total Funding Sources	$ 4,000,000	$ 5,853,545	$ 10,706,248	$ 12,656,165	$ 6,217,816	$ 7,270,295	$ 46,704,067	$ 131,369,718
Revenue Bond Issuances	$ -	$ -	$ -	$ 15,758,202	$ 14,588,366	$ 25,697,439	$ 56,044,006	$ 61,739,683
Total Funding Sources	**$ 4,000,000**	**$ 5,853,545**	**$ 10,706,248**	**$ 28,414,366**	**$ 20,806,181**	**$ 32,967,734**	**$ 102,748,074**	**$ 193,109,401**

Based on the analysis of available and projected resources, and City implementation of the recommended SDC (discussed further in this section), the majority of future project costs can be cash funded (SDC, rate funded capital and existing reserves). Roughly 32 percent of the total $193.1 million anticipated capital spending is projected to be debt-funded. In the absence of existing secured state loans or other lower cost financing options, revenue bonds are the assumed future debt financing mechanism. Total debt issuance is $56 million for the 6-year capital financing forecast and $61.7 million for the 20-year forecast. The annual debt service obligations for the new debt issuances are included in the operating forecast which will define operating cash flow needs on an annual basis.

12.4 AVAILABLE FUNDING ASSISTANCE AND FINANCING RESOURCES

Feasible long-term capital financing strategies must be defined to ensure adequate resources are available to fund the CIP identified in this plan. In addition to the City's utility resources such as accumulated cash reserves, rate funded capital and SDCs, capital needs can be met from outside resources such as grants, low interest loans and bond financing. The following is a summary of Utility Resources and Outside Resources.

12.4.1 Utility Resources

Utility resources appropriate for funding capital needs include accumulated resources in the wastewater CIP Fund, rate revenues designated for capital spending purposes, and capital-related charges, such as SDC and other connection fees. Capital-related charges are discussed below.

General Facilities Charges

A general facilities charge (GFC), also called a "connection charge" or a "system development charge" is authorized under RCW 35.92.025. This fee represents a one-time charge imposed on new customers as a condition of connection to the utility system. The purpose of the GFC is two-fold: (1) to promote equity between new and existing customers and (2) to provide a source of revenue to fund capital projects. Equity is served by providing a vehicle for new customers to share in the capital costs incurred to support their addition to the system. GFC revenues provide a source of cash flow used to support utility capital needs; revenue can only be used to fund utility capital projects or to pay debt service incurred to finance those projects. In the absence of a GFC, growth-related capital costs would be borne in large part by existing customers. In addition, the net investment in the utility already collected from existing customers, whether through rates, charges and/or assessments, would be diluted by the addition of new customers, effectively subsidizing new customers with prior customers' payments. To establish equity, a GFC should recover a proportionate share of the existing and future infrastructure costs from a new customer. From a financial perspective, a new customer should become financially equivalent to an existing customer by paying the GFC.

The SDC is imposed based on equivalent residential units (ERUs) designed to charge in proportion to the relative burden imposed on the wastewater system. In this system, single family homes are assigned 1 ERU, while other development is determined based on the scale of estimated sewage contribution relative to a single family home. The SDC structure is defined in ordinance.

In 2007, the City charged a system development charge of $3,436 per ERU to all new water customers. This financial analysis recommends increasing this fee to $7,637 per ERU based upon the projected infrastructure needs identified in this Plan and as discussed later in this chapter.

Local Facilities Charges

While a GFC is the manner in which new customers pay their share of general facilities costs, local facilities funding is used to pay the costs of local facilities that connect each property to the system's infrastructure. Local facilities funding is often overlooked in a rate forecast since it is funded upfront by either connecting customers, developers, or through an assessment to properties – but typically not from rates. Although these funding mechanisms do not provide a capital revenue source toward funding CIP costs, the discussion of these charges is included in this chapter, as they are an impact to the new customer of the system.

There are a number of mechanisms that can be considered toward funding local facilities. One of the following scenarios typically occurs: (a) the utility charges a connection fee based on the cost of the local facilities (under the same authority as the GFC); (b) a developer funds extension of the system to their development and turns those facilities over to the utility (contributed capital); or (c) a local assessment is set up called a Utility Local Improvement district (ULID/LID) which collects assessment revenue from benefited properties.

The *Local Facilities Charge (LFC)* is a variation of the connection charge authorized through RCW 35.92.025. It is a City-imposed charge to recover the cost related to sewer service extension to local properties. Often called a front-footage charge and imposed on the basis of footage of sewer main “fronting” a particular property, it is a reimbursement to the City for the cost of a local facility that directly serves a property. It is a form of connection charge and, as such, can accumulate up to 10 years of interest. It typically applies to instances where no developer-installed facilities are needed through developer extension due to the prior existence of available mains already serving the developing property.

The *Developer Extension* is a requirement that a developer install onsite and sometimes offsite improvements as a condition of extending service. These are in addition to the GFC required and must be built to City standards. The City is authorized to enter into developer extension agreements under RCW 35.91.020. Part of the agreement between the City and the developer for the developer to extend service might include a late-comer agreement, resulting in a late-comer charge to new connections to the developer extension.

Latecomer Charges are a variation of developer extensions whereby a new customer connecting to a developer-installed improvement makes a payment to the City based on their share of the developers cost (RCW 35.91.020). The City passes this on to the developer who installed the facilities. This is part of the developer extension process, and defines the allocation of costs and records latecomer obligations on the title of affected properties. No interest is allowed, and the reimbursement agreement cannot exceed 15 years in duration.

In 2007, the City Council adopted revised SDC that has a phased approach, which will reach full implementation in 2009. The existing SDC is $3,436 per ERU to all new sewer customers. The 2007 financial analysis recommended an increase in the fees to a final SDC amount of $7,637 per ERU. Based upon the project infrastructure needs identified in this Plan and discussed later in this chapter. The Bellingham City Council did adopt the recommended SDC by authorizing at fee of $5,536 in 2008 and then an increase in the fee to the full SDC amount of $7,637 in 2009.

12.4.2 Outside Resources

Government Programs

Historically, federal and state grant programs were available to local utilities for capital funding assistance. However, these assistance programs have been mostly eliminated, substantially reduced in scope and amount, or replaced by loan programs. Remaining miscellaneous grant programs are generally lightly funded and heavily subscribed. Nonetheless, the benefit of even the very low-interest loans makes the effort of applying worthwhile. State programs identified as potential funding sources for the utility improvements set forth in this Comprehensive Wastewater System Plan are discussed next.

Public Works Trust Fund – The Public Works Trust Fund (PWTF) is a commonly used, low-cost revolving-loan fund established by the 1985 State Legislature to provide financial assistance to local governments for public works projects. Eligible projects now include repair, replacement, rehabilitation, reconstruction, or improvement of eligible public works systems to meet current standards for existing users. With recent revisions to the program, growth-related projects consistent with 20-year projected needs are now eligible.

PWTF loans are available at interest rates of 0.5 percent, 1 percent, and 2 percent, with the lower interest rates given to applicants who pay a larger share of the total project costs. The loan applicant must pay a minimum of 5 percent towards the project cost to qualify for a 2 percent loan, 10 percent for a 1 percent loan, and 15 percent for a 0.5 percent loan. The useful life of the project determines the loan term up to a maximum of 20 years. The applicant must be a local government, such as a City, County, or special purpose utility district, and have an approved long-term plan for financing its public works needs. Local governments must compete for PWTF dollars since more funds are requested each year than are available. The Public Works Board evaluates each application and transmits a prioritized list of projects to the legislature. The legislature then indicates its approval by passing an appropriation from the Public Works Assistance Account to cover the cost of the approved loans. Once the Governor has signed the appropriations bill into law, the local governments receiving the loans are offered a formal loan agreement with the appropriate interest rate and term, as determined by the Public Works Board. Normally these loans are given, but the proceeds are drawn down as expenditures are made and then reported to the State.

Through the provision of low interest loans, the PWTF is an extremely attractive assistance program that is equivalent to partial grant funding. It has increased in popularity and demand, and has become increasingly competitive. Even so, the program continues to grow through the repayment of loans and ongoing influx of new funds, providing substantial assistance for as many as 100 projects in a biennial funding cycle.

Community Economic Revitalization Board – Managed by the Department of Community Trade and Economic Development, this program provides grants and loans to fund public facilities that result in specific private-sector development. Eligible projects include water, sewer, roads, and bridges. Program criteria are tied to economic development and job creation.

Community Development Block Grant (CDBG) Program – A federal government program administered by the State Department of Community Trade and Economic Development, the CDBG program provides grants and loans for infrastructure improvements, including utility projects, for business development that create or retain jobs for low and moderate-income residents. The program is need-based and while many projects may be eligible, the funds are targeted to mitigate impacts on specific customers, rather than serving as a general broad-based funding source.

Department of Ecology – The Department's Water Quality Financial Assistance Program sponsors 3 grant and loan programs: the Centennial Clean Water Fund (grant), Federal 319 Programs (grant), and the State Revolving Fund Loan (SRF). Most of the funding goes to wastewater programs. The Centennial Fund grants are available for projects serving 110 percent of existing capacity (limiting funding of growth) and the SRF is available to fund 20 years of growth (based on Growth Management Act-compliant comprehensive plans). The 2007 interest rate for SRF loan repayment periods ranging from 5 to 20 years is 2.6 percent.

Of these programs, the SRF and PWTF are the most attractive low cost financing programs for the City. However, given the level of competition for these funds, they should not be relied on as a source of future funding for wastewater capital projects in financial projections.

Public Debt

General Obligation Bonds – General obligation (G.O.) bonds are bonds secured by the full faith and credit of the issuing agency, committing all available tax and revenue resources to debt repayment. With this high level of commitment, G.O. bonds enjoy relatively low interest rates and few financial restrictions. However, the authority to issue G.O. bonds is restricted in terms of the amount and use of the funds, as defined by Washington constitution and statute. Specifically, the amount of debt that can be issued is linked to assessed valuation. Included in the City's G.O. authority is a portion of debt capacity specifically authorized for water and sewer utility purposes.

There are also two specific levels of general obligation bond capacity: limited "non-voted" bonding capacity can be issued without a public vote by authorization of the City Council, while additional voted capacity is subject to public vote prior to issuance.

While limited bonding capacity often limits availability of G.O. bonds for utility purposes, these can sometimes play a valuable role in project financing. Even with the voting requirement, an increasing number of agencies have proposed and successfully issued G.O. bonds for utility purposes through public vote, premised on the rate savings that could be realized. This can occur through two avenues: the lower interest rate and related bond costs; and the extension of repayment obligation to all tax-paying properties (not just developed properties) through the authorization of an ad valorem property tax levy.

Revenue Bonds – Revenue bonds are commonly used to fund utility capital improvements. The debt is secured by the revenues of the issuing utility and the debt obligation does not extend to the City's other revenue sources. With this limited commitment, revenue bonds typically bear higher interest rates than G.O. bonds and also require security conditions related to the maintenance of dedicated reserves (a bond reserve) and financial performance (added bond debt service coverage). The City agrees to satisfy these requirements by ordinance as a condition of bond sale.

Revenue bonds can be issued in Washington without a public vote. There is no bonding limit, except perhaps the practical limit of the utility's ability to generate sufficient revenue to repay the debt and provide coverage. In some cases, poor credit might make issuing bonds problematic. In the case of the City of Bellingham, strong historical financial performance bodes well for continued reliance on this form of financing capital projects.

An ideal funding strategy would include a combination of City utility internal resources and outside resources. The City should pursue the use of grants and low-cost loans when debt issuance is required. However, these resources are very limited and competitive in nature and do not provide a reliable source of funding for planning purposes. Therefore, we have assumed revenue bonds to meet needs above the City's available cash resources.

12.5 FINANCIAL FORECAST

The Financial Forecast, or revenue requirement analysis, forecasts the amount of annual revenue needed in a given year to meet that year's expected financial obligations. The analysis incorporates operating revenues, operating and maintenance (O&M) expenses, debt service payments, rate funded capital needs, and any other identified revenues or expenses related to utility operations, and determines the sufficiency of the current level of rates. Revenue needs are also impacted by debt covenants (typically applicable to revenue bonds) and specific fiscal policies and financial goals of the utility.

For this analysis, two revenue sufficiency criteria have been developed to reflect the financial goals and constraints of the utility: (1) cash needs must be met, and (2) debt coverage requirements must be realized. In order to operate successfully with respect to these goals, both tests of revenue sufficiency must be met.

Cash Test – The cash flow test identifies all known cash requirements for the utility in each year of the planning period. Capital needs are identified and a capital funding strategy is established. This may include the use of debt, reserves, outside assistance, and rate funding. Cash requirements to be funded from rates are determined. Typically, these include O&M expenses, debt service payments, depreciation funding or directly funded capital outlays, and any additions to specified reserve balances. The total annual cash needs of the utility are then compared to projected cash revenues using the current rate structure. Any projected revenue shortfalls are identified and the rate increases necessary to make up the shortfall are estimated.

Coverage Test – The coverage test is based on a commitment made by the City when issuing revenue bonds and some other forms of long-term debt. For purposes of this analysis, revenue bond debt is assumed for any needed debt issuance. As a security condition of issuance, the City would be required per covenant to agree that the revenue bond debt would have a higher priority for payment (a senior lien) compared to most other utility expenditures; the only outlays with a higher lien are O&M expenses. Debt service coverage is expressed as a multiplier of the annual revenue bond debt service payment. For example, a 1.0 coverage factor would imply no additional cushion is required. A 1.25 coverage factor means revenues must be sufficient to pay O&M expenses, annual revenue bond debt service payments, plus an additional 25 percent of annual revenue bond debt service payments. The excess cash flow derived from the added coverage, if any, can be used for any utility purpose, including funding capital projects. The coverage requirement on the City's outstanding revenue bonds is currently 1.25 times revenue bond debt

In determining the annual revenue requirement, both the cash and coverage sufficiency tests must be met – the test with the greatest deficiency drives the level of needed rate increase in any given year.

Financial Forecast

The financial forecast is developed from the 2008 budget documents along with other key factors and assumptions to develop a complete portrayal of the wastewater utility annual financial obligations. The following is a list of the key revenue and expense factors and assumptions used to develop the financial forecast

- Growth rate for the wastewater system is projected to average about 1.35 percent per year. While a growth rate of 2.7 percent is used as the basis for flow forecasts and facilities planning, this lower growth rate is consistent with recent growth experience. Just as the higher growth rate provides a conservative basis for system planning, the lower growth rate provides a conservative basis for financial forecasting.
- The 2008 budget revenues and expenses form the baseline for this forecast.
- Rate revenue includes revenue from metered and unmetered customers, septic tank dumping and Water District #10. The City Council approved Ordinance 2007-12-108 on December 10, 2007, a 6.5 percent annual rate increase for 2008-2012. These rate adjustments have been included in the revenue figures shown.
- Other revenue includes fines, penalties and fees, interfund general government services and rents.

- Operation and maintenance expenses are escalated from the 2008 budget figures at 3 percent per year for general cost inflation, 5 percent for labor and 3.5 percent for fund interest earnings.
- Existing debt service obtained from debt schedules. Include a 1999 and 1994 revenue bond and one 1991 Public Works Trust Fund (PWTF) Loan for the Silver Beach Trunk Sewer. The PWTF is eliminated in 2012.
- Future debt service has been added as outlined in the capital funding plan. The forecast assumes revenue bond interest rate of 5 percent, issuance cost of 2 percent, and the term of 20 years.
- Terms are 5.0-6.0 percent interest rate for a twenty year term.
- Annual rate funded capital is budgeted at policy levels (annual depreciation net of annual debt service principal).
- A budget realization factor has been introduced into this forecast to take into consideration the City's historical wastewater budget spending levels. This factor reduces budgeted operating expenses by 10 percent, consistent with historical budget expenditure performance. It is intended to more accurately reflect anticipated spending levels. However, this also introduces a financial risk, that the expense budget may be fully utilized and expended.

Although the financial plan is completed for the 20-year time horizon of this Plan the rate strategy focuses on the shorter term planning period of 2008-2012. It is imperative that the City revisit the proposed rates every two to three years to ensure that the rate projections developed remain adequate. Any significant changes should be incorporated into the financial plan and future rates adjusted as needed. Table 12.6 summarizes the projected financial performance and rate requirements for 2008-2014 based on the above assumptions.

Table 12.6 Financial Forecast
Comprehensive Sewer Plan
City of Bellingham

		2008	2009	2010	2011	2012	2013	2014
Revenues								
Rate Revenues at 2008 Rate Levels		$ 13,597,687	$ 13,964,493	$ 14,337,272	$ 14,716,023	$ 15,100,747	$ 15,491,444	$ 15,921,622
Non-Rate Revenues		2,146,463	1,150,493	1,169,449	1,202,496	1,257,714	1,340,410	1,436,819
Total Revenues		**$ 15,744,150**	**$ 15,114,985**	**$ 15,506,721**	**$ 15,918,519**	**$ 16,358,461**	**$ 16,831,855**	**$ 17,358,441**
Expenses								
Cash O&M Expenses		$ 12,707,112	$ 12,554,214	$ 13,018,224	$ 13,502,169	$ 14,007,046	$ 14,536,030	$ 15,242,337
Existing Debt Service		2,248,981	2,244,782	2,266,355	1,246,561	-	-	-
New Debt Service		-	-	-	1,538,808	2,963,381	5,472,768	5,518,806
Rate Funded System Reinvestment		1,113,545	1,286,248	1,624,366	1,606,181	1,837,734	2,005,349	1,973,758
Rate Funded CIP		-	-	-	-	-	-	-
Total Expenses		**$ 16,069,638**	**$ 16,085,244**	**$ 16,908,945**	**$ 17,893,720**	**$ 18,808,161**	**$ 22,014,147**	**$ 22,734,901**
Surplus/(Deficiency)		**$ (325,488)**	**$ (970,258)**	**$ (1,402,224)**	**$ (1,975,201)**	**$ (2,449,699)**	**$ (5,182,292)**	**$ (5,376,460)**
Annual Rate Adjustment		**0.00%**	**6.50%**	**6.50%**	**6.50%**	**6.50%**	**6.00%**	**6.00%**
Collection / (Use) of Reserves for Rate Management		*(325,488)*	*(248,127)*	*132,954*	*472,369*	*1,018,745*	*(641,795)*	*322,435*
Coverage after Rate Increase		2.25	3.71	4.01	2.52	3.39	2.09	2.25
Bi-Monthly Single Family Rate	**$51.65**	$51.65	$55.01	$58.59	$62.39	$66.45	$70.44	$74.66
difference		$0.00	$3.36	$3.58	$3.81	$4.06	$3.99	$4.23
cummulative		$0.00	$3.36	$6.93	$10.74	$14.80	$18.78	$23.01

Table 12.6 shows the rate forecast based on projected 2008 rate levels (incorporating the 2008 6.5 percent rate increase) as well as the City's adopted rate plan through 2012. The plan as adopted indicates that during 2008 and 2009 approximately $570,000 of existing reserves will be required to meet operating cash flow deficiencies not covered by the 6.5 percent increases during those years. During the third year of the rate plan the cash flow becomes positive. Over the remaining years of the Plan, an additional 16.5 percent rate increase is forecast to meet the cash flow needs. Most of this anticipated future increase (10 percent) is needed during 2013 when a large annual debt service obligation begins and represents the last of the new debt issuances anticipated to meet capital needs during the Plan period. Since the City historically has desired to have consistent annual rate increases, the additional 16 percent can be generated with a 6 percent increase in 2013 and 2014 followed by a 4 percent increase in 2015. This rate strategy would require that fund balance be available in 2013 to cover the $641,000 cash flow deficiency not covered by the 6 percent increase. It is imperative that the City update the financial forecast regularly (every two to three years) to ensure that the rate strategy is adjusted as necessary to adequately meet rate revenue needs.

12.5.1 City Funds and Reserves

Table 12.7 shows a summary of the projected City operating, capital and restricted debt reserve fund balances through 2013 based on the rate forecasts presented herein. The operating forecast has a minimum target of 60 days of O&M expenses. The capital fund target balance is set at 1 percent of original cost plant in service ranging from $1.3 million to $3.1 million during the 20-year period. Both of the operating and capital fund balances are maintained above the target balances throughout the time period. The debt reserve balances are set by covenant and are in compliance. While fund balances are projected to increase, this is primarily due to mandatory increases in bond reserves related to new debt issues.

Table 12.7 Cash Balance Summary
Comprehensive Sewer Plan
City of Bellingham

Ending Fund Balances		**2008**		**2009**		**2010**		**2011**		**2012**
Operating Fund	$	2,083,588	$	1,835,461	$	1,968,415	$	2,194,959	$	2,270,144
Capital Fund		13,311,931		13,240,879		8,663,925		2,215,243		2,918,827
Debt Reserve Fund		1,021,025		1,021,025		1,021,025		1,538,808		2,963,381
Total	**$**	**16,416,544**	**$**	**16,097,365**	**$**	**11,653,366**	**$**	**5,949,011**	**$**	**8,152,352**
Combined Minimum Target Balance	*$*	*4,327,258*	*$*	*5,537,744*	*$*	*5,714,659*	*$*	*5,366,406*	*$*	*7,074,226*

12.6 CURRENT AND PROJECTED RATES

12.6.1 Existing Retail Rates

The City's existing wastewater rates are comprised of a single fixed bi-monthly rate for single family residential customers, and non-single family customers pay a fixed charge including 800 CF monthly, and a volume rate for each 100 CF unit above the 800 CF per month. There are both bi-monthly and monthly billed non-single family customers. Table 12.8 shows the City's existing retail wastewater rates.

Table 12.8 Existing Retail Wastewater Rates
Comprehensive Sewer Plan
City of Bellingham

Existing 2008 Rates

Bi-Monthly Rates	Base Rate up to 1600 CF	Volume Rate >1600, per 100 CF
Single Family		
Inside City	$51.65	n/a
Outside City	$77.48	n/a
Non-Single Family		
Inside City	$51.65	$2.71
Outside City	$77.48	$4.06

Monthly Rates	Base Rate up to 800 CF	Volume Rate >800, per 100 CF
Non-Single Family		
Inside City	$25.83	$2.71
Outside City	$38.74	$4.06

12.6.2 Projected Retail Rates

Table 12.9 shows the City's retail wastewater rates with the approved 6.5 percent annual rate increases through 2012. The rate increase has been applied equally to each customer class and each rate component (fixed and variable), when applicable.

Table 12.9	Retail Wastewater Rates with Projected Rate Increases Comprehensive Sewer Plan City of Bellingham

	2008 Rates	2009	2010	2011	2012	2013
Annual Rate Increase		***6.5%***	***6.5%***	***6.5%***	***6.5%***	***6.5%***
BI-MONTHLY RATES						
Single Family						
Inside City Flat Rate	$51.65	$55.01	$58.59	$62.40	$66.46	$70.78
Outside City Flat Rate	$77.48	$82.52	$87.88	$93.59	$99.67	$106.15
Non-Single Family						
Inside City						
Base Rate up to 1600 CF	$51.65	$55.01	$58.59	$62.40	$66.46	$70.78
Volume Rate >1600 CF per 100 CF	$2.71	$2.89	$3.08	$3.28	$3.49	$3.72
Outside City						
Base Rate up to 1600 CF	$77.48	$82.52	$87.88	$93.59	$99.67	$106.15
Volume Rate >1600 CF	$4.06	$4.32	$4.60	$4.90	$5.22	$5.56
MONTHLY RATES						
Non-Single Family						
Inside City						
Base Rate up to 800 CF	$25.83	$27.51	$29.30	$31.20	$33.23	$35.39
Volume Rate >800 CF per 100 CF	$2.71	$2.89	$3.08	$3.28	$3.49	$3.72
Outside City						
Base Rate up to 800 CF	$38.74	$41.26	$43.94	$46.80	$49.84	$53.08
Volume Rate >800 CF per 100 CF	$4.06	$4.32	$4.60	$4.90	$5.22	$5.56

12.7 AFFORDABILITY

A common affordability benchmark for utility rates is to test the monthly median income equivalent against the existing and projected monthly utility rates. The forecasted rates shown here are projected to be somewhat above the affordability threshold for this particular index of affordability in some years. Though, the projected rates are well within the range of surveyed wastewater rates, suggesting it may be that the comparative median income is relatively low, rather than cost to provide service by the City being relatively high. Table 12.10 shows the affordability threshold for future years.

Table 12.10 Affordability Test
Comprehensive Sewer Plan
City of Bellingham

$32,530	Median household income (2000 Census from 1999 data)
1.50%	of median income - maximum affordable bill
$40.66	maximum affordable monthly bill 1999

Maximum Affordable Bill	Year	Inflation	Average Bill	Annual Increase
$42.09	2000	3.50%	---	---
$43.64	2001	3.70%	---	---
$44.47	2002	1.90%	---	---
$45.41	2003	2.10%	---	---
$46.45	2004	2.30%	---	---
$47.89	2005	3.10%	---	---
$49.52	2006	3.40%	---	---
$50.93	2007	2.86%	---	---
$52.39	2008	2.86%	$51.65	---
$53.89	2009	2.86%	$55.01	6.50%
$55.43	2010	2.86%	$58.58	6.50%
$57.01	2011	2.86%	$62.39	6.50%
$58.64	2012	2.86%	$66.45	6.50%
$60.31	2013	2.86%	$70.43	6.00%
$62.04	2014	2.86%	$74.66	6.00%
$63.81	2015	2.86%	$74.66	0.00%
$65.63	2016	2.86%	$74.66	0.00%
$67.51	2017	2.86%	$74.66	0.00%
$69.44	2018	2.86%	$74.66	0.00%
$71.42	2019	2.86%	$74.66	0.00%
$73.46	2020	2.86%	$75.00	0.46%
$75.56	2021	2.86%	$75.00	0.01%
$77.72	2022	2.86%	$76.07	1.43%
$79.94	2023	2.86%	$77.90	2.40%
$82.22	2024	2.86%	$79.93	2.61%
$84.57	2025	2.86%	$82.46	3.17%
$86.99	2026	2.86%	$86.41	4.78%

12.8 SYSTEM DEVELOPMENT CHARGES

System Development Charges (SDCs) are legal sources of funding provided through development and growth in customers typically used by utilities to support capital needs. SDCs are a form of connection charges as authorized in the Washington Revised Code 35.92.025. SDCs are imposed on new customers connecting to the system as a condition of service, in addition to any other costs incurred to connect the customer such as meter installation charges. The underlying premise of the SDC is that new growth (i.e., future customers) will pay an equitable share of system costs through an upfront charge for system capacity.

The purpose of the SDC is two-fold: 1) to provide funding sources for capital financing, and 2) to recover an equitable level of investment in the system from new customers. In the absence of such a right-to-connect charge, growth-related costs would be borne, in large part, by existing customers. In addition, the current customers' net investment in the utility would be diluted by the addition of new customers absent an SDC. This dilution, if allowed, would in effect be a subsidy to new connections.

The method used to determine the SDC includes provisions for both the City's investment in existing system capacity and its planned investments in system expansion. The resulting system cost is then spread proportionally over the total customer base served.

A brief description of the components that can be included in the SDC is provided below:

- **Existing Cost Basis** – The original cost of the existing system is determined from utility records. In accordance with statute, interest costs are added at the rate of interest applicable at the time of construction for up to a 10-year period, not to exceed 100 percent of the construction costs. This cost is net of donated facilities and non-utility cash payments, whether from grants, developers or through Local Improvement District assessments. Although not required by state law, outstanding debt principal (net of existing cash balances) is then subtracted from this cost basis to avoid double-charging in recognition that the new customer will share debt service costs through their ongoing rates.

- **Future Cost Basis** – Future facilities needed to serve growth and improve the system for regulatory compliance are also included in the connection charge. The future cost basis can include utility capital projects planned for construction and identified in an approved comprehensive system planning document. It is important to note that current year dollars are used when calculating the SDC and not inflated dollars. This approach assumes that the SDC will be updated annually to track construction cost inflation. Projects directly funded by developers, grants or special property assessments are not included in the calculation. Replacement projects are most often excluded from the calculation unless needed to increase the size of the system. The original cost of replacement projects is already included in the existing cost basis. Further, replacement costs are typically recovered through user rates. The capital improvement program has been allocated between existing and future customers based on engineering and planning criteria. Table 12.11 summarizes the allocation of projects to future growth related customers.

Table 12.11 Project Cost Allocation
Comprehensive Sewer Plan
City of Bellingham

Project	Total Cost (2007 dollars)	% New Customer	Cost for Future Customer
Remote Wet Weather Facility	$28,240,000	89%	$25,133,600
WWTP Phase 1 Improvements	$44,609,400	86%	$38,364,084
I and I Study	$2,000,000	0%	$0
Priority 1 Collection System Improvements	$12,659,065	89%	$11,266,568
Priority 2 Collection System Improvements	$977,365	89%	$869,855
WWTP Phase 2 Improvements	$7,933,200	100%	$7,933,200
Priority 3 Collection System Improvements	$15,540,466	100%	$15,540,466
Total	$111,959,496		$99,107,773

- **Customer Base / System Capacity** – The sum of the existing cost basis and future cost basis is divided by the total customer base to determine the maximum allowable connection charge. The customer base represents equivalent residential units that can be supported by the planned system capacity. The customer projections used to estimate the total ERUs is shown in Table 12.12. The customer base was determined by using the population distribution planning totals (based on available traffic analysis zones data), by area and dividing by 2.24 persons per household (pph) to determine the number of ERUs.

Table 12.12 Customer Projections
Comprehensive Sewer Plan
City of Bellingham

	2006	2012	2016	2022	2026
City Limits	72,597	78,948	82,660	88,577	94,542
UGA	14,651	17,158	20,557	24,478	26,935
Total	87,248	96,106	103,217	113,055	121,477
pph	2.24	2.24	2.24	2.24	2.24
Total ERUs	**38,950**	**42,904**	**46,079**	**50,471**	**54,231**

The current rates and SDCs were adopted by the City Council prior to the finalization of the Comprehensive Sewer Plan. At the time that the rates were adopted, the estimated population within the City Limits and UGA was 121,477 for the year 2026. This population estimate was further refined as the plan was taken from draft to final to include an additional 530 people within the waterfront development area, bringing the total estimated population at 2026 to 122,007. The rates and SDCs presented in this chapter are reflective of the numbers adopted by the council, however future financial studies should use the revised population number of 122,007 or a better estimate available at that time.

Table 12.13 summarizes the SDC analysis and results.

Table 12.13 System Development Charge
Comprehensive Sewer Plan
City of Bellingham

System Development Charge Calculation	
Existing Sewer System	
Existing Sewer System-in-Service	$ 114,289,743
Less: Grant Funded or Developer Donated Facilities	(64,485,506)
Less: Outstanding Debt Net of Cash Reserves	-
Allocable Existing Sewer System	$ 49,804,237
Cumulative Interest on Allocable Sewer System	$ 12,632,502
Net Allocable Existing Sewer System	$ 62,436,738
Customer Base (ERUs)	
Current Customer Base (Y-E 2006 ERUs)	38,950
Projected Growth through 2026	15,281
Total Projected Customer Base	54,231
EXISTING INVESTMENT BUY-IN COMPONENT	**$ 1,151**
Future Sewer System	
Growth Related Projects	$ 99,107,773
Customer Base (ERUs)	
Projected Growth through 2026	15,281
FUTURE INVESTMENT COMPONENT	**$ 6,486**
TOTAL SYSTEM DEVELOPMENT CHARGE PER ERU	**$ 7,637**

The City's 2007 SDC was $3,436 per ERU. The updated analysis based on the current system and capital improvement plan results in a charge of $7,637 per ERU. The increase in the charge is primarily attributable to an increase in the future facilities portion of the charge.

On December 2007, the City Council approved moving forward with the $7,637 SDC update in a two year phased approach. The first step would be a charge of $5,536 in 2008. This would be followed by the second step in 2009 to $7,637.

12.9 CONCLUSION

The financial analysis indicates that the City of Bellingham will maintain reasonable wastewater rate levels while financing the capital projects identified in this Plan. The City has in place fiscal policies, such as annual system reinvestment reserve funding, that will allow the City to continue to maintain strong fiscal and financial health of the wastewater utility.

These findings are dependent on the City increasing rates and fees as identified in this Chapter and on the source data and assumptions used in the financial forecast. Should there be significant change to the assumptions such as the changes to cost or timing of the CIP, financial forecast findings would change as well.

Appendix A

SEPA DETERMINATIONS

PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT

Planning Division
210 Lottie Street, Bellingham, WA 98225
Telephone: (360) 676-6982 Fax: (360) 738-7306 TTY: (360) 676-6883

SEP2007-00036

Determination of Nonsignificance

Description of proposal: The 2007 Bellingham Comprehensive Sewer Plan. This plan describes utility policies, makes growth projections, analyses the sewer system under various scenarios, and forecasts general areas of infrastructure improvements, such as collection and conveyance piping and treatment plant upgrades. Many upgrades are along the west side of the city and are associated with the sewer treatment plant. Specific construction plans are not addressed in this document.

Proponent: Sam Shipp, Public Works Department, 360-676-6961

Location of proposal: Within the City limits of Bellingham, Urban Growth Areas, and possible future planning areas as identified in the 2007 Comprehensive Sewer Plan (Figure ES.1).

Lead agency: Planning and Community Development Department.

Environmental Information Considered:

1) 2006 Comprehensive Plan
2) 2004 Comprehensive Plan Environmental Impact Statement
3) SEPA Checklist, dated 10/17/07

The lead agency for this proposal has determined that it does not have a probable significant adverse impact on the environment. An environmental impact statement (EIS) is not required under RCW 43.21C.030 (2) (c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

(X) This DNS is issued under 197-11-340(2); the lead agency will not act on this proposal for 14 days from the date of issuance.

( ) There is no comment period required for this proposal.

Comments must be submitted by: November 1, 2007

Responsible Official: **Tim Stewart, SEPA Official**
Position: **Director Planning and Community Development**
Address: **210 Lottie Street, Bellingham, WA 98225**

10-18-07

Signature Date

Contact Person: Sam Shipp, sshipp@cob.org, 360-676-6961.
The City of Bellingham complies with the Americans with Disabilities Act. If you need special accommodations, please call 676-6982 (voice) or 676-6883 (TDD).

TO. TIM STEWART 8/21/07 TO [illegible] [illegible] 9/7/7
LABELS TO [illegible] 9/7/07

CITY OF BELLINGHAM • WASHINGTON •

PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT
Planning Division
210 Lottie Street, Bellingham, WA 98225
Telephone: (360) 676-6982 Fax: (360) 738-7306 TTY: (360) 676-6883

ENVIRONMENTAL CHECKLIST
City of Bellingham

PURPOSE:

The State Environmental Policy Act (SEPA), Chapter 43.21C RCW, requires all agencies to consider the environmental impacts of a proposal before making decisions. An environmental impact statement (EIS) must be prepared for all proposals with probable significant adverse impacts on the quality of the environment. The purpose of this checklist is to provide information to help you and the agency identify impacts from your proposal (and to reduce or avoid impacts from the proposal, if it can be done) and to help the agency decide whether an EIS is required.

INSTRUCTIONS FOR APPLICANTS:

This environmental checklist asks you to describe some basic information about your proposal. Governmental agencies use this checklist to determine whether the environmental impacts of your proposal are significant, requiring preparation of an EIS. Answer the questions briefly, with the most precise information known, or give the best description you can.

You must answer each question accurately and carefully, to the best of your knowledge. In most cases, you should be able to answer the questions from your own observations or project plans without the need to hire experts. If you really do not know the answer, or if a question does not apply to your proposal, write "do not know" or does not apply". Complete answers to the questions now may avoid unnecessary delays later.

Some questions ask about governmental regulations, such as zoning, shoreline, etc. Answer these questions if you can. If you have problems, the governmental agencies can assist you.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

USE OF CHECKLIST FOR NON-PROJECT PROPOSALS:

Complete this checklist for non-project proposals, even though questions may be answered "does not apply". In addition, complete the supplemental sheet for non-project actions (Part D).

For non-project actions, the references in the checklist to the words "project", "applicant", and "property or site" should be read as "proposal", "proposer", and "affected geographic area," respectively.

PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT
Planning Division
210 Lottie Street, Bellingham, WA 98225
Telephone: (360) 676-6982 Fax: (360) 738-7306 TTY: (360) 676-6883

TO BE COMPLETED BY STAFF

TIDEMARK PROJECT/CASE # __
DATE APPLICATION RCVD____________________
ASSIGNED TO: ____________________

ENVIRONMENTAL CHECKLIST
City of Bellingham

A. BACKGROUND

1. Name of proposed project, if applicable:

   2007 BELLINGHAM COMPREHENSIVE SEWER PLAN

2. Name, address, and phone number of owner/decision maker:

   PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT
   PLANNING DIVISION
   210 LOTTIE ST.
   BELLINGHAM, WA 98225
   (360) 676-6982
   ATTN: TIM STEWART, PLANNING DIRECTOR

3. Name, address and phone number of contact person

   PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT
   PLANNING DIVISION
   210 LOTTIE ST.
   BELLINGHAM, WA 98225
   (360) 676-6982
   ATTN: TIM STEWART, PLANNING DIRECTOR

5. Tax Assessor's Parcel Number and Legal Description of Subject Property **(the parcel number is mandatory to begin processing of the application)** Give sufficient information for a person to understand the precise location of your proposed project. If a proposal would occur over a large area, provide the boundaries of the site. Provide a complete legal description, site plan, vicinity map, and topographical map, if reasonably available. You are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

WITHIN THE CITY OF BELLINGHAM, WHATCOM COUNTY, WASHINGTON, INCLUDING:

- ALL OR PORTIONS OF SECTIONS 1,2,11,12,13,14,24,25,26,36 IN TOWNSHIP 37 NORTH, RANGE 2 EAST;
- ALL OR PORTIONS OF SECTIONS 4,5,6,7,8,9,16,17,18,19,30 IN TOWNSHIP 37 NORTH, RANGE 3 EAST;
- ALL OR PORTIONS OF SECTIONS 1,2,3,4,9,10,11,12,13,14,15,22,23,24,25,26,36 IN TOWNSHIP 38 NORTH, RANGE 2 EAST;
- ALL OR PORTIONS OF SECTIONS 2,3, 4,5,6,7,8,9,10,11,14,15,16,17,18,19,20,21,22,23,26, 27,28,29,30,31,32,33,34,35 IN TOWNSHIP 38 NORTH, RANGE 3 EAST.

6. Street Address of Subject Property:

CITY OF BELLINGHAM, LOCATED WITHIN WHATCOM COUNTY. GENERALLY DESCRIBED AS THE AREA EAST OF BELLINGHAM BAY AND THE BELLINGHAM INTERNATIONAL AIRPORT, WEST OF LAKE WHATCOM AND SQUALICUM MOUNTAIN, NORTH OF CHUCKANUT MOUNTAIN AND CHUCKANUT BAY, AND SOUTH OF KELLY ROAD.

7. Neighborhood and Area Designation (as per Comprehensive Plan):

- RESIDENTIAL SINGLE
- RESIDENTIAL MULTI
- COMMERCIAL
- INDUSTRIAL
- PUBLIC
- INSTITUTIONAL

8. Zoning/Land Use Designation of Subject Property (see Neighborhood Plan – **required for processing**):

REFERENCE MAP FROM CITY OF BELLINGHAM 2006 COMPREHENSIVE PLAN (FIGURE 1)

- COMMERCIAL
- COMMERCIAL/ INDUSTRIAL
- COMMERCIAL/ RES MULTI
- COMMERCIAL/ INDUSTRIAL/ RES MULTI
- INDUSTRIAL
- INDUSTRIAL/RESIDENTIAL MULTI
- INDUSTRIAL/ WATERFRONT MIXED-USE
- INSTITUTIONAL
- INSTITUTIONAL/ RESIDENTIAL MULTI

- PUBLIC
- PUBLIC/ WATERFRONT MIXED-USE
- PUBLIC/ INSTITUTIONAL
- RESIDENTIAL MULTIPLE
- RESIDENTIAL SINGLE
- RESIDENTIAL SINGLE/ RESIDENTIAL MULTI

9. Date checklist prepared:

   JULY 16, 2007

10. Departments requesting checklist:

CITY OF BELLINGHAM
PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT
PLANNING DIVISION
210 LOTTIE ST.
BELLINGHAM, WA 98225

WASHINGTON STATE DEPT. OF ECOLOGY
ENVIRONMENTAL REVIEW
PO BOX 47703
OLYMPIA WA 98504-7703
ATTN: MS. BARBARA RITCHIE

WHATCOM COUNTY
COUNTY COURTHOUSE
311 GRAND AVENUE
BELLINGHAM, WA 98225

CITY OF FERNDALE
P.O. BOX 936
FERNDALE, WA 98248

CITY OF LYNDEN
ATTN: AMY HARKSELL
323 FRONT STREET
LYNDEN, WA 98264

LUMMI INDIAN BUSINESS COUNCIL AND TRIBAL HISTORIC PRESERVATION OFFICE
2616 KWINA ROAD
BELLINGHAM, WA 98226

NOOKSACK TRIBAL COUNCIL
P.O. BOX 157
DEMING, WA 98244

DEPARTMENT OF ECOLOGY, SEPA UNIT
P.O. BOX 47703
OLYMPIA, WA 98504-7703

DEPARTMENT OF NATURAL RESOURCES
1111 WASHINGTON STREET SE
OLYMPIA, WA 98504-7001

DEPARTMENT OF TRANSPORTATION
MAIL STOP 138
P.O. BOX 330310
SEATTLE, WA 98133-9710.

DEPARTMENT OF FISH & WILDLIFE
ATTN: JULIE KLACAN
P.O. BOX 1100
LACONNER, WA 98257

DEPARTMENT OF SOCIAL AND HEALTH SERVICES
NEW MARKET INDUSTRIAL CAMPUS
7211 CLEANWATER LANE
P.O. BOX 47820
OLYMPIA, WA 98504-7820

STATE PARKS & RECREATION COMMISSION
P.O. BOX 42650
OLYMPIA, WA 98504-2650

OFFICE OF ARCHAEOLOGY & HISTORIC PRESERVATION
1063 SOUTH CAPITAL WAY, SUITE 106
P.O. BOX 48343
OLYMPIA, WA 98504-8343

ENVIRONMENTAL PROTECTION AGENCY
REGIONAL OFFICE
1200 6TH AVENUE
SEATTLE, WA 98101

NATIONAL MARINE FISHERIES SERVICE
1315 EASTWEST HIGHWAY
SSMC3
SILVER SPRINGS, MD 20910

NATIONAL OCEAN & ATMOSPHERE ADMINISTRATION
WESTERN REGIONAL OFFICE
206-526-6647

WATER DISTRICT 2
1615 BAYON ROAD
BELLINGHAM, WA 98225

WATER DISTRICT 7
1853 ACADEMY ROAD
BELLINGHAM, WA 98226

LAKE WHATCOM WATER & SEWER DISTRICT
1010 LAKEVIEW STREET
BELLINGHAM, WA 98226

BELLINGHAM SCHOOL DISTRICT 501
ATTN: DALE KINSLEY, SUPERINTENDENT
1306 DUPONT
BELLINGHAM, WA 98225

FERNDALE SCHOOL DISTRICT 502
ATTN: SUPERINTENDENT
P.O. BOX 698
BELLINGHAM, WA 98226

MERIDIAN SCHOOL DISTRICT 505
DON BAYTHUES, SUPERINTENDENT
214 WEST LAUREL ROAD
BELLINGHAM, WA 98226

MOUNT BAKER SCHOOL DISTRICT 507
ATTN: SUPERINTENDENT, RICHARD GANTMAN
P.O. BOX 95
DEMING, WA 98244

WESTERN WASHINGTON UNIVERSITY
-GEOGRAPHY DEPARTMENT
-HUXLEY COLLEGE
-WILSON LIBRARY
BELLINGHAM, WA 98225-9079

WHATCOM COMMUNITY COLLEGE
237 W. KELLOG ROAD
BELLINGHAM, WA 98225

BELLINGHAM TECHNICAL COLLEGE
3028 LINDBERGH AVENUE
BELLINGHAM, WA 98225

NORTHWEST SALMON ENHANCEMENT ASSOCIATION
2445 EAST BAKERVIEW
BELLINGHAM, WA 98226

11. Proposed timing or schedule (including phasing, if applicable):

THE 2007 COMPREHENSIVE SEWER PLAN IS EXPECTED TO BE REVIEWED FOR APPROVAL DURING THE FALL OF 2007/ WINTER OF 2008. THE PLAN PROJECTS IMPROVEMENTS FOR 20 YEARS INTO THE FUTURE AND WILL BEGIN CONSTRUCTION AS NEEDED TO MEET DEVELOPMENT AND GROWTH DEMANDS.

12. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain: THE SEWER SYSTEM PLAN DISCUSSES ADDITIONS AND IMPROVEMENTS TO THE SYSTEM. HIGH PRIORITY IMPROVEMENTS WILL PROBABLY OCCUR WITHIN 5 YEARS, LOWER TO INTERMEDIATE IMPROVEMENTS MAY OR MAY NOT OCCUR WITHIN TEN TO TWENTY YEARS DEPENDING ON SYSTEM DEMAND. FUTURE ADJUSTMENTS IN THE SEWER SERVICE AREA WILL BE REVIEWED AS THEY OCCUR.

13. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal:
NONE, BUT THE CITY OF BELLINGHAM ENVIRONMENTAL IMPACT STATEMENT, JULY 1, 2004, PROVIDED MUCH OF THE RELEVANT DATA FOR THIS CHECKLIST.

14. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain:
NONE KNOWN.

15. List any government approvals or permits that will be needed for your proposal, if known:
THE PROJECTS OUTLINED IN THE 2007 COMPREHENSIVE PLAN WILL, GENERALLY, REQUIRE APPROVAL FROM THE FOLLOWING AGENCIES:

- WASHINGTON STATE DEPARTMENT OF HEALTH (DOH)
- WHATCOM COUNTY HEALTH DEPARTMENT
- WHATCOM COUNTY COUNCIL
- WHATCOM DEPARTMENT OF PLANNING AND DEVELOPMENT SERVICES
- LAKE WHATCOM WATER AND SEWER DISTRICT (FORMER WATER DISTRICT #10)

16. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page:

THE PLAN DESCRIBES UTILITY POLICIES, MAKES GROWTH PROJECTIONS, ANALYZES THE SEWER SYSTEM UNDER VARIOUS SCENARIOS, AND FORECASTS GENERAL AREAS OF INFRASTRUCTURE IMPROVEMENTS, SUCH AS COLLECTION AND CONVEYANCE PIPING AND TREATMENT PLANT UPGRADES.

MANY OF THE PROJECTS ARE LOCATED ALONG THE WEST SIDE OF THE CITY BECAUSE THAT IS WHERE THE LARGER PIPES ARE LOCATED. MANY OTHERS IMPROVEMENTS ARE ASSOCIATED WITH THE TREATMENT PLANT.

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site (circle one): FLAT, ROLLING, HILLY, STEEP SLOPES, MOUNTAINOUS, other____________________________

b. What is the steepest slope on the site (approximate percent slope)?
APPROXIMATELY 35 PERCENT

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland:

OVER 40 DIFFERENT SOIL TYPES HAVE BEEN IDENTIFIED WITHIN THE AREA (REFERENCED FROM THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CITY OF BELLINGHAM, JULY 1, 2004). THE MOST PREDOMINANT OF THOSE ARE:

QAL – ALLUVIAL DEPOSITS
QB – BELLINGHAM DRIFT
QF – UNDIFFERENTIATED GLACIAL DEPOSITS
QSC – TILL & ICE-CONTACT DEPOSITS
QSO – OUTWASH SAND AND GRAVEL
QT – TERRACE DEPOSITS
TCS – CHUCKANUT FORMATION
TH – HUNTINGTON FORMATION
VH – PEAT

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe:

THE BELLINGHAM CAO IDENTIFIES AREAS AS GEOLOGICALLY HAZARDOUS AREAS THAT MAY NOT BE SUITED TO DEVELOPEMNT CONSISTENT WITH PUBLIC HEALTH SAFETY, OR ENVIRONMENTAL STANDARDS, BECAUSE OF THEIR SUSCEPTIBIYT TO EROSION, SLIDING , EATHQUAKE, OR OTHER GEOLOGICAL EVENTS AS DESIGNATED BY WAC 365-190-080(4). THE TYPES OF GEOLOGICALLY HAZARARDOUS AREAS INCLUDE: EROSION, LANDSLIDE, SEISMIC, MINE, AND VOLCANIC HAZARDS. HAZARD AREAS: AREAS DESIGNATED AS FREQURELTY FLOODED AREAS OR GEOLOGICALLY HAZARDOUS AREAS DUE TO POTENTIAL FOR ERSION, LANDSLIDE, SEISMIC ACTIVITY, MINE COLLAPSE, OR OTHER GEOLOGICAL CONDTION. SEISMIC HAZARD ARES: AREAS THAT ARE SUBJECT TO SEVERE RISK OF DAMAGE AS A RESULT OF EATHUQAKE-INDUCED GROUND SHAKING SLOPE FAILURE, SETTLEMENT, OR SOIL LIQUEFACTION. THESE AREAS EXIST WITHIN THE STUDY BOUNDARIS.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill: NONE AS A RESULT OF THIS PROPOSAL.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe: NOT AS A RESULT OF THIS PROPOSAL

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)? NONE AS A RESULT OF THIS PROPOSAL

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any: DOES NOT APPLY

2. Air

a. What types of emission to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known: NONE AS A RESULT OF THIS PLAN

b. Are there any off-site sources of emissions or odor that may effect your proposal? If so, generally describe: NO

c. Proposed measures to reduce or control emissions or other impacts to air, if any: DOES NOT APPLY

3. <u>Water</u>

a. Surface:

1). Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into:

<u>THE PLANNING AREA WHOLLY OR PARTIALLY OVERLIES 12 WATERSHEDS, EACH OF WHICH INCLUDES ONE OR MORE DRAINAGE BASINS. EACH WATERSHED AND SUB-BASIN CONTAINS ONE OR MORE YEAR-ROUND OR SEASONAL STREAM. ALL DRAINAGE BASINS IN THE PLANNING AREA ULTIMATELY DISCHARGE INTO BELLINGHAM BAY (REFERENCED FROM THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CITY OF BELLINGHAM, JULY 1, 2004).</u>

- LUMMI BAY WATERSHED
  - LUMMI PENINSULA WEST DRAINAGE BASIN
- SILVER/ NOOKSACK CHANNEL AND DELTA WATERSHED
  - SILVER CREEK DRAINAGE BASIN
- BARRETT LAKE WATERSHED
  - DEER CREEK DRAINAGE BASIN
  - TENMILE CREEK DRAINAGE BASIN
- ANDERSON WATERSHED
  - LOWER ANDERSON CREEK DRAINAGE BASIN
- SQUALICUM WATERSHED
  - SPRING CREEK DRAINAGE BASIN
  - BAKER CREEK DRAINAGE BASIN
  - McKORMICK CREEK DRAINAGE BASIN
  - UPPER SQUALICUM CREEK DRAINAGE BASIN
  - TOAD CREEK DRAINAGE BASIN
  - LOWER SQUALICUM CREEK DRAINAGE BASIN
- LAKE WHATCOM WATERSHED
  - SILVER BEACH DRAINAGE BASIN
  - HILLSDALE DRAINAGE BASIN
  - ACADEMY DRAINAGE BASIN
  - ORIENTAL DRAINAGE BASIN

- BLOEDEL DRAINAGE BASIN
  - GENEVA DRAINAGE BASIN
  - CABLE DRAINAGE BASIN
  - STRAWBERRY DRAINAGE BASIN
- WHATCOM CREEK WATERSHED
- PADDEN CREEK WATERSHED
- BELLINGHAM BAY WATERSHED
  - FORT BELLINGHAM DRAINAGE BASIN
  - LITTLE SQUALICUM CREEK DRAINAGE BASIN
  - SOUTH BELLINGHAM BAY DRAINAGE BASIN
- CHUCKANUT WATERSHED
  - CHUCKANUT CREEK DRAINAGE BASIN

2). Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans:

NO.

3). Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material:

NONE AS A RESULT OF THIS PLAN.

4). Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known:

NO.

5). Does the proposal lie within a 100-year floodplain? If so, note the location on the site plan:

THE 100-YEAR FLOODPLAINS WITHIN THE CITY LIMITS FLOW THROUGH (REFERENCE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CITY OF BELLINGHAM, JULY 1, 2004):

- SQUALICUM CREEK, BUG LAKE, AND SUNSET POND
- WHATCOM CREEK
- PADDEN CREEK
- CHUCKANUT BAY INLET

6). Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge:

NO.

b. Ground

1). Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known:

NO.

2). Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: domestic sewage; industrial, containing chemicals; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve:

DOES NOT APPLY.

c. Water Runoff (including storm water):

1). Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe:

DOES NOT APPLY.

2). Could waste materials enter ground or surface waters? If so, generally describe:

NOT AS A RESULT OF THIS PLAN.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

DOES NOT APPLY.

4. Plants

a. Check or circle types of vegetation found on the site:

X deciduous tree: ALDER, MAPLE, aspen, other: BLACK COTTONWOOD,

X evergreen tree: fir, CEDAR, pine, other: HEMLOCK

X shrubs:

X grass

X pasture

X crop or grain

X wet soil plants: CATTAIL, buttercup, BULLRUSH, SKUNK CABBAGE, other

X water plants: WATER LILY, EELGRASS, MILFOIL, other

X other types of vegetation: FERNS, HERBS, STINGING NETTLES,

b. What kind and amount of vegetation will be removed or altered?

NONE AS A RESULT OF THIS PLAN.

c. List threatened or endangered species known to be on or near the site:

NONE KNOWN.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

DOES NOT APPLY.

5. Animals

a. Circle any birds and animals, which have been observed on or near the site or are known to be on or near the site:

birds: HAWK, HERON, EAGLE, SONGBIRDS, other: ____________

mammals: DEER, BEAR, ELK, BEAVER, other: ____________________

fish: BASS, SALMON, TROUT, HERRING, SHELLFISH, other: ________________

b. List any threatened or endangered species known to be on or near the site:

UPLAND SANDPIPER, MARDON SKIPPER, SEA OTTER, WESTERN POND TURTLE, OREGON SPOTTED FROG, BALD EAGLE, MARBELED MURRELET, FERRUGINOUS HAWK, CHINOOK SALMON, AND BULL TROUT.

c. Is the site part of a migration route? If so, explain:

THE ENTIRE AREA LIES WITHIN THE PACIFIC FLYWAY, WHICH IS A MAJOR MIGRATORY ROUTE FOR BIRDS, AND EXTENDS WESTWARD FROM THE CREST OF THE CASCADE MOUNTAINS TO THE PACIFIC OCEAN AND FROM BRITISH COLUMBIA, CANADA SOUTHWARD TO NORTHERN CALIFORNIA.

d. Proposed measures to preserve or enhance wildlife, if any:

DOES NOT APPLY.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

NONE AS A RESULT OF THIS PLAN.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe:

NO.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

DOES NOT APPLY.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, which could occur as a result of this proposal? If so, describe:

NOT AS A RESULT OF THIS PLAN.

1). Describe special emergency services that might be required:

DOES NOT APPLY.

2). Proposed measures to reduce or control environmental health hazards, if any:

DOES NOT APPLY.

b. Noise

1). What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

DOES NOT APPLY.

2). What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site:

NONE AS A RESULT OF THIS PLAN.

3). Proposed measures to reduce or control noise impacts, if any:

DOES NOT APPLY.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

EXISTING LAND USES WITHIN THE CITY INCLUDE (REFERENCED FROM THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CITY OF BELLINGHAM, JULY 1, 2004):

- SINGLE-FAMILY RESIDENTIAL
- MULTIFAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- PUBLIC AND QUASI-PUBLIC
- FORESTRY
- AGRICULTURE
- OPEN SPACE
- VACANT LAND

b. Has the site been used for agriculture? If so, describe:

AGRICULTURAL LAND WITHIN THE CITY IS LOCATED PRIMARILY AT THE VERY WESTERN EXTENT OF THE SUBAREA OUTSIDE OF THE BELLINGHAM URBAN GROWTH AREA. AGRICULTURAL AREAS IN THE RURAL ZONE ARE COMPRISED OF DAIRY, HORTICULTURE, BEEF CATTLE, POULTRY, HEIFER REPLACEMENT OPERATIONS, AND FORAGE/ PASTURELAND. THERE ARE NO LARGE COMMERCIAL

FARMS (REFERENCED FROM THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CITY OF BELLINGHAM, JULY 1, 2004).

c. Describe any structures on the site:

STRUCTURES INCLUDE, BUT ARE NOT LIMITED TO, RESIDENTIAL HOMES, OFFICE BUILDINGS, COMMERCIAL BUILDINGS, AND MULTIFAMILY HOUSING.

d. Will any structures be demolished? If so, what?

NOT AS A RESULT OF THIS PLAN.

e. What is the current comprehensive plan designation of the site?

URBAN.

f. If applicable, what is the current shoreline master program designation of the site?

CITY OF BELLINGHAM PLANNING DIVISION SHORELINE MASTER PROGRAM INFO LISTS THE FOLLOWING SHORELINES:

- BELLINGHAM BAY SHORELINE AND TRIBUTARIES INCLUDE:
  - URBAN MARITIME- WATER ORIENTED USES
  - URBAN MARITIME- SHORELINE MIXED USE
  - URBAN CONSERVANCY
  - NATURAL
- LAKE WHATCOM SHORELINE, WHATCOM CREEK, AND TRIBUTARIES INCLUDE:
  - NATURAL
  - SHORELINE RESIDENTIAL
  - URBAN CONSERVANCY
  - URBAN MARITIME
- SQUALICUM CREEK AND TRIBUTARIES INCLUDE:
  - NATURAL
  - URBAN CONSERVANCY
  - URBAN MARITIME
- PADDEN CREEK, PADDEN LAGOON, AND TRIBUTARIES INCLUDE:
  - URBAN CONSERVANCY
  - URBAN MARITIME
  - URBAN MARITIME- WATER ORIENTED USES
- CHUCKANUT BAY, CHUCKANUT CREEK, AND TRIBUTARIES INCLUDE:

- NATURAL
- URBAN CONSERVACEY

g. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify:

THE ENVIRONEMENTALLY SENSITVE AREAS INCLUDE THOSE WHICH LIE ON OR WITHIN THE SHORLINEA AND/OR ANY WILDLIFE BEARING WATER BODIES. THE BELLINGHAM CAO IDENTIFIES AREAS AS GEOLOGICALLY HAZARDOUS AREAS THAT MAY NOT BE SUITED TO DEVELOPEMNT CONSISTENT WITH PUBLIC HEALTH SAFETY, OR ENVIRONMENTAL STANDARDS, BECAUSE OF THEIR SUSCEPTIBIYT TO EROSION, SLIDING , EATHQUAKE, OR OTHER GEOLOGICAL EVENTS AS DESIGNATED BY WAC 365-190-080(4). THE TYPES OF GEOLOGICALLY HAZARARDOUS AREAS INCLUDE: EROSION, LANDSLIDE, SEISMIC, MINE, AND VOLCANIC HAZARDS. HAZARD AREAS: AREAS DESIGNATED AS FREQURELTY FLOODED AREAS OR GEOLOGICALLY HAZARDOUS AREAS DUE TO POTENTIAL FOR ERSION, LANDSLIDE, SEISMIC ACTIVITY, MINE COLLAPSE, OR OTHER GEOLOGICAL CONDTION. SEISMIC HAZARD ARES: AREAS THAT ARE SUBJECT TO SEVERE RISK OF DAMAGE AS A RESULT OF EATHUQAKE-INDUCED GROUND SHAKING SLOPE FAILURE, SETTLEMENT, OR SOIL LIQUEFACTION. THESE AREAS EXIST WITHIN THE STUDY BOUNDARIS.

h. Approximately how many people would reside or work in the completed project? NONE AS A RESULT OF THIS PLAN

i. Approximately how many people would the completed project displace? NONE

j. Proposed measures to avoid or reduce displacement impacts, if any: DOES NOT APPLY

k. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any: ANY PROPOSED PROJECTS THAT RESULT FROM THIS PLAN WILL BE REVIEWED FOR COMPATIBLIYT WITH EXISTING AND PROJECTED LAND USES AND PLANS BY THE APPROPRIATE AGENCIES.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle or low-income housing: ______

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing:

NONE AS A RESULT OF THIS PROJECT.

c. Proposed measures to reduce or control housing impacts, if any:

DOES NOT APPLY.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

DOES NOT APPLY.

b. What views in the immediate vicinity would be altered or obstructed?

NONE AS A RESULT OF THIS PLAN.

c. Proposed measures to reduce or control aesthetic impacts, if any:

DOES NOT APPLY.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

NONE AS A RESULT OF THIS PLAN.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

NOT AS A RESULT OF THIS PLAN.

c. What existing off-site sources of light or glare may affect your proposal?

NONE.

d. Proposed measures to reduce or control light and glare impacts, if any:

DOES NOT APPLY.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

THE FOLLOWING RECREATIONAL VENUES CAN BE FOUND WITHIN THE CITY LIMITS:

- FAIRHAVEN PARK
- BIRCHWOOD PARK
- LITTLE SQUALICUM PARK
- ZUANICH PARK
- CARL LOBE PARK
- ELIZABETH PARK
- FAUTS PARK
- BATTERSBY FIELD
- MARITIME HERITAGE PARK
- ST. CLAIR PARKNORTH RIDGE PARK
- ROCK HILL PARK
- FRANKLIN PARK
- LAUREL PARK
- PINE & CEDAR PARK
- SEHOME HILL ARBORETUM
- MEMORIAL PARK
- HIGHLAND HEIGHTS PARK
- ROOSEVELT NATIONAL AREA
- ROOSEVELT PARK
- BROADWAY PARK
- MARINE PARK
- VILLAGE GREEN PARK
- CONNELLY CREEK NATIONAL AREA
- WHATCOM FALLS PARK
- HAPPY VALLEY PARK
- RIDGEMONT PARK
- EAST MEADOW PARK
- ARROYO PARK
- BLOEDEL DONOVAN PARK
- CORNWALL PARK
- BOULEVARD PARK
- LAKE PADDEN PARK

- CIVIC FIELD AQUATIC CENTER
- CIVIC FIELD ICE SKATING PARK
- LAKE WHATCOM
- LAKE PADDEN
- BUG LAKE
- SUNSET POND

b. Would the proposed project displace any existing recreational uses? If so, describe:

NO.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

DOES NOT APPLY.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe:

THERE ARE 33 NATIONAL REGISTER SITES,5 STATE REGISTER SITES, AND 9 LOCAL HISTORIC REGISTRY SITES (FINAL ENVIRONMENTAL IMPACT STATEMENT, THE CITY OF BELLINGHAM, JULY 1, 2004).

b. Generally describe any landmarks or evidence of historic, archeological, scientific, or cultural importance known to be on or next to the site:

- NATIONAL REGISTER SITES

o AFTERMATH CLUBHOUSE	1300 BROADWAY
o B&B FURNITURE BUILDING	1313 BAY STREET
o BELLINGHAM NATIONAL BANK BUILDING	101-111 E. HOLLY STREET
o ALFRED L. BLACK HOUSE	158 S. FOREST STREET
o WARDNER'S "CASTLE"/ HILLTOP HOUSE	1103 15TH STREET
o J.J. DONOVAN HOUSE	1201 N. GARDEN STREET
o EDWARD ELDRIDGE HOMESITE	2915 ELDRIDGE AVENUE
o FLATIRON BUILDING	1311-1319 BAY STREET
o ROLAND G. GAMWELL HOUSE	1001 16TH STREET
o GREAT NORTHERN RAILROAD STATION	HOLLY/D STREET

o C.X. LARRABEE HOUSE	405 FIELDSTONE ROAD
o LEOPOLD HOTEL	1224 CORNWALL AVENUE
o ROBERT L. MORSE HOUSE	1014 N. GARDEN STREET
o MOUNT BAKER THEATRE	106 N. COMMERCIAL STREET
o OLD MAIN BUILDING	WESTERN WASHINGTON UNIVERSITY
o CAPTAIN GEORGE PICKETT HOUSE	910 BANCROFT STREET
o VICTOR A. ROEDER HOUSE	2600 SUNSET DRIVE
o LOTTIE ROTH BLOCK	1106 W. HOLLY STREET
o WHATCOM MUSEUM OF HISTORY AND ART	121 PROSPECT STREET
o YWCA BUILDING	1026 N. FOREST STREET
o ELDRIDGE HISTORIC DISTRICT	
o FAIRHAVEN HISTORIC DISTRICT	
o SEHOME HILL HISTORIC DISTRICT	
o FEDERAL BUILDING	104 W. MAGNOLIA
o ELK'S CLUB BUILDING	1412 CORNWALL
o GEORGE H. BACON HOUSE	2001 ELDRIDGE AVENUE
o COUNTY COURTHOUSE/T.G. RICHARDS BLDG.	1308 E. STREET
o FAIRHAVEN LIBRARY	1117 12TH STREET
o LAUBE HOTEL	1226 N. STATE STREET
o OAKLAND BLOCK	HOLLY/CHAMPION
o J.J. RICHARDS BUILDING	1308 E. STREET
o TERMINAL BUILDING	1101-03 HARRIS AVENUE
o WASHINGTON GROCERY BUILDING	1133-35 RAILROAD AVENUE

- STATE REGISTER SITES

o MORSE HARDWARE COMPANY BUILDING	1025 N. STATE STREET
o OLD WHATCOM COUNTY COURTHOUSE	1308 E STREET
o TERMINAL BUILDING	1101-03 HARRIS AVENUE
o WARDNER'S "CASTLE"/ HILLTOP HOUSE	1103 15TH STREET
o FORT BELLINGHAM SITE (URBAN FRINGE)	1346 MARINE DRIVE

- LOCAL HISTORIC REGISTRY

o MOUNT BAKER THEATRE	106 N. COMMERCIAL STREET
o BELLINGHAM/ WHATCOM COUNTY MUSEUM	121 PROSPECT
o OLD COURTHOUSE	1308 E STREET
o LEOPOLD HOTEL	1224 CORWALL AVENUE
o YOUNG WOMEN'S CHRISTIAN ASSOCIATION	1026 N. FOREST

o ROEDER HOME	2600 SUNSET DRIVE
o LAIRMONT MANOR	405 FIELDSTONE ROAD
o ROTH BLOCK	HOLLY AND G STREETS
o MONAHAN AND MCHUGH BUILDING	MAGNOLIA AND CORNWALL

c. Proposed measures to reduce or control impacts, if any:

DOES NOT APPLY.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any:

THE CITY OF BELLINGHAM CAN BE ACCESSED VIA:

- INTERSTATE- 5, WHICH RUNS NORTH AND SOUTH THROUGH THE CITY
- HIGHWAY 542, WHICH COMES FROM THE WEST AND CONNECTS TO I-5
- HIGHWAY 539, WHICH COMES FROM THE NORTH AND CONNECTS TO I-5
- HIGHWAY 11, WHICH COMES FROM THE SOUTH AND CONNECTS TO I-5

b. Is the site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

THE CITY OF BELLINGHAM IS CURRENTLY SERVED BY 34 DIFFERENT BUS ROUTES THAT SERVICE ALL AREAS OF THE CITY.

c. How many parking spaces would the completed project have? How many would the project eliminate?

NONE.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private):

NO.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe:

NO.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur:

NONE.

g. Proposed measures to reduce or control transportation impacts, if any:

DOES NOT APPLY.

15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe:

NO.

b. Proposed measures to reduce or control direct impacts on public services, if any:

DOES NOT APPLY.

16. Utilities

a. Circle utilities currently available at the site: ELECTRICITY, NATURAL GAS, WATER, REFUSE SERVICE, TELEPHONE, SANITARY SEWER, septic system, other:

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed:

THE 2007 SEWER COMPREHENSIVE PLAN SERVES AS A GUIDE FOR THE CONTROLLED EXPANSION OF SEWER SERVICE WITHIN THE SERVICE AREA. SUBSEQUENT ACTIONS MAY INCLUDE CONSTRUCTION OF SEWER MAINS AND TREATMENT AND PUMPING FACILITIES.

C. <u>SIGNATURE</u>

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Sam [signature]

Date Submitted: 10-17-07

D. FEE

An application fee shall be submitted in the amount set by the City Council. See separate Fee Schedule handout.

PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT
Planning Division
210 Lottie Street, Bellingham, WA 98225
Telephone: (360) 676-6982 Fax: (360) 738-7306 TTY: (360) 676-6883

ENVIRONMENTAL CHECKLIST

CITY OF BELLINGHAM

SUPPLEMENTAL SHEET "D" FOR NONPROJECT ACTIONS
(Not to be used for project actions)

Because these questions are very general, it may be helpful to read them in conjunction with the list of elements on the environment.

When answering these questions, be aware of the extent the proposal, or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general terms.

D. Supplemental Sheet for Non-project Actions

1. How would the proposal be likely to increase discharge to water; emissions to air; production, storage, or release of toxic or hazardous substances; or production of noise?

   THE CITY OF BELLINGHAM 2007 COMPREHENSIVE SEWER PLAN WILL NOT AFFECT THE ENVIRONMENT. THE PLAN RESPONDS, IN AN ORDERLY MANNER, TO FUTURE DEVELOPMENT AS APPROVED BY VARIOUS AGENCIES, IN ACCORDANCE WITH FEDERAL, STATE, AND LOCAL REQUIREMENTS. SUBSEQUENT ACTIONS MAY INCLUDE PROPERTY OWNER REQUESTS FOR CONSTRUCTION OF SEWER MAINS CONSISTENT WITH WHATCOM COUNTY AND CITY OF BELLINGHAM GUIDELINES.

   Proposed measures to avoid or reduce such increases are:

   PROPOSED PROJECTS WILL BE REVIEWED AND ADDRESSED BY APPROPRIATE AGENCIES AS PROJECTS COMMENCE. ADDITIONALLY, DEVELOPMENT AND GROWTH WILL BE MONITORED AND CONTROLLED BY THE APPROPRIATE COUNTY AND CITY AGENCIES.

2. How would the proposal be likely to affect plants, animals, fish or marine life?

THE PROPOSED PROJECTS AND POTENTIAL DEVELOPMENT WILL RESULT IN THE LOSS OF PLANTS WHERE SEWER SYSTEM FACILITIES ARE INSTALLED ALONG EASEMENTS OR ON SPECIFIC SITES. IT IS NOT ANTICIPATED THAT THE PROPOSED PROJECTS WILL HAVE A SIGNIFICANT IMPACT UPON FISH OR WILDLIFE.

Proposed measures to protect or conserve plants, animals, fish or marine life are:

PROPOSED PROJECTS WILL BE REVIEWED AND ADDRESSED BY APPROPRIATE AGENCIES AS THEY COMMENCE.

3. How would the proposal be likely to deplete energy or natural resources?

DOES NOT APPLY. THE PROPOSAL WILL HAVE NO DIRECT EFFECT UPON ENERGY RESOURCES OR MOST NATURAL RESOURCES. THE PLAN SUMMARIZES IMPROVEMENTS TO THE COLLECTION SYSTEM THAT ARE NEEDED TO ACCOMMODATE FUTURE GROWTH PATTERNS AS WELL AS PROVIDE SERVICE TO THE CURRENTLY UNSEWERED AREAS OF THE CITY.

Proposed measures to protect or conserve energy and natural resources are:

DEVELOPMENT MUST CONFORM TO WHATCOM COUNTY AND CITY OF BELLINGHAM GUIDELINES AND REGULATIONS.

4. How would the proposal be likely to use or affect environmentally sensitive areas or area designated (or eligible or under study) for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?

THE 2007 COMPREHENSIVE SEWER PLAN WILL NOT AFFECT THE CURRENT USAGE OF SITES. PROJECTS WITHIN THE SERVICES AREA WILL NEED TO ADDRESS THESE CONCERNS MORE SPECIFICALLY.

Proposed measures to protect such resources or to avoid or reduce impacts are:

PROPOSED PROJECTS WILL BE REVIEW AND ADDRESSED BY THE APPROPRIATE AGENCIES AS THEY COMMENCE.

5. How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?

THIS PLAN DOES OT ALLOW OR ENCOUAGE USES INCOMPATIBLE WITH EXISTING PLANS. THE PLAN DOES SHOW SOME PROPOSED FACILITEIS IN THE VICINITY OF WATER BODIES, HOVEVER, LAND AND SHORELINE USES SHOULD NOT BE AFFECTED.

Proposed measures to reduce or respond to such demand(s) are:

CONFORMANCE TO WHATCOM COUNTY AND CITY OF BELLINGHAM GUIDELINES, ZONINGI REQIREMENTS ALL STATE REGULATIONS AND DISTRICT STANDARDS WILL BE REQUIRED WHEN FUTURE DEVELOPEMNT OCCURS.

6. How would the proposal be likely to increase demands on transportation or public services and utilities?

THE 2007 COMPREHENSIVE SEWER PLAN DOES OT CONFLICT WITH ANY KNOWN ENVIROMENTAL LAWS. DEVELOPENT AND GROWTH WHICH MAY FOLLOW WILL BE IN ACCORDANCE WITH ENVIROMENATL RESTRICTIONS, AS WELL AS LOCAL GUIDELINES.

THE PLANS RECOMMEND PROJECTS THAT WILL ADD TO AND IMPROVE THE EXISTING SEWER SYSTEM IN RESPONCSE TO DEVELOPMENTS NAD GROWTH. THE PLAN IS NOT LIKELY TO INCREASE THE DEMAND UPON TRASPORATION.

Proposed measures to reduce or respond to such demand(s) are:

GROWTH WILL BE GUIDED BY WHATCOM COUNTY AND THE CITY OF BELLINHAM COMPREHENSIVE PLAN AND COMMUNITY PLANNING. UTILITIES AND SERVICES MAY BE EXTEDNED AND EXPANDED TO MEET THESE PROJECTED NEEDS

7 Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.

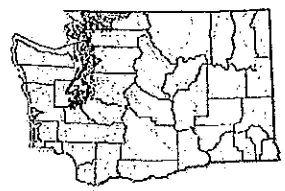
THE 2007 COMPREHENSIEVE SEWER PLAN DOES NOT CONFLICT WITH ANY KNOWN ENVIROMENTAL LAWS. PORTIONS OF SOME OF THE PROJECTS MAY REQUIRE A UTLITY EXCEPTION FOR MINOR VARIANCES TO PORTIONS OF THE SESITIVE ARES ORDINANCE. DEVELOPMENT AND GROTH WHICH MAY FOLLOW WILL BE IN ACORDANCE WITH THE ENVIROMENTAL RESTIRCTION, AS WLL AS COUNTY AND CITY PLANNING GUIDELINES.

Appendix B

AGENCY COMMENT LETTERS

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Bellingham Field Office • 1440 10th Street, Ste 102 • Bellingham, WA 98225
(360) 715-5200 • FAX (360) 715-5225

August 20, 2008



Your address is in the **Nooksack** watershed

Geoff Smyth
Public Works Superintendent – Operations
City of Bellingham
2221 Pacific Street
Bellingham, WA 98229

Subject: City of Bellingham Comprehensive Sewer Plan

Dear Mr. Smyth:

In accordance with RCW 90.48.110 and Chapter 173.240 WAC, and on behalf of the Department of Ecology (Ecology), the subject documents received in our office August 15, 2008, are hereby APPROVED. One copy of the approved document is enclosed for your project records.

Please provide prompt notification to Ecology of any proposed changes or revisions to the approved documents. Any such changes or revisions need to be issued in the form of addenda, technical appendices or supplemental reports to the original, approved documents. As a reminder, revisions must be approved in writing by Ecology before submitting plans and specifications for the proposed facilities to Ecology for review and approval.

Please note that Ecology's review and approval authority is limited to assuring compliance and consistency with the appropriate rules, regulations, guidelines, planning and design criteria, and/or other similar documents. You, as manager, and your engineer retain full responsibility for the technical completeness, accuracy and adequacy of this document. You will also be responsible for obtaining other required permits and approvals and for compliance with environmental laws and regulations during the design, construction and operation of the proposed facilities. This approval does not relieve City of Bellingham, or the design engineer, from the responsibility for the technical adequacy or accuracy of the content of the above referenced document.

Nothing in this approval shall be construed as satisfying other applicable federal, state or local statutes, ordinances or regulations.

If you have any questions or need any additional information please contact Steve Hood, Water Quality Engineer, at (360) 715-5211.

Sincerely,

Richard M. Grout
Manager

RG:sh

Enclosure: Approved Comprehensive Sewer Plan

cc: James P. Hagstrom, P.E.
Brian R. Matson, P.E.
BFO Reading File
BFO Central File

carollo

Engineers...Working Wonders With Water™

August 15, 2008
7489A.00

Washington Department of Ecology
1440 10th Street, Suite 102
Bellingham, WA 98225-7028

Attention: Steven L. Hood, P.E.

Subject: City of Bellingham Comprehensive Sewer Plan

Dear Mr. Hood:

On behalf of the City of Bellingham (City), we are pleased to submit the Final Comprehensive Sewer Plan (Plan) for your review and approval.

In summary, a SEPA Determination of Nonsignificance was issued on October 18, 2007 by the City Planning and Community Development Department. No public comments were received. A copy of the Determination and Checklist is included in Appendix A. Agency comments were received by both Department of Ecology and Department of Health. These comments and our responses are included in Appendix B.

The attached log summarizes the City's response to Agency comments, and documents modifications made to the Plan. The Agency comments are summarized as follows:

1.) Department of Ecology (DOE) Email received November 20, 2007
- Comments included on Response Log. Modifications made to text, figures, and tables within Chapters 2, 5, 6, 7, 10, and 11. Modification of Appendices F and J, Update of Appendix G and Incorporation of Model in Appendix I.

2.) Department of Ecology (DOE) Letter dated April 4,2008
- Comments included on Response Log. Modifications made to text, figures, and tables within Chapters 2, 6, 7, 10, and 11.

3.) Department of Health (DOH) Letter dated March 7,2008
- Comments included on Response Log. Modifications made to text, figures, and tables within Chapters 2, 4, 5, 6, 7 and 9.

Additionally, during the City Council Approval of the Agency Review Draft, City Staff received comments from Council members. Chapter 12, Financial Analysis was modified, as the City approved new rates and charges in December 2007, prior to the Plan Adoption. A new Chapter 12 has been included in the Final Plan.

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P. 206.684.6532 F. 206.903.0419
carollo.com

We believe these revisions adequately address all Agency Comments. Please contact the City or Carollo Engineers if you wish to discuss these items in more detail.

Sincerely,

CAROLLO ENGINEERS, P.C.

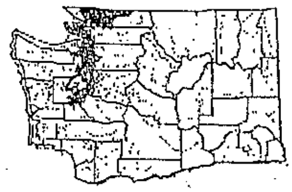
Brian Matson, P. E.
Project Manager

BRM:jnl

cc: City of Bellingham
File

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Bellingham Field Office • 1440 10th Street, Ste 102 • Bellingham, WA 98225
(360) 715-5200 • FAX (360) 715-5225

April 4, 2008



Your address is in the **Nooksack** watershed

Geoff Smyth
Public Works Superintendent, Operations
2221 Pacific Street
Bellingham, WA 98229

Subject: City of Bellingham Comprehensive Sewer Plan

Dear Mr. Smyth:

The draft of City of Bellingham Comprehensive Sewer Plan (Plan) received January 10, 2008, is still being reviewed. We need to extend the review period to gather more information to assess:

- Your compliance with the non-exceedence of the base line for your Combined Sewer Overflow.
- Confirmation that none of the planned improvements are outside of designated UGAs.

As soon as those issues are addressed we can take action on your plan. By this notice we are extending our deadline to July 8, 2008, but anticipate taking action soon after the additional information is provided.

If you have any questions or need any additional information, please contact Steve Hood, Water Quality Engineer, at (360) 715-5211.

Sincerely,

Richard M. Grout, Manager by Douglas R. Allen

Richard M. Grout
Manager

RG:sh:la

cc: BFO Reading File
BFO Central File, 1-C-B-SB-**-McKenzie Ave, 200-G-W
Sam Shipp, P.E.

carollo
Engineers...Working Wonders With Water™

June 9, 2008
7489A.00

Washington Department of Ecology
1440 10th Street, Suite 102
Bellingham, WA 98225-7028

Attention: Steven L. Hood, P.E.

Subject: City of Bellingham Comprehensive Sewer Plan

Dear Mr. Hood:

We are writing on behalf of the City of Bellingham (City) to respond to a Department of Ecology (DOE) letter dated April 4, 2008 regarding the City's Agency Review Draft Comprehensive Sewer Plan (Plan). In this letter DOE requested more information to asses the following:

- Item 1 - Compliance with the non-exceedence of the base line for Combined Sewer Overflow (CSO).
- Item 2 - Confirmation that none of the planned improvements are outside of designated Urban Growth Areas (UGAs).

Pursuant to your letter request and our April 18, 2008 meeting with you to discuss these items, we have performed additional analyses and made modifications to the Plan. A description of the changes is summarized below.

Item 1 - Compliance with the non-exceedence of the base line CSO volume

The Long Term Simulation (LTS) model used to establish base line CSO frequency was run to predict base line volume. The model predicts a base line CSO volume of 1.2 million gallons (MG) per year under current system conditions, calculated by totalizing the volume of CSO that was predicted to occur over the rainfall record, and dividing that total by the number of years in the record (59 years). The Plan will be modified to include this volume as the base line condition.

The LTS model was then updated to reflect the revised service area for planning (see Item 2). Without storage or other peak flow reduction improvements, the model predicts that base line frequency and volume will be exceeded in the near term. The updated LTS model was then run with a number of storage scenarios. Modeling the system with a 1.7 MG peak flow storage facility yields the following annual CSO volume estimates:

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carollo.com

Table 1 - Predicted Annual CSO Volume	
Year	Predicted Volume (MG)
2006	0.5
2016	1.3
2026	2.5

The updated modeling shows that constructing a 1.7 MG peak flow storage facility will control CSOs to an average of one event per year through 2026, and will limit CSOs to their base line volume through year 2016 (within the margin of the model's error). The modeling also shows that further improvements will be needed to control CSO volume to base line levels beyond year 2016.

The City currently funds an ongoing infiltration and inflow (I/I) reduction program with the goal of controlling or reducing overall system I/I. A preliminary analysis of the "leakiest" sub-basins (approximately 2,800 acres, or 15 percent of the existing system that exhibit the highest measured response to rainfall) was conducted to determine the level of I/I reduction required to provide the necessary level of future CSO volume control. Based on measured reductions in other collection systems that have undergone substantial rehabilitation, a 60 percent reduction in rainfall response may be expected in sub-basins with high I/I. The LTS model was run under year 2026 conditions assuming a 60 percent reduction in these sub-basins. The model predicted that the combination of 1.7 MG of peak flow storage and targeted I/I reduction in 15 percent of the City's collection system will control CSO volume to base line levels through the year 2026.

This analysis demonstrates that combined improvements to the collection system implemented over time will effectively control CSOs to their base line levels. The Comprehensive Sewer Plan will be revised to reflect this analysis, and will include the following recommendations:

1. A phased approach is recommended to control CSOs to base line levels.
2. One element of the City's phased CSO control strategy is storage. A 1.7 MG peak flow storage facility is recommended in the initial phase, to control CSO frequency to an average of 1 event per year over the long term, and control CSO volume to base line levels through the year 2016.
3. The City's ongoing I/I rehabilitation and reduction program will be identified in the Comprehensive Sewer Plan. The financial analysis presented in the Plan will reflect an annual expenditure of up to one percent of the value of the system, currently estimated at $1 million per year, that is dedicated to removing I/I from the system.
4. The City will conduct future flow monitoring and collection system analyses to evaluate the technical feasibility and cost effectiveness of future CSO control improvements, including I/I

reduction. The cost of additional flow monitoring and CSO control analyses will be included as a line item in the CIP.

Item 2 - Confirmation of planned sewer service within the designated UGS

The City has revised the service area boundaries to reflect the City's resolution supporting Whatcom County's proposed revisions to the UGA boundary. If any changes to Bellingham's Comprehensive Plan or development regulations are required as a result of the County's final decisions on the City's UGA, the City will consider those changes after the County's decision has been adopted and determined to be compliant with the State Growth Management Act. The City will consider those amendments as part of the annual review of its Comprehensive Plan in the year following final adoption or as otherwise permitted under the Growth Management Act.

We believe these revisions will address the items you have raised, and allow you to take action on the Plan. In addition to this letter we will be providing you with a summary of the City's responses to your original comments on the Plan, received on November 19, 2007.

Please contact the City or Carollo Engineers if you wish to discuss these items in more detail.

Sincerely,

CAROLLO ENGINEERS, P.C.

Brian Matson, P. E.
Project Manager

BRM:jnl

cc: City of Bellingham
File

Engineers...Working Wonders With Water™

August 15, 2008
7489A.00

Washington Department of Health
1500 West Fourth Avenue, Suite 403
Spokane, WA 99204-1656

Attention: Craig Riley, P.E.

Subject: City of Bellingham Comprehensive Sewer Plan
DOH Project #: R07-31, Initial Plan Review

Dear Mr. Riley:

We are writing on behalf of the City of Bellingham (City) to respond to a Department of Health letter to the City of Bellingham dated March 7, 2008. Responses to your comments included in this letter are summarized below.

1. The Plan must be stamped and signed by a professional Engineer currently licensed in the State of Washington.

   Response:
   The Final document will be stamped and signed by a licensed Washington Professional Engineer.

2. Provide some explanation for the high ADWF in 2004. Was that spike caused entirely by the large 3-day storm?

   Response:
   The high ADWF in 2004 was caused by an abnormal precipitation event in that year. Comment addressed in Chapter 4 text.

3. Please explain the significance of 2005 projected flows (Table 4.8) compared to 2005 actual effluent flows (Table 4.1)?

   Response:
   As identified by Note 1. in Table 4.8, 2005 flows presented in the Table were calculated by applying the projected growth rate in flow to the 2003 base flows. Minor differences in the measured versus projected 2005 flows does not affect subsequent analysis of capacity limitations. Comment addressed in Chapter 4 text.

4. Please provide the details describing how the Average Dry Weather Flows for 2016 and 2026 in Table 4.8 were derived, and an explanation of why the various peaking flows do not correspond with the ADWFs times the peaking factors in Table 4.2.

   <u>*Response:*</u>
   The first paragraph under Section 4.5.1 describes the approach used to project ADWF for the years 2016 and 2026. The second paragraph notes that the projected peak day and peak hour flows (PDF and PIF) were derived from the hydraulic model and were not calculated by the peaking factors in Table 4.2. Differences in these future peak values are expected, as the model predicts future peak flows based on the expanded system's response to rainfall.

5. Please complete Table 5.4 (Existing Sewage Pump Station Summary), clarify the status of the comments (planned improvements or City/Plan recommendations).

   <u>*Response:*</u>
   Table 5.4 has been updated to reflect the status of these facilities based on discussions with City Staff.

6. Please include more current data or explain why the existing WWTP performance data and curves do not include information since 2003.

   <u>*Response:*</u>
   More recent data has been included in Chapter 9, extending the analysis to April 2007.

7. The Plan must include a discussion of water reclamation opportunities.

   <u>*Response:*</u>
   The City is currently preparing their Water System Plan. The draft Water System Plan identifies "Recycling/Reuse" as a Water Conservation Program measure. However, at this time, no program specifics are identified in the draft Water System Plan. As the plan is finalized, the sewer utility will assist the water utility implement water reclamation opportunities, as defined in the final Water System Plan. Section 2.3 of the plan will be modified to include the summary above.

8. Please provide information regarding the current status of the CSO project, and the City's efforts to address I/I issues.

   <u>*Response:*</u>
   Chapters 6 and 7 of the Sewer Comprehensive Plan are being modified to include a discussion of the City's past efforts to separate storm water and reduce I/I, and will address future projects in the CIP (including the annual budget for line rehabilitation and

a more comprehensive I/I Study) to further reduce peak flows through collection system improvements.

Please contact the City or Carollo Engineers if you wish to discuss these items in more detail.

Sincerely,

CAROLLO ENGINEERS, P.C.

Brian Matson, P. E.
Project Manager

BRM:jnl

cc: Geoff Smyth, City of Bellingham
Steve Hood, WA Dept. of Ecology, NWRO/Bellingham Field Office
File

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
OFFICE OF SHELLFISH AND WATER PROTECTION
1500 West Fourth Ave • Suite 403 • Spokane, Washington 99204-1656
(509) 456-4431 • Fax (509) 456-3127

March 7, 2008

Mr. Sam Shipp, P.E.
City of Bellingham
Department of Public Works
210 Lottie Street
Bellingham, WA 98225

Dear Mr. Shipp:

RE: City of Bellingham, Whatcom County, Comprehensive Sewer Plan,
DOH Project #: R07-31, Initial Plan Review

We have completed our initial review of the City's Comprehensive Sewer Plan received in our office on November 5, 2007 for conformance with the requirements of WAC 246-271-PUBLIC SEWAGE.

1. The Plan must be stamped and signed by a professional engineer currently licensed in the State of Washington
2. Provide some explanation for the high ADWF in 2004. Was that spike caused entirely by the large 3 day storm?
3. Please explain the significance of 2005 projected flows (Table 4.8) compared to 2005 actual effluent flows (Table 4.1)
4. Please provide the details describing how the Average Dry Weather Flows for 2016 and 2026 in Table 4.8 were derived, and an explanation of why the various peaking flows do not correspond with the ADWFs times the peaking factors in Table 4.2.
5. Please complete table 5.4 (Existing Sewage Pump Station Summary), clarify the status of the comments (planned improvements or City / Plan recommendations).
6. Please include more current data or explain why the existing WWTP performance data and curves do not include information since 2003.
7. The Plan must include a discussion of water reclamation opportunities.
8. Please provide information regarding the current status of the CSO project, and the City's efforts to address I/I issues.

We appreciate the opportunity to review this plan and provide input. If you have any questions, please feel free to contact me at (509) 456-2466 or by email at craig.riley@doh.wa.gov.

Sincerely,

Craig L. Riley

Craig L. Riley, P.E.

cc: Whatcom County Health Department
Carollo Engineers, Seattle
Steve Hood, WA Dept. of Ecology, NWRO/Bellingham Field Office
John Thielemann, WA Dept. of Health, NWRO, Kent

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
OFFICE OF SHELLFISH AND WATER PROTECTION
1500 West Fourth Ave • Suite 403 • Spokane, Washington 99204-1656
(509) 456-4431 • Fax (509) 456-3127

RECEIVED
JAN 10 2008
Carollo Engineers
Seattle, WA

January 7, 2008

Dick McKinley
Public Works Director
City of Bellingham
210 Lottie Street
Bellingham, WA 98225

Subject: City of Bellingham: General Sewer Plan, Whatcom County — DOH Project No. R07-031

Dear Mr. McKinley:

The documents for the above project were received in this office November 6, 2007, and are now in the review process. RCW 43.208.020 authorizes fees for services for the review of engineering plans, reports, and construction documents. A fee will be charged for the review and approval of your engineering documents. You will receive an invoice for payment upon completion of review and approval of the documents. Payment is due at that time. The fee is based on the time required to complete the review at a flat hourly rate which is currently $99.00 per hour, but is subject to change.

This letter serves as official notice that penalties may be imposed if construction of any facilities that are the subject of these documents begins prior to receiving all required approvals under Chapter 246-271 WAC. The utility may be required to expose system components for DOH inspection at your expense. The Department is under no obligation to accept or approve any component installed or constructed prior to approval.

This project has been assigned a unique DOH Project number, which is shown above. Please use this project number on future correspondence or submittals pertaining to this project. If you have any questions, please feel free to contact me at (509) 456-2466 or by email at craig.riley@doh.wa.gov.

Sincerely,

Craig L. Riley

Craig L. Riley, P.E.
Water Reclamation & Reuse Program
Environmental Health Division

cc: Whatcom County Health Department
Carollo Engineers - Seattle
Steve Hood, P.E., Ecology , Bellingham Field Office
Jim McCauley, P.E., Ecology Headquarters
John Thielmann, P.E., DOH Regional Engineer

Carollo

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August 15, 2008
7489A.00

Washington Department of Health
1500 West Fourth Avenue, Suite 403
Spokane, WA 99204-1656

Attention: Craig Riley, P.E.

Subject: City of Bellingham Comprehensive Sewer Plan
DOH Project #: R07-31, Initial Plan Review

Dear Mr. Riley:

We are writing on behalf of the City of Bellingham (City) to respond to a Department of Health letter to the City of Bellingham dated March 7, 2008. Responses to your comments included in this letter are summarized below.

1. The Plan must be stamped and signed by a professional Engineer currently licensed in the State of Washington.

   Response:
   The Final document will be stamped and signed by a licensed Washington Professional Engineer.

2. Provide some explanation for the high ADWF in 2004. Was that spike caused entirely by the large 3-day storm?

   Response:
   The high ADWF in 2004 was caused by an abnormal precipitation event in that year. Comment addressed in Chapter 4 text.

3. Please explain the significance of 2005 projected flows (Table 4.8) compared to 2005 actual effluent flows (Table 4.1)?

   Response:
   As identified by Note 1. in Table 4.8, 2005 flows presented in the Table were calculated by applying the projected growth rate in flow to the 2003 base flows. Minor differences in the measured versus projected 2005 flows does not affect subsequent analysis of capacity limitations. Comment addressed in Chapter 4 text.

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4. Please provide the details describing how the Average Dry Weather Flows for 2016 and 2026 in Table 4.8 were derived, and an explanation of why the various peaking flows do not correspond with the ADWFs times the peaking factors in Table 4.2.

   <u>Response:</u>
   The first paragraph under Section 4.5.1 describes the approach used to project ADWF for the years 2016 and 2026. The second paragraph notes that the projected peak day and peak hour flows (PDF and PIF) were derived from the hydraulic model and were not calculated by the peaking factors in Table 4.2. Differences in these future peak values are expected, as the model predicts future peak flows based on the expanded system's response to rainfall.

5. Please complete Table 5.4 (Existing Sewage Pump Station Summary), clarify the status of the comments (planned improvements or City/Plan recommendations).

   <u>Response:</u>
   Table 5.4 has been updated to reflect the status of these facilities based on discussions with City Staff.

6. Please include more current data or explain why the existing WWTP performance data and curves do not include information since 2003.

   <u>Response:</u>
   More recent data has been included in Chapter 9, extending the analysis to April 2007.

7. The Plan must include a discussion of water reclamation opportunities.

   <u>Response:</u>
   The City is currently preparing their Water System Plan. The draft Water System Plan identifies "Recycling/Reuse" as a Water Conservation Program measure. However, at this time, no program specifics are identified in the draft Water System Plan. As the plan is finalized, the sewer utility will assist the water utility implement water reclamation opportunities, as defined in the final Water System Plan. Section 2.3 of the plan will be modified to include the summary above.

8. Please provide information regarding the current status of the CSO project, and the City's efforts to address I/I issues.

   <u>Response:</u>
   Chapters 6 and 7 of the Sewer Comprehensive Plan are being modified to include a discussion of the City's past efforts to separate storm water and reduce I/I, and will address future projects in the CIP (including the annual budget for line rehabilitation and

a more comprehensive I/I Study) to further reduce peak flows through collection system improvements.

Please contact the City or Carollo Engineers if you wish to discuss these items in more detail.

Sincerely,

CAROLLO ENGINEERS, P.C.

Brian Matson, P. E.
Project Manager

BRM:jnl

cc: Geoff Smyth, City of Bellingham
Steve Hood, WA Dept. of Ecology, NWRO/Bellingham Field Office
File

COMMENT RESPONSE LOG

ID	Agency	Agency Comment	City Response
A	Department of Ecology - April 4, 2008	Your compliance with the non-exceedence of the base line for your Combined Sewer Overflow.	The Comprehensive Sewer Plan Chapters 6, 7, 10 and 11 will be revised to reflect comments summarized in June 9, 2008 Carollo letter to Department of Ecology.
B	Department of Ecology - April 4, 2008	Confirmation that none of the planned improvements are outside of designated UGAs.	The City has revised the service area boundaries to reflect the City's resolution supporting Whatcom County's proposed revisions to the UGA boundary. Modifications to Chapter 2 and Figure 2.2 and other associated figures.
C	Department of Health - March 7, 2008	The Plan must be stamped and signed by a professional engineer currently licensed in the State of Washington.	The Final document will be stamped and signed by a licensed Washington professional Engineer.
D	Department of Health - March 7, 2008	Provide some explanation for the high ADWF in 2004. Was that spike caused entirely by the large 3 day storm?	The high ADWF in 2004 was caused by an abnormal precipitation event in that year. Chapter 4, section 4.3.1 modified.
E	Department of Health - March 7, 2008	Please explain the significance of 2005 projected flows (Table 4.8) compared to 2005 actual effluent flows (Table 4.1)?	The first paragraph under Section 4.5.1 describes the approach used to project ADWF for the years 2016 and 2026. The second paragraph notes that the projected peak day and peak hour flows (PDF and PHF) were derived from the hydraulic model and were not calculated by the peaking factors in Table 4.2. Differences in these future peak values are expected, as the model predicts future peak flows based on the expanded system's response to rainfall. Chapter 4, Table 4.8 modified.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment	City Response
F	Department of Health - March 7, 2008	Please provide the details describing how the Average Dry Weather Flows for 2016 and 2026 in Table 4.8 were derived, and an explanation of why the various peaking flows do not correspond with the ADWFs times the peaking factors in Table 4.2.	The first paragraph under Section 4.5.1 describes the approach used to project ADWF for the years 2016 and 2026. The second paragraph notes that the projected peak day and peak hour flows (PDF and PAF) were derived from the hydraulic model and were not calculated by the peaking factors in Table 4.2. Differences in these future peak values are expected, as the model predicts future peak flows based on the expanded system's response to rainfall. No changes to plan proposed.
G	Department of Health - March 7, 2008	Please complete Table 5.4 (Existing Sewage Pump Station Summary), clarify the status of the comments (planned improvements of City/Plan recommendations).	Table 5.4 modified in Plan.
H	Department of Health - March 7, 2008	Please include more current data or explain why the existing WWTP performance and curves do not include information since 2003.	City has provided data that are more recent. New data has been included in Chapter 9, extending the analysis to April 2007.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment	City Response
I	Department of Health - March 7, 2008	The Plan must include a discussion of water reclamation opportunities.	The City is currently preparing their Water System Plan. The draft Water System Plan identifies "Recycling/Reuse" as a Water Conservation Program measure. However, at this time, no program specifics are identified in the draft Water System Plan. As the plan is finalized, the sewer utility will assist the water utility to implement water reclamation opportunities, as defined in the final Water System Plan. Section 2.3 of the plan will be modified, as summarized above.
J	Department of Health - March 7, 2008	Please provide information regarding the current status of the CSO project, and the City's efforts to address I/I issues.	Chapters 6 and 7 of the Sewer Comprehensive Plan are being modified to include a discussion of the City's past efforts to separate storm water and reduce I/I, and will address future projects in the CIP (including the annual budget for line rehabilitation and a more comprehensive I/I Study) to further reduce peak flows through collection system improvements.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
K	Department of Ecology - November 2007	(1) All general sewer plans required of any governmental agency prior to providing sewer service are "plans" within the requirements of RCW 90.48.110. Three copies of the proposed general sewer plan and each amendment to it shall be submitted to and approved by the department prior to its implementation.	Two must be hard copy. One may be in the format of PDF on disc.	Two hard copy and one electronic (PDF) copy to the Final Plan will be submitted to DOE.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
L	Department of Ecology - November 2007	(2) The general sewer plan shall be sufficiently complete so that engineering reports can be developed from it without substantial alterations of concept and basic considerations.		No Modifications.
M	Department of Ecology - November 2007	(3) The general sewer plan shall include the following information together with any other relevant data as requested by the department. To satisfy the requirements of the local government jurisdiction, additional information may be necessary.	See (a) through (n)	Summarized below
N	Department of Ecology - November 2007	(3) (a) The purpose and need for the proposed plan.	OK – See Section 1.1	No Modifications.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
O	Department of Ecology - November 2007	(3) (b) A discussion of who will own, operate, and maintain the system(s).	Own and Operate in Section 1.6 Need to add Maintain	See Section 8.6, which covers maintenance of the collection and treatment systems. No modifications to Plan.
P	Department of Ecology - November 2007	(3) (c) The existing and proposed service boundaries.		No Modifications.
Q	Department of Ecology - November 2007	(3) (d) Layout map including the following:		No Modifications.
R	Department of Ecology - November 2007	(3) (d) (i) Boundaries. The boundary lines of the municipality or special district to be sewered, including a vicinity map;	Vicinity Map – Fig 1.1 Existing Boundary Fig 2.1 Future Boundary Figure 2.2 – Problem incorporates area not in UGA. Ecology cannot approve a plan not in compliance with GMA. Plan can be amended if area is in UGA in future. City may want to incorporate flow from future area in capacity analysis but cannot show as future boundary.	The City has revised the service area boundaries to reflect the City's resolution supporting Whatcom County's proposed revisions to the UGA boundary. Modification to Chapter 2, and Figure 2.2.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
S	Department of Ecology - November 2007	(3) (d) (ii) Existing sewers. The location, size, slope, capacity, direction of flow of all existing trunk sewers, and the boundaries of the areas served by each;	Detail of figure 5.2 does not allow determination of what is trunk sewer. (see orange book defn). 5.3 legend implies that some trunks may be less than 8" Combination of 8" with less than 8" on both 5.2 and 5.3 prevents using maps to determine compliance with Orange book C1-4.1 no sewer less than 8" Slope, capacity and direction of flow not shown	Chapter 5, Section 5.2.2 modified. See Revised Figure 5.2 depicts the extent of the collection system. See revised Figure 5.3 that depicts the existing trunk and interceptor sewers. See additional Table 5.3 showing trunk/interceptor size, slope, and capacity data. A soft copy of the collection system model will be included with the Comprehensive Plan Appendix I.
T	Department of Ecology - November 2007	(3) (d) (iii) Proposed sewers. The location, size, slope, capacity, direction of flow of all proposed trunk sewers, and the boundaries of the areas to be served by each;	Not shown?	See revised Figure 7.6 shows the locations and flow direction of the proposed sewers. In Appendix J, see revised Table J.4, includes the slope and capacity data.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
U	Department of Ecology - November 2007	(3) (d) (iv) Existing and proposed pump stations and force mains. The location of all existing and proposed pumping stations and force mains, designated to distinguish between those existing and proposed;	Not shown? Pump stations described in section 5.2.3 and table 5.4 but no reference to map. Force mains inventoried in table 5.2 but not mapped. Future pump station mentioned in section 7.2.2 but not mapped?	See revised Figure 5.2 that shows existing and proposed location of pump stations and force mains.
V	Department of Ecology - November 2007	(3) (d) (v) Topography and elevations. Topography showing pertinent ground elevations and surface drainage shall be shown, as well as proposed and existing streets;	Existing streets in Figure 5.2 and 5.3 Not shown Topography, surface drainage	See revised Figure 5.1 that includes topography.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
W	Department of Ecology - November 2007	(3) (d) (vi) Streams, lakes, and other bodies of water. The location and direction of flow of major streams, the high and low elevations of water surfaces at sewer outlets, and controlled overflows, if any. All existing and potential discharge locations should be noted; and	Most can be covered with existing plus topography. Need elevation information for C street CSO compared to surface water elevations. Location of CSO	See revised Section 5.2.4 that indicates elevation of C Street CSO weir.
X	Department of Ecology - November 2007	(3) (d) (vii) Water systems. The location of wells or other sources of water supply, water storage reservoirs and treatment plants, and water transmission facilities.	Missing? Purveyor areas shown but not wells, storage reservoirs or treatment plants nor Transmission facilities.	See revised Section 2.3 and revised Figure 2.3, modified to include the City's Water System Facilities as included in the City's Comprehensive Water System Plan.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
Y	Department of Ecology - November 2007	(3) (e) The population trend as indicated by available records, and the estimated future population for the stated design period. Briefly describe the method used to determine future population trends and the concurrence of any applicable local or regional planning agencies.	OK – see section 3	No Modifications.
Z	Department of Ecology - November 2007	(3) (f) Any existing domestic and/or industrial wastewater facilities within twenty miles of the general plan area and within the same topographical drainage basin containing the general plan area.	OK covered in Section 2.3	No Modifications.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
1	Department of Ecology - November 2007	(3) (g) A discussion of any infiltration and inflow problems. Also a discussion of actions which will alleviate these problems in the future.	Missing? Discussion on CSO and control but does not address I/I adequacy in non CSO basins.	Chapter 6, 7, 10, and 11 of plan will be modified to include discussion of past and ongoing projects to reduce peak flows. Recommended phased approach to CSO control.
2	Department of Ecology - November 2007	(3) (h) A statement regarding provisions for treatment and discussion of the adequacy of such treatment.	OK – Section 8	No Modification
3	Department of Ecology - November 2007	(3) (i) List of all establishments producing industrial wastewater, the quantity of wastewater and periods of production, and the character of such industrial wastewater insofar as it may affect the sewer system or treatment plant. Consideration shall be given to future industrial expansion.	Listed in Appendix I No quantity, quality, periods of production character etc.	Information will be added to the Plan. Appendix G modified.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
4	Department of Ecology - November 2007	(3) (j) Discussion of the location of all existing private and public wells, or other sources of water supply, and distribution structures as they are related to both existing and proposed domestic wastewater treatment facilities.	Water purveyors shown in figure 2.3 but not wells or other sources, or distribution structures Could be addressed by showing outfall, alternate outfall, CSO outfall and noting all no sources affected by domestic wastewater treatment facilities.	See response to (3)(d)(vii), Figure 2.3 modified to show number and general location of water facilities to demonstrate no impact. Lake Whatcom as a source of water supply was added to Plan.
5	Department of Ecology - November 2007	(3) (k) Discussion of the various alternatives evaluated, and a determination of the alternative chosen, if applicable.	Does not address compliance with maintaining CSO volume below baseline volume.	Plan will be modified to establish baseline annual condition. Future level of CSO control will be compared to the baseline.

COMMENT RESPONSE LOG

ID	Agency	Agency Comment		City Response
6	Department of Ecology - November 2007	(3) (l) A discussion, including a table, which shows the cost per service in terms of both debt service and operation and maintenance costs, of all facilities (existing and proposed) during the planning period.	OK chapter 12	No Modification.
7	Department of Ecology - November 2007	(3) (m) A statement regarding compliance with any adopted water quality management plan pursuant to the Federal Water Pollution Control Act as amended.	CSO controls are addressed but do not reference baseline volume from CSO plan and compliance with requirements to not exceed baseline volume. Frequency addressed	Plan will be modified to establish baseline annual condition. Future level of CSO control will be compared to the baseline.
8	Department of Ecology - November 2007	(3) (n) A statement regarding compliance with the State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA), if applicable		Included in Appendix A.

From: Lara Kammereck
To: Brian Matson; SShipp@cob.org
Subject: RE: Comments on Draft Comp Plan

>>> <SShipp@cob.org> 11/20/2007 3:16 PM >>>

Steve Hood from DOE had some comments that I have attached. They came in yesterday afternoon.

DOE COMMENTS-
This checklist doesn't directly address GMA because WAC 173-240-050 was written long before there was GMA. But you will see that the future boundary is constrained. I think you population estimates are consistent with GMA and if you use them to estimate capacity issues but place some of that population outside the UGA boundary because the and county haven't agreed on where the population will land that isn't' a deal breaker.

CC: Geoffery Smyth; Jim Hagstrom; rmckinley@cob.org

Project:

WAC 173–240–050 General sewer plan.

Citation	Acceptable information N/A Deficiency comment
(1) All general sewer plans required of any governmental agency prior to providing sewer service are "plans" within the requirements of RCW 90.48.110. Three copies of the proposed general sewer plan and each amendment to it shall be submitted to and approved by the department prior to its implementation.	Two must be hard copy. One may be in the format of PDF on disc.
(2) The general sewer plan shall be sufficiently complete so that engineering reports can be developed from it without substantial alterations of concept and basic considerations.	
(3) The general sewer plan shall include the following information together with any other relevant data as requested by the department. To satisfy the requirements of the local government jurisdiction, additional information may be necessary.	See (a) through (n)
(3) (a) The purpose and need for the proposed plan.	OK – See Section 1.1
(3) (b) A discussion of who will own, operate, and maintain the system(s).	One and Operate in Section 1.6 Need to add Maintain
(3) (c) The existing and proposed service boundaries.	
(3) (d) Layout map including the following:	
(3) (d) (i) Boundaries. The boundary lines of the municipality or special district to be sewered, including a vicinity map;	Vicinity Map – Fig 1.1 Existing Boundry Fig 2.1 Future Boundry Figure 2.2 – Problem in corporates area not in UGA. Ecology cannot approve a plan not in compliance with GMA. Plan can be amended if area is in UGA in future. City may want to incorporate flow from future area in capacity analysis but cannot show as future boundry.

Project:

Citation	Acceptable information N/A Deficiency comment
(3) (d) (ii) Existing sewers. The location, size, slope, capacity, direction of flow of all existing trunk sewers, and the boundaries of the areas served by each;	Detail of figure 5.2 does not allow determination of what is trunk sewer. (see orange book defn). 5.3 legend implies that some trunks may be less than 8" Combination of 8" with less than 8" on both 5.2 and 5.3 prevents using maps to determine compliance with Orange book C1-4.1 no sewer less than 8" Slope, capacity and direction of flow not shown
(3) (d) (iii) Proposed sewers. The location, size, slope, capacity, direction of flow of all proposed trunk sewers, and the boundaries of the areas to be served by each;	Not shown?
(3) (d) (iv) Existing and proposed pump stations and force mains. The location of all existing and proposed pumping stations and force mains, designated to distinguish between those existing and proposed;	Not shown? Pump stations described in section 5.2.3 and table 5.4 but no reference to map. Force mains inventoried in table 5.2 but not mapped. Future pump station mentioned in section 7.2.2 but not mapped?
(3) (d) (v) Topography and elevations. Topography showing pertinent ground elevations and surface drainage shall be shown, as well as proposed and existing streets;	Existing streets in Figure 5.2 and 5.3 Not shown Topography, surface drainage
(3) (d) (vi) Streams, lakes, and other bodies of water. The location and direction of flow of major streams, the high and low elevations of water surfaces at sewer outlets, and controlled overflows, if any. All existing and potential discharge locations should be noted; and	Most can be covered with existing plus topography. Need elevation information for C street CSO compared to surface water elevations. Location of CSO
(3) (d) (vii) Water systems. The location of wells or other sources of water supply, water storage reservoirs and treatment plants, and water transmission facilities.	Missing? Purveyor areas shown but not wells, storage reservoirs or treatment plants nor Transmission facilities.
(3) (e) The population trend as indicated by available records, and the estimated future population for the stated design period. Briefly describe the method used to determine future population trends and the concurrence of any applicable local or regional planning agencies.	OK – see section 3

Project:

Citation	Acceptable information N/A Deficiency comment
(3) (f) Any existing domestic and/or industrial wastewater facilities within twenty miles of the general plan area and within the same topographical drainage basin containing the general plan area.	OK covered in Section 2.3
(3) (g) A discussion of any infiltration and inflow problems. Also a discussion of actions which will alleviate these problems in the future.	Missing? Discussion on CSO and control but does not address I/I adequacy in non CSO basins.
(3) (h) A statement regarding provisions for treatment and discussion of the adequacy of such treatment.	OK – Section 8
(3) (i) List of all establishments producing industrial wastewater, the quantity of wastewater and periods of production, and the character of such industrial wastewater insofar as it may affect the sewer system or treatment plant. Consideration shall be given to future industrial expansion.	Listed in Appendix I No quantity, quality, periods of production character etc.
(3) (j) Discussion of the location of all existing private and public wells, or other sources of water supply, and distribution structures as they are related to both existing and proposed domestic wastewater treatment facilities.	Water purveyors shown in figure 2.3 but not wells or other sources, or distribution structures Could be addressed by showing outfall, alternate outfall, CSO outfall and noting all no sources affected by domestic wastewater treatment facilities.
(3) (k) Discussion of the various alternatives evaluated, and a determination of the alternative chosen, if applicable.	Does not address compliance with maintaining CSO volume below baseline volume.
(3) (l) A discussion, including a table, which shows the cost per service in terms of both debt service and operation and maintenance costs, of all facilities (existing and proposed) during the planning period.	OK chapter 12
(3) (m) A statement regarding compliance with any adopted water quality management plan pursuant to the Federal Water Pollution Control Act as amended.	CSO controls are addressed but do not reference baseline volume from CSO plan and compliance with requirements to not exceed baseline volume. Frequency addressed
(3) (n) A statement regarding compliance with the State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA), if applicable	

Appendix C

ADOPTING RESOLUTIONS

RESOLUTION NO. 2009-18

A RESOLUTION ADOPTING THE CITY OF BELLINGHAM COMPREHENSIVE SEWER PLAN, INCLUDING DOCUMENTS, MAPS AND REFERENCED STUDIES, REPORTS AND PLANS INCLUDED THEREIN.

WHEREAS, the Washington State Department of Ecology requires updates of Sewer System Plans; and,

WHEREAS, City Council adopted a draft Sewer Comprehensive Plan by Resolution 2007-35 in December 2007, which was submitted to the Washington State Department of Ecology for review and approval; and,

WHEREAS, the Department of Ecology reviewed and approved the City's Sewer Comprehensive Plan on August 18, 2008; and,

WHEREAS, City Council has considered the updated Plan as approved by the Department of Ecology and finds it is in the City's best interests to adopt the plan as the City's final plan;

NOW THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF BELLINGHAM:

The City of Bellingham Comprehensive Sewer Plan, which is attached hereto as Exhibit A and includes all documents, maps, and studies, reports, and plans referenced therein, is hereby adopted.

PASSED by the Council this 15th day of June, 2009.

Council President

APPROVED by me this 25th day of June, 2009.

Mayor Pro Tempore

City of Bellingham
City Attorney
210 Lottie Street
Bellingham, Washington 98225
360-778-8270

ATTEST: ______________________
Finance Director

APPROVED AS TO FORM:

____
Office of the City Attorney

City of Bellingham
City Attorney
210 Lottie Street
Bellingham, Washington 98225
360-778-8270

Appendix D

SERVICE AREA AGREEMENTS

A G R E E M E N T

THIS AGREEMENT, made and executed this 13th day of February, 1974, but effective as of January 1, 1974, between the CITY OF BELLINGHAM, hereinafter called "City", and WATER DISTRICT NO. 10 OF WHATCOM COUNTY, WASHINGTON, hereinafter called "District", as authorized by proper resolutions of the governing boards of said municipal corporations, WITNESSETH:

WHEREAS, the District is operating and maintaining a Lake Whatcom South Shore sewerage system which presently discharges sewage to the City's sewerage system at Flynn Street by temporary agreement with the City; and

WHEREAS, the City presently has an interim agreement with Sudden Valley and the District providing for treatment, use of the City trunk sewers and for maintenance of the Sudden Valley and District sewer systems; and

WHEREAS, "density" charges paid by Sudden Valley users are to be refunded to the District when said interim agreement is replaced by the terms of this long term agreement; and

WHEREAS, the City agrees to receive, transport and treat sewage from the District system and dispose of the resulting effluent under the terms to be agreed upon; and

WHEREAS, the City and District agree that the sanitary sewer system proposed for construction by the District in the "Edgewater Lane" section of the Lake Whatcom North Shore Area will be operated and maintained by the City under a separate conventional Agreement for Provision of Sewer Services, or such other agreement as may be mutually established;

NOW, THEREFORE, the District and the City agree as follows:

SECTION I

PURPOSE

A. The purpose of this agreement is as follows:

1. To set forth the terms and conditions under which the City will receive sewage from the District Lake Whatcom South Shore system and the methods of charging for receiving, transporting, and treating of the District's sewage and disposing of the resulting effluent.

2. To provide a basis for the District's financial contribution towards the cost of future expansion of the City sewerage system allocable to the District.

3. To provide a basis for charging the District during the first 5-year period from the date of execution of this agreement, and for additional 5-year periods thereafter.

4. To establish the basis for identifying and distributing costs to the District.

SECTION II

GLOSSARY OF TERMS

A. For the purpose of this agreement, the following words and terms shall have the meanings as herein defined:

1. "Domestic Sewage" shall include what is commonly known as domestic and commercial sewage and shall exclude industrial wastes.

2. "Industrial Wastes" shall mean the liquid wastes from industrial manufacturing processes, trade or business as distinct from domestic sewage.

3. "Capital Costs" shall mean the total costs incurred by the City in constructing, expanding and renewing

any of its sewerage facilities used by the District including, without limitation, the following:

a. Cost of construction.

b. Engineering fees.

c. Legal fees.

d. Financial consultant fees.

e. Interest, including interest during construction and bond discount.

f. Acquisition of property and property rights, including appraisers' fees and costs of condemnation, if any.

4. "Treatment Plant" shall mean the City's sewage treatment plant which is further described herein in Section IV A.

5. "Pump Station" shall mean a sewage pump station which shall include a building or prefabricated pump station containing pumps, motors, and appurtenances installed for the purposes of lifting sewage that cannot flow by gravity to the desired location.

SECTION III

CITY TRUNK SEWER SYSTEM

A. The City agrees to accept into the City's Whatcom Creek and other connection points at or near the intersection of Flynn and Decatur Streets and at the South end of Lakeside Avenue (City Limits) domestic sewage from the District Lake Whatcom South Shore sewage system in accordance with the following terms and covenants:

1. The domestic sewage shall be delivered to the City's

Whatcom Creek Trunk Sewer at Flynn Street at a rate of flow not to exceed 2,500 gallons per minute.

2. The District agrees, upon formal request by the City, to pay the costs of purchasing and installing in the District's 10-inch-diameter interceptor sewer adjacent to the City's Whatcom Creek Trunk Sewer a sewage flow measuring device and flow recording instrument approved by the City with suitable access for its employees. City will also monitor, upon a 24 hour basis, an emergency warning system, to be installed and paid for by the District, which will alert City and District personnel of any pump stoppages or other faults which may occur or develop in the system. It is presently contemplated that this shall be of a telemetering type, but a different design may be agreed upon if deemed equally suitable by the parties hereto.

3. The District agrees to pay all costs of maintaining and replacing the flow measuring device and recording instrument. In the event the District does not maintain the equipment in operating condition, the City will perform the necessary work and charge the District therefor with addition of appropriate overhead charges.

4. The District agrees to pay an annual charge for the use of each of the City's trunk sewers conveying District sewage based upon annual depreciation of each sewer, interest at 5.5 percent of the present depreciated worth of each sewer, and a charge for operation, maintenance, administration and general costs based on 1 percent of the original cost of each sewer specified below, with the resulting total annual cost for each year allocated in the ratio of annual peak sewage flow

received from the District to the limiting capacity of each sewer.

5. Champion Street Box Culvert: With reference to CH^2M Drawing S 7895.0 - "Allocation of Trunk Sewer Use Charges";

   a. It is agreed that the 1949 cost of the Champion Street box culvert, which was constructed in the year 1908, is $56,592, and the assumed life of the facility is 75 years from the year 1949.

   b. It is agreed that the annual cost of the Champion Street box culvert for the year 1973 is $3,437.

   c. The District agrees that the allocation of costs to the District for the year 1973 shall be $3,437 multiplied by the fraction 600/3,200.

   d. The charge shall be computed annually to provide for reduction of interest on the present worth of the facility.

   e. The District agrees to pay its proportionate share of necessary improvement work on the Champion Street box culvert to enable the facility to continue serving the City and the District. Improvements to the facility for the benefit of the City, including control of City line infiltration and storm flow collection, shall be excluded from computation of charges to the District; provided, however, that when and if the City and District agree that the District shall extend the District's existing interceptor to the Treatment Plant, the District will be relieved from such payment.

   f. Should a new facility be constructed, cost will be allocated as above.

6. Whatcom Creek Trunk Sewer - Flynn Street to Nevada Street:

   a. It is agreed that the 1949 cost of the Whatcom Creek Trunk Sewer is $110,651, and the assumed life of the facility is 75 years from the year 1949.

   b. It is agreed that the annual cost of the Whatcom Creek Trunk Sewer for the year 1973 is $6,719.

   c. The District agrees that the allocation of costs to the District for the year 1973 shall be $6,719 multiplied by the fraction 600/2500.

   d. The charge shall be computed annually to provide for reduction of interest on the present worth of the facility.

   e. It is agreed that the Whatcom Creek Trunk Sewer presently has sufficient capacity to transport the projected flow of 1,900 gallons per minute of sewage from the City's existing and future customers.

   f. It is agreed that the City shall receive at Flynn Street in the existing trunk up to 600 gallons per minute of sewage flow from the District, and the City at its option may agree to receive additional sewage flow from the District when the District's requirements exceed the 600 gallons per minute if the City has available unused capacity within its projected sewage flow requirements of 1,900 gallons per minute at which time the maintenance costs allocated to the District shall be increased proportionately to the newly agreed ratio of City and District sewage flows in the line.

   g. It is agreed that the capacity of the Whatcom Creek Trunk Sewer shall be increased when the sewage flow requirements from the District exceeds the amount the

City has agreed to accept in the existing line, with said increase or increases being made in the line for the line to receive sewage flow from the District to a maximum rate of flow of 3,200 gallons per minute.

h. It is agreed that the District shall pay for all capital costs and pro-rata maintenance costs to increase the capacity of the Whatcom Creek Trunk Sewer providing the City's sewage flow requirements in the Whatcom Creek Trunk Sewer does not exceed the projected flow of 1,900 gallons per minute. In the event that the City's requirements shall exceed a sewage flow of 1,900 gallons per minute, the City shall pay a share of the capital costs based upon the ratio of the additional capacity required by the City above the presently projected 1,900 gallons per minute to the total increase in capacity resulting from the construction.

7. Sanitary sewer service shall be provided by City to the Flynn-Dakin, Dakin-Van Horn, and Van Horn-Academy areas, set forth in that map which is hereto attached, by separate contracts between the City and the District, each entitled "Agreement for Provision of Sewer Services".

B. By means of the terms of this contract, the City will provide trunk sewer capacity for the District, including the area known as Sudden Valley, upon a volumetric or other total cost basis. Upon completion of such arrangements, the prior "connection" or "density" charges shall be refunded by the City to the District.

SECTION IV

TREATMENT FACILITIES

It is agreed that, for the purposes of this Agreement, the treatment facilities shall be defined as the City's sewage interceptor system downstream of point of connection with the Champion Street box culvert to the Post Point sewage treatment plant and shall include the plant, the interceptor, sewage pump station, and the outfall line to Bellingham Bay and any subsequent additions thereto or modifications thereof.

B. The City agrees, subject to the provisions of this section, to accept domestic sewage from the District at the points specified in Section III, transmit said sewage to the Post Point treatment plant and to provide for primary treatment and disposal of said sewage, all in accordance with the terms of this agreement and applicable federal, state and local regulations.

C. The District agrees to participate in the cost of any future treatment facilities serving the District constructed by the City in accordance with future federal, state, and local requirements.

D. The City agrees to receive for treatment, domestic sewage only and limited to a maximum rate of flow of 3,200 gallons per minute, as measured by flow-measuring procedures, techniques or recording devices installed on the District's sewerage system at Flynn Street and the North Shore city limits.

E. The annual charge to the District for treatment of sewage shall be calculated on a volumetric basis. The charge shall be computed annually based on actual flows measured and actual operating and maintenance costs. Pending the availability of actual costs the City's Engineers and Accountants shall provide estimated costs which shall be the temporary basis for payment. When actual costs for a continuous twelve month period become available, the total amount paid based upon said estimates shall be adjusted to said actual costs.

F. It is agreed that the amortized capital costs of the sewage treatment facilities are as follows:

Capital Cost of Treatment	$8,313,360
Land Costs	(830,000)
	$7,483,360
Legal & Administrative Costs	(214,000)
Grant Eligible Costs	$7,269,360
Government Grants (48%)	(3,489,290)
	$3,780,070
Land, Legal & Administrative Costs	1,044,000
Net Costs to be Financed	$4,824,070
Amortized at 5-1/2% for 13.6 years	$ 513,470

G. It is agreed that the estimated 1974 O & M costs of the treatment facilities are $284,730.

H. 1. It is agreed that the charge to the District for treatment of sewage shall be based on the following computation:

Estimated 1974 Annual Flow to STP	3,103 mg (8.5 mgd)
Amortized Capital Costs per mg	$165
O & M Costs per mg	$ 92
Total Charge	$257/mg
Estimated 1974 District Annual flow to STP (90,000 gpd x 365)	32.8 mg
Total Annual Charge for Treatment	$8,400/year

2. It is understood that the charge to the District for the amortized capital costs shall cease in 13.6 years.

3. It is agreed that the District shall benefit from any

additional government grants for this treatment plant or any of the other facilities covered by this agreement.

SECTION V

TERM OF CONTRACT, REVIEW AND RENEWAL

A. This agreement shall be binding upon the parties hereto, their successors and assigns, but it may be revised, not earlier than five years from the date of commencement of the rendition of services hereunder by the City, to meet changing circumstances and conditions, but shall continue in full force and effect for a period of at least twenty (20) years if the District is at all times in full performance of all terms hereof unless alternative and at least equally adequate means for the disposal of the sewage referred to herein are created or exist.

B. This agreement shall not be assigned by either party without the consent of the other.

SECTION VI

MISCELLANEOUS PROVISIONS

A. The District sewage collection system shall be built to specifications at least equivalent to the latest edition of the "Standard Specifications for Municipal Public Works Construction" as prepared and published by the Washington State Chapter, American Public Works Association, and the rules and regulations of concerned federal and state agencies. All construction shall be properly inspected during construction by District representatives to insure conformation to set standards and minimizing infiltration, exfiltration and the initial deposit of rocks, sand, and other debris. The City shall have the right to inspect the District's sewer system and to refuse to accept sewage from any portion of the system which does not conform to the standards herein established or mutually agreed to.

B. The District agrees to prohibit all storm, surface, or ground water, including, but not limited to, roof drains, downspouts and footing drains, from entering its sanitary sewer system. Adequate inspection of all building, sewer and street construction shall be provided by the District for controlling such construction to insure compliance with this provision.

C. The District agrees to maintain complete and current "as built" record drawings of the District's sewer system at all times. Included in these records shall be the location of all service connections.

D. The City agrees to operate and maintain its treatment facilities in accordance with standards established by all regulatory federal, state and local laws applicable to its operations.

SECTION VII

EFFECTIVE DATE

A. This Agreement shall take effect at 12:01 A.M., January 1, 1974.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the day and year first above written.

CITY OF BELLINGHAM

By ______________________
Mayor

FORM APPROVED

BELLINGHAM CITY ATTORNEY

ATTEST:

Finance Director

WATER DISTRICT NO. 10

By

Chairman of Commissioners

ATTEST:

Secretary of Board of Commissioners

ADDENDUM

WHEREAS, the City of Bellingham, hereinafter referred to as "City" and Water District No. 10 of Whatcom County, hereinafter called "District" have an existing contract for the provision of sewer services effective January 1, 1974 covering the District Lake Whatcom South Shore system, and

WHEREAS, the parties now desire to enter into an agreement covering the District Lake Whatcom North Shore system and replacing the agreement between the parties covering the "Edgewater Lane" are of the District, and

WHEREAS, many of the terms and conditions placed in the January 1, 1974 contract are acceptable to both parties with minor modification, and

WHEREAS, it is the intention of the parties to add certain additional terms to the January 1, 1974 agreement to cover the District Lake Whatcom North Shore system and the sewer service to Edgewater Lane,

NOW, THEREFORE, the parties agree as follows:

1. That all terms of the January 1, 1974 agreement between the parties shall be effective as if part of this agreement and the same are hereby incorporated herein, unless hereby amended.

2. The City agrees to accept a peak flow of one hundred fifty (150) gallons per minute from the District Lake Whatcom North Shore system and Edgewater Lane which is part of that system.

City of Bellingham
CITY ATTORNEY
210 Lottie Street
Bellingham, Washington 98225
Telephone (206) 676-6903

3. The District will pay charges for use of the City's trunk system based on the 150 gallons per minute flow rate or maximum peak flow whichever is the greater, which volume shall be stablsihed by meter readings. The District will pay charges for treatment based on the total annual flow as established by meter readings.

4. The City reserves and the District hereby acknowledges the right of the city to require the District to remove the 150 gallon per minute flow from the city's trunk facilities in the event that such facilities ever reach capacity flow. In such eventuality the District agrees that it will build its own sewer trunk to the Whatcom Creek trunk line or enter into a joint arrangement with the City to build such a line.

5. The District agrees to pay a pro-rata share of the costs to provide replacement facilities as needed from the District to the Whatcom Creek trunk.

6. The District agrees to assume all responsibility for the maintenance of Edgewater Lane and the parties agree that the previous agreement covering this area of the District dated the 10th day of October, 1974 is hereby rescinded.

7. A metering station similar to that used for the South Shore system shall be placed at the city limits by the District for the purpose of measuring the flow from the North Shore system.

8. The District must agree to adopt a rate structure for this system and for areas already served, which will meet the requirements of any future grants which may be obtained for treat-

City of Bellingham
CITY ATTORNEY
210 Lottie Street
Bellingham, Washington 98225
Telephone (206) 676-6903

ment or transportation of wastes by the City of Bellingham.

9. The District shall pay a pro-rata share based on flow of the costs to operate and maintain the Martin Street and North Shore pump stations based upon the following formula and upon the basis of the contribution by the District of 150 gallons per minute flow rate:

$$\frac{\text{Total City pumping costs - Oak Street cost}}{\text{Total number of stations - Oak Street}} = \text{Cost/Pump station}$$

IN WITNESS WHEREOF, the parties by their signatures below have executed this agreement this 1st day of August, 1977.

CITY OF BELLINGHAM

Mayor

Attest: D. K. Hoffman
Finance Director

Approved as to form:

Bellingham City Attorney

WATER DISTRICT NO. 10

By
Chairman of Commissioners

Attest:
Secretary of Board of Commissioners

City of Bellingham
CITY ATTORNEY
210 Lottie Street
Bellingham, Washington 98225
Telephone (206) 676-6903

Appendix E

NPDES PERMIT

Issuance Date: September 15, 2000
Effective Date: September 15, 2000
Expiration Date: June 30, 2005

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
WASTE DISCHARGE PERMIT No. WA-002374-4

State of Washington
DEPARTMENT OF ECOLOGY
Northwest Regional Office
3190 160th Avenue SE
Washington 98504-8711

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington
and
The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1251 et seq.

CITY OF BELLINGHAM
210 Lottie Street
Bellingham, Washington 98225

Plant Location: 200 McKenzie Bellingham, WA 98225	Receiving Water: Bellingham Bay
Water Body I.D. No.: 01-01-02	Discharge Location: Latitude: 48° 43' 11" N Longitude: 122° 31' 22" W
Plant Type: Pure Oxygen Activated Sludge	

is authorized to discharge in accordance with the special and general conditions that follow.

John H. Glynn
Water Quality Manager
Northwest Regional Office
Washington State Department of Ecology

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GENERAL CONDITIONS

SUMMARY OF PERMIT REPORT SUBMITTALS

Refer to the Special and General Conditions of this permit for additional submittal requirements.

Permit Section	Submittal	Frequency	First Submittal Date
S3.	Discharge Monitoring Report	Monthly	
S6.F.	Industrial User Survey (Option 1 - No existing pretreatment program)	1/permit cycle	January 31, 2005
S7.B.	Residual Solids Management Plan	1/permit cycle	
S8.A.	Acute Toxicity Characterization Data	Quarterly	March 31, 2001
S8.A.	Acute Toxicity Tests Characterizaton Summary Report	1/permit cycle	June 30, 2002
S9.A.	Chronic Toxicity Characterization Data	Quarterly	March 31, 2001
S9.A.	Chronic Toxicity Characterization Summary Report	1/permit cycle	June 30, 2002
S10.B	Combined Sewer Overflow Report	Annually	March 31, 2001
S10.C	Combined Sewer Overflow Reduction Amendment	Annually	January 31, 2005
S11.	Sediment Baseline Sampling and Analysis Plan	1/permit cycle	August 1, 2001
S11.	Sediment Chemistry Analyses	1/permit cycle	August 1, 2003
S12.	Outfall Evaluation	As necessary	
G1.	Notice of Change in Authorization	As necessary	
G7.	Application for Permit Renewal	1/permit cycle	January 31, 2005

SPECIAL CONDITIONS

S1. DISCHARGE LIMITATIONS

A. Effluent Limitations

All discharges and activities authorized by this permit shall be consistent with the terms and conditions of this permit. The discharge of any of the following pollutants more frequently than, or at a concentration in excess of, that authorized by this permit shall constitute a violation of the terms and conditions of this permit.

Beginning on the effective date of this permit and lasting through the expiration date, the Permittee is authorized to discharge municipal wastewater at the permitted location subject to the following limitations:

	EFFLUENT LIMITATIONS[a]: OUTFALL # 001	
Parameter	**Average Monthly**	**Average Weekly**
Biochemical Oxygen Demand[b] (5 day)	30 mg/L, 5004 lbs./day	45 mg/L, 7506 lbs./day
Total Suspended Solids[b]	30 mg/L, 5004 lbs./day	45 mg/L, 7506 lbs./day
Fecal Coliform Bacteria	200/100 mL	400/100 mL
pH[c]	Daily minimum is equal to or greater than 6 and the daily maximum is less than or equal to 9.	
Parameter	**Average Monthly**	**Maximum Daily[d]**
Total Residual Chlorine	198 µg/L, 33 lbs./Day	429 µg/L

[a] The average monthly and weekly effluent limitations are based on the arithmetic mean of the samples taken with the exception of fecal coliform, which is based on the geometric mean.

[b] The average monthly effluent concentration for BOD_5 and Total Suspended Solids shall not exceed 30 mg/L or 15 percent of the respective monthly average influent concentrations, whichever is more stringent except during the "wet weather" months extending from October 1st through May 31st.

[c] Indicates the range of permitted values.

[d] The maximum daily effluent limitation is defined as the highest allowable daily discharge. The daily discharge means the discharge of a pollutant measured during a calendar day. For pollutants with limitations expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged over the day. For other units of measurement, the daily discharge is the average measurement of the pollutant over the day.

B. Mixing Zone Descriptions

The maximum boundaries of the mixing zones and attainable dilution within mixing zones are defined as follows:

A zone where chronic criteria may be exceeded extends a maximum distance of 276 feet in any horizontal direction from any individual discharge port. The dilution attained within the chronic mixing zone for the critical conditions is 70:1 in the plume flowing in the direction of the current.

A zone where acute criteria may be exceeded extends a maximum distance of 27.6 feet in any direction from any individual discharge port. The dilution attained within the chronic mixing zone for the critical conditions is 33:1 in the plume flowing in the direction of the current.

S2. MONITORING REQUIREMENTS

A. Monitoring Schedule

Category	Parameter	Units	Sample Point	Minimum Sampling Frequency	Sample Type
Wastewater Influent	BOD_5	mg/l	Influent Headworks	5/week	24-hr. Comp.
"	TSS	mg/l	Influent Headworks	5/week	24-hr. Comp.
Wastewater Effluent	Flow	MGD	Influent or Effluent	7/week	Continuous
	BOD_5	mg/l	Final Effluent	5/week	24-hr. Comp.
"	TSS	mg/l	"	5/week	24-hr. Comp.
"	pH	Standard Units	"	7/week	Grab
"	Total Residual Chlorine	ug/L	"	7/week	Grab
"	Fecal Coliform	Count/100 mL	"	5/week	Grab
"	Priority Pollutant Metals [a]: Antimony Arsenic Beryllium Cadmium Chromium Copper Lead Mercury Nickel Selenium Silver Thallium Zinc	µg/L	"	1/quarter	24-hr. Comp.

Category	Parameter	Units	Sample Point	Minimum Sampling Frequency	Sample Type
"	Organics [a] Acid Extractable Base-Neutral Pesticides Polychlorinate-Biphenyles	µg/L	"	1/year	24-hr. Comp.
"	Volatile Organics[a]	µg/L	"	1/year	Grab
"	Whole Effluent Toxicity Acute & Chronic	See Sections S8. and S9.			

[a] The priority pollutant sampling shall correspond with sampling for whole effluent toxicity testing.

B. Sampling and Analytical Procedures

Samples and measurements taken to meet the requirements of this permit shall be representative of the volume and nature of the monitored parameters, including representative sampling of any unusual discharge or discharge condition, including bypasses, upsets, and maintenance-related conditions affecting effluent quality.

Sampling and analytical methods used to meet the water and wastewater monitoring requirements specified in this permit shall conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 CFR, Part 136, or to the latest revision of *Standard Methods for the Examination of Water and Wastewater* (APHA), unless otherwise specified in this permit or approved in writing by the Department of Ecology (Department).

C. Flow Measurement

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to ensure the accuracy and reliability of measurements of the quantity of monitored flows. The devices shall be installed, calibrated, and maintained to ensure that the accuracy of the measurements are consistent with the accepted industry standard for that type of device. Frequency of calibration shall be in conformance with manufacturer's recommendations and at a minimum frequency of at least one calibration per year. Calibration records shall be maintained for at least three (3) years.

D. Laboratory Accreditation

All monitoring data required by the Department shall be prepared by a laboratory registered or accredited under the provisions of, *Accreditation of Environmental Laboratories*, Chapter 173-50 WAC. Flow, temperature, settleable solids, conductivity, pH, and internal process control parameters are exempt from this requirement. Conductivity and pH shall be accredited if the laboratory must otherwise be registered or accredited. Crops, soils, and hazardous waste data are exempted from this requirement pending accreditation of laboratories for analysis of these media by the Department.

S3. REPORTING AND RECORDKEEPING REQUIREMENTS

The Permittee shall monitor and report in accordance with the following conditions. The falsification of information submitted to the Department shall constitute a violation of the terms and conditions of this permit.

A. Reporting

The first monitoring period begins on the effective date of the permit. Monitoring results shall be submitted monthly. Monitoring data obtained during the previous month shall be summarized and reported on a form provided, or otherwise approved, by the Department, and be received no later than the 15th day of the month following the completed monitoring period, unless otherwise specified in this permit. Priority pollutant analysis data shall be submitted no later than 45 days following the monitoring period. The report(s) shall be sent to the:

Department of Ecology
Northwest Regional Office
3190 - 160th Avenue SE
Bellevue, WA 98008-5452

All lab reports providing data for organic and metal parameters shall include the following information: sampling date, sample location, date of analysis, parameter name, CAS number, analytical method/number, method detection limit (MDL), lab practical quantitation limit (PQL), reporting units, and concentration detected.

Discharge Monitoring Report forms must be submitted monthly whether or not the facility was discharging. If there was no discharge or the facility was not operating during a given monitoring period, submit the form as required with the words "no discharge" entered in place of the monitoring results.

In addition to the monthly report, a monthly summary report form (EPA No. 3320-1) shall be received no later than the 15th day of the following month. This report is limited to the parameters specified in condition(s) S1.

B. Records Retention

The Permittee shall retain records of all monitoring information for a minimum of three years. Such information shall include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by the Director.

C. Recording of Results

For each measurement or sample taken, the Permittee shall record the following information: (1) the date, exact place, method, and time of sampling; (2) the individual who performed the sampling or measurement; (3) the dates the analyses were performed; (4) who performed the analyses; (5) the analytical techniques or methods used; and (6) the results of all analyses.

D. Additional Monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by this permit using test procedures specified by Condition S2. of this permit, then the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Permittee's self-monitoring reports.

E. Noncompliance Notification

In the event the Permittee is unable to comply with any of the permit terms and conditions due to any cause, the Permittee shall:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the violation, and correct the problem;
2. Repeat sampling and analysis of any violation and submit the results to the Department within thirty (30) days after becoming aware of the violation;
3. Immediately notify the Department of the failure to comply; and
4. Submit a detailed written report to the Department within thirty (30) days [five (5) days for upsets and bypasses], unless requested earlier by the Department. The report should describe the nature of the violation, corrective action taken and/or planned, steps to be taken to prevent a recurrence, results of the resampling, and any other pertinent information.

Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

F. Reporting - Shellfish Protection

Unauthorized discharges such as collection system overflows, plant bypasses, or failure of the disinfection system, shall be reported immediately to the Department of Ecology and the Department of Health, Shellfish Program. The Department of Ecology's Northwest Regional Office 24-hour number is 425-649-7000 and the Department of Health's Shellfish 24-hour number is 360-753-5992.

S4. FACILITY LOADING

A. Design Criteria

Flows or wasteloadings of the following design criteria for the permitted treatment facility shall not be exceeded:

Average flow for the maximum month:	20 MGD
BOD_5 loading for maximum month:	25,530 lbs./day
TSS loading for maximum month:	27,100 lbs./day

B. Plans for Maintaining Adequate Capacity

When the actual flow or wasteload reaches 85 percent of any one of the design criteria in S4.A. for three consecutive months, or when the projected increases would reach design capacity within five years, whichever occurs first, the Permittee shall submit to the Department, a plan and a schedule for continuing to maintain capacity at the facility sufficient to achieve the effluent limitations and other conditions of this permit. This plan shall address any of the following actions or any others necessary to meet this objective.

1. Analysis of the present design including the introduction of any process modifications that would establish the ability of the existing facility to achieve the effluent limits and other requirements of this permit at specific levels in excess of the existing design criteria specified in paragraph A above.
2. Reduction or elimination of excessive infiltration and inflow of uncontaminated ground and surface water into the sewer system.
3. Limitation on future sewer extensions or connections or additional wasteloads.
4. Modification or expansion of facilities necessary to accommodate increased flow or wasteload.
5. Reduction of industrial or commercial flows or wasteloads to allow for increasing sanitary flow or wasteload.

Engineering documents associated with the plan must meet the requirements of WAC 173-240-060, "Engineering Report," and be approved by the Department prior to any construction. The plan shall specify any contracts, ordinances, methods for financing, or other arrangements necessary to achieve this objective.

C. Notification of New or Altered Sources

The Permittee shall submit written notice to the Department whenever any new discharge or increase in volume or change in character of an existing discharge into the sewer is proposed which: (1) would interfere with the operation of, or exceed the design capacity of, any portion of the collection or treatment system; (2) is not part of an approved general sewer plan or approved plans and specifications; or would be subject to pretreatment standards under 40 CFR Part 403 and Section 307(b) of the Clean Water Act. This notice shall include an evaluation of the system's ability to adequately transport and treat the added flow and/or wasteload.

D. Wasteload Assessment

The Permittee shall conduct an assessment of their flow and wasteload and submit a report to the Department by December 31, 2004, in conjunction with their NPDES permit application. The report shall contain the following: an indication of compliance or noncompliance with the permit effluent limitations; a comparison between the existing and design monthly average dry weather and wet weather flows, peak flows, BOD, and total suspended solids loadings; and percentage annual increase in these parameters since issuance date of this permit. The report shall also state the present and design population or population equivalent, projected population growth rate, and the estimated date upon which the design capacity is projected to be reached, according to the most restrictive of the parameters above. The interval for review and reporting may be modified if the Department determines that a different frequency is sufficient.

S5. OPERATION AND MAINTENANCE

The Permittee shall at all times be responsible for the proper operation and maintenance of any facilities or systems of control installed to achieve compliance with the terms and conditions of the permit.

A. Certified Operator

An operator certified for at least a Class IV plant by the State of Washington shall be in responsible charge of the day-to-day operation of the wastewater treatment plant. An operator certified for at least a Class III plant shall be in charge during all regularly scheduled shifts.

B. O & M Program

The Permittee shall institute an adequate operation and maintenance program for their entire sewage system. Maintenance records shall be maintained on all major electrical and mechanical components of the treatment plant, as well as the sewage system and pumping stations. Such records shall clearly specify the frequency and type of maintenance recommended by the manufacturer and shall show the frequency and type of maintenance performed. These maintenance records shall be available for inspection at all times.

C. Short-term Reduction

If a Permittee contemplates a reduction in the level of treatment that would cause a violation of permit discharge limitations on a short-term basis for any reason, and such reduction cannot be avoided, the Permittee shall give written notification to the Department, if possible, thirty (30) days prior to such activities, detailing the reasons for, length of time of, and the potential effects of the reduced level of treatment. This notification does not relieve the Permittee of their obligations under this permit.

D. Electrical Power Failure

The Permittee is responsible for maintaining adequate safeguards to prevent the discharge of untreated wastes or wastes not treated in accordance with the requirements of this permit during electrical power failure at the treatment plant and/or sewage lift stations either by means of alternate power sources, standby generator, or retention of inadequately treated wastes. The Permittee shall maintain Reliability Class II (EPA 430-99-74-001) at the wastewater treatment plant, which requires primary sedimentation and disinfection.

E. Prevent Connection of Inflow

The Permittee shall strictly enforce their sewer ordinances and not allow the connection of inflow (roof drains, foundation drains, etc.) to the sanitary sewer system.

F. Bypass Procedures

The Permittee shall immediately notify the Department of any spill, overflow, or bypass from any portion of the collection or treatment system.

The bypass of wastes from any portion of the treatment system is prohibited unless one of the following conditions (1, 2, or 3) applies:

1. Unavoidable Bypass -- Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

   If the resulting bypass from any portion of the treatment system results in noncompliance with this permit, the Permittee shall notify the Department in accordance with condition S3.E "Noncompliance Notification."

2. Anticipated Bypass That Has the Potential to Violate Permit Limits or Conditions -- Bypass is authorized by an administrative order issued by the Department. The Permittee shall notify the Department at least thirty (30) days before the planned date of bypass. The notice shall contain: (1) a description of the bypass and its cause; (2) an analysis of all known alternatives which would eliminate, reduce, or mitigate the need for bypassing; (3) a cost-effectiveness analysis of alternatives including comparative resource damage assessment; (4) the minimum and maximum duration of bypass under each alternative; (5) a recommendation as to the preferred alternative for conducting the bypass; (6) the projected date of bypass initiation; (7) a statement of compliance with SEPA; (8) if a water quality criteria exceedance is unavoidable, a request for modification of water quality standards as provided for in WAC 173-201A-110, and (9) steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

For probable construction bypasses, the need to bypass is to be identified as early in the planning process as possible. The analysis required above shall be considered during preparation of the engineering report or facilities plan and plans and specifications and shall be included to the extent practical. In cases where the probable need to bypass is determined early, continued analysis is necessary up to and including the construction period in an effort to minimize or eliminate the bypass.

The Department will consider the following prior to issuing an administrative order:

a. If the bypass is necessary to perform construction or maintenance-related activities essential to meet the requirements of the permit.

b. If there are feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, maintenance during normal periods of equipment down time, or transport of untreated wastes to another treatment facility.

c. If the bypass is planned and scheduled to minimize adverse effects on the public and the environment.

After consideration of the above and the adverse effects of the proposed bypass and any other relevant factors, the Department will approve or deny the request. The public shall be notified and given an opportunity to comment on bypass incidents of significant duration, to the extent feasible. Approval of a request to bypass will be by administrative order issued by the Department under RCW 90.48.120.

3. Bypass For Essential Maintenance Without the Potential to Cause Violation of Permit Limits or Conditions -- Bypass is authorized if it is for essential maintenance and does not have the potential to cause violations of limitations or other conditions of the permit, or adversely impact public health as determined by the Department prior to the bypass.

G. Operations and Maintenance Manual

The approved Operations and Maintenance Manual shall be kept available at the treatment plant and all operators shall follow the instructions and procedures of this Manual.

S6. PRETREATMENT

A. General Requirements

The Permittee shall work with the Department to ensure that all commercial and industrial users of the publicly owned treatment works (POTW) are in compliance with the pretreatment regulations promulgated in 40 CFR Part 403 and any additional regulations that may be promulgated under Section 307(b) (pretreatment) and 308 (reporting) of the Federal Clean Water Act.

B. Wastewater Discharge Permit Required

The Permittee shall not allow significant industrial users (SIUs) to discharge wastewater to the Permittee's sewerage system until such user has received a wastewater discharge permit from the Department in accordance with Chapter 90.48 RCW and Chapter 173-216 WAC, as amended.

C. Identification and Reporting of Existing, New, and Proposed Industrial Users

1. The Permittee shall take continuous, routine measures to identify all existing and new proposed SIUs discharging or proposing to discharge to the Permittee's sewerage system (see Appendix B of Fact Sheet for definitions).

2. Within thirty (30) days of becoming aware of an unpermitted existing, new, or proposed industrial user who may be an SIU, the Permittee shall notify such user by registered mail that, if classified as an SIU, they shall be required to apply to the Department and obtain a State Waste Discharge Permit. A copy of this notification letter shall also be sent to the Department within this same 30-day period.

D. Industrial User Survey

1. The Permittee shall complete and submit to the Department an Industrial User Survey listing all SIUs discharging to the POTW. The survey shall be received by the Department in conjunction with permit application by January 31, 2005. At a minimum, the list of SIUs shall be developed by means of a telephone book search, a water utility billing records search, and a physical reconnaissance of the service area.

E. Duty to Enforce Discharge Prohibitions

1. In accordance with 40 CFR 403.5(a), the Permittee shall not authorize or knowingly allow the discharge of any pollutants into its POTW which cause pass through or interference, or which otherwise violates general or specific discharge prohibitions contained in 40 CFR Part 403.5or WAC-173-216-060.

2. The Permittee shall not authorize or knowingly allow the introduction of any of the following into its POTW:

   a. Pollutants which create a fire or explosion hazard in the POTW (including, but not limited to waste streams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21).

b. Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, or greater than 11.0 standard units, unless the works are specifically designed to accommodate such discharges.

c. Solid or viscous pollutants in amounts that could cause obstruction to the flow in sewers or otherwise interfere with the operation of the POTW.

d. Any pollutant, including oxygen demanding pollutants, (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the POTW.

e. Petroleum oil, nonbiodegradable cutting oil, or products of mineral origin in amounts that will cause interference or pass through.

f. Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity which may cause acute worker health and safety problems.

g. Heat in amounts that will inhibit biological activity in the POTW resulting in interference but in no case heat in such quantities such that the temperature at the POTW headworks exceeds 40° C (104° F) unless the Department, upon request of the Permittee, approves, in writing, alternate temperature limits.

h. Any trucked or hauled pollutants, except at discharge points designated by the Permittee.

i. Wastewaters prohibited to be discharged to the POTW by the Dangerous Waste Regulations (Chapter 173-303 WAC), unless authorized under the Domestic Sewage Exclusion (WAC 173-303-071).

3. All of the following are prohibited from discharge to the POTW unless approved in writing by the Department under extraordinary circumstances (such as a lack of direct discharge alternatives due to combined sewer service or the need to augment sewage flows due to septic conditions):

   a. Non-contact cooling water in significant volumes.

   b. New stormwater, and other new direct inflow sources.

   c. Wastewaters significantly affecting system hydraulic loading, which do not require treatment, or would not be afforded a significant degree of treatment by the system.

4. The Permittee shall notify the Department if any industrial user violates the prohibitions listed in this section.

S7. RESIDUAL SOLIDS

Residual solids include screenings, grit, scum, primary sludge, waste activated sludge, and other solid waste. The Permittee shall store and handle all residual solids in such a manner so as to prevent their entry into state ground or surface waters. The Permittee shall not discharge leachate from residual solids to state surface or ground waters.

S8. ACUTE TOXICITY

A. Effluent Characterization

The Permittee shall conduct acute toxicity testing on the final effluent to determine the presence and amount of acute (lethal) toxicity. The two acute toxicity tests listed below shall be conducted on each sample taken for effluent characterization.

Effluent characterization for acute toxicity shall be conducted quarterly for one year from January 1, 2001, to December 30, 2001, to determine presence and amount of acute (lethal) toxicity. The first test shall be conducted no later than February 1, 2001. A written report shall be submitted to the Department within sixty (60) days after the sample date. A final effluent characterization summary report shall be submitted to the Department no later than June 30, 2002. This summary report shall include a tabulated summary of the individual test results and any information on sources of toxicity, toxicity source control, correlation with effluent data, and toxicity treatability which is developed during the period of testing.

Acute toxicity testing shall follow protocols, monitoring requirements, and quality assurance/quality control procedures specified in this Section. A dilution series consisting of a minimum of five concentrations and a control shall be used to estimate the concentration lethal to 50% of the organisms (LC_{50}). The percent survival in 100% effluent shall also be reported.

Acute toxicity tests shall be conducted with the following species and protocols:

1) Fathead minnow, *Pimephales promelas* (96-hour static-renewal test, method: EPA/600/4-90/027F)

2) Daphnid, *Ceriodaphnia dubia*, *Daphnia pulex*, or *Daphnia magna* (48-hour static test, method: EPA/600/4-90/027F). The Permittee shall choose one of the three species and use it consistently throughout effluent characterization.

B. Effluent Limit for Acute Toxicity

The Permittee has an effluent limit for acute toxicity if, after completing one year of effluent characterization, either:

(1) The median survival of any species in 100% effluent is below 80%, or

(2) Any one test of any species exhibits less than 65% survival in 100% effluent.

If an effluent limit for acute toxicity is required by subsection B at the end of one year of effluent characterization, the Permittee shall immediately complete all applicable requirements in subsections C, D, and F.

If no effluent limit is required by subsection B at the end of one year of effluent characterization, then the Permittee shall complete all applicable requirements in subsections E and F.

The effluent limit for acute toxicity is no acute toxicity detected in a test concentration representing the acute critical effluent concentration (ACEC).

In the event of failure to pass the test described in subsection C of this section for compliance with the effluent limit for acute toxicity, the Permittee is considered to be in compliance with all permit requirements for acute whole effluent toxicity as long as the requirements in subsection D are being met to the satisfaction of the Department.

The ACEC means the maximum concentration of effluent during critical conditions at the boundary of the zone of acute criteria exceedance assigned pursuant to WAC 173-201A-100. The zone of acute criteria exceedance is authorized in Section S1.B of this permit. The ACEC equals 3.03% effluent.

C. Monitoring for Compliance With an Effluent Limit for Acute Toxicity

Monitoring to determine compliance with the effluent limit shall be conducted monthly for the remainder of the permit term using each of the species listed in subsection A above on a rotating basis and performed using at a minimum 100% effluent, the ACEC, and a control. The Permittee shall schedule the toxicity tests in the order listed in the permit unless the Department notifies the Permittee in writing of another species rotation schedule. The percent survival in 100% effluent shall be reported for all compliance monitoring.

Compliance with the effluent limit for acute toxicity means no statistically significant difference in survival between the control and the test concentration representing the ACEC. The Permittee shall immediately implement subsection D if any acute toxicity test conducted for compliance monitoring determines a statistically significant difference in survival between the control and the ACEC using hypothesis testing at the 0.05 level of significance (Appendix H, EPA/600/4-89/001). If the difference in survival between the control and the ACEC is less than 10%, the hypothesis test shall be conducted at the 0.01 level of significance.

D. Response to Noncompliance With an Effluent Limit for Acute Toxicity

If the Permittee violates the acute toxicity limit in subsection B, the Permittee shall begin additional compliance monitoring within one week from the time of receiving the test results. This additional monitoring shall be conducted weekly for four consecutive weeks using the same test and species as the failed compliance test. Testing shall determine the LC_{50} and effluent limit compliance. The discharger shall return to the original monitoring frequency in subsection C after completion of the additional compliance monitoring.

If the Permittee believes that a test indicating noncompliance will be identified by the Department as an anomalous test result, the Permittee may notify the Department that the compliance test result might be anomalous and that the Permittee intends to take only one additional sample for toxicity testing and wait for notification from the Department before completing the additional monitoring required in this subsection. The notification to the Department shall accompany the report of the compliance test result and identify the reason for considering the compliance test result to be anomalous. The Permittee shall complete all of the additional monitoring required in this subsection as soon as possible after notification by the Department that the compliance test result was not anomalous. If the one additional sample fails to comply with the effluent limit for acute toxicity, then the Permittee shall proceed without delay to complete all of the additional monitoring required in this subsection. The one additional test result shall replace the compliance test result upon determination by the Department that the compliance test result was anomalous.

If all of the additional compliance monitoring conducted in accordance with this subsection complies with the permit limit, the Permittee shall search all pertinent and recent facility records (operating records, monitoring results, inspection records, spill reports, weather records, production records, raw material purchases, pretreatment records, etc.) and submit a report to the Department on possible causes and preventive measures for the transient toxicity event which triggered the additional compliance monitoring.

If toxicity occurs in violation of the acute toxicity limit during the additional compliance monitoring, the Permittee shall submit a Toxicity Identification/Reduction Evaluation (TI/RE) plan to the Department within sixty (60) days after test results are final. The TI/RE plan shall be based on WAC 173-205-100(2) and shall be implemented in accordance with WAC 173-205-100(3).

E. Monitoring When There Is No Permit Limit for Acute Toxicity

The Permittee shall test final effluent once in the last summer and once in the last winter prior to submission of the application for permit renewal. All species used in the initial acute effluent characterization or substitutes approved by the Department shall be used and results submitted to the Department as a part of the permit renewal application process.

F. Sampling and Reporting Requirements

1. All reports for effluent characterization or compliance monitoring shall be submitted in accordance with the most recent version of Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria,* in regards to format and content. Reports shall contain bench sheets and reference toxicant results for test methods. If the lab provides the toxicity test data on floppy disk for electronic entry into the Department's database, then the Permittee shall send the disk to the Department along with the test report, bench sheets, and reference toxicant results.

2. Testing shall be conducted on 24-hour composite effluent samples. Samples taken for toxicity testing shall be cooled to 4 degrees Celsius while being collected and shall be sent to the lab immediately upon completion. The lab shall begin the toxicity testing as soon as possible but no later than 36 hours after sampling was ended.

3. All samples and test solutions for toxicity testing shall have water quality measurements as specified in Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria,* or most recent version thereof.

4. All toxicity tests shall meet quality assurance criteria and test conditions in the most recent versions of the EPA manual listed in subsection A and the Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria.* If test results are determined to be invalid or anomalous by the Department, testing shall be repeated with freshly collected effluent.

5. Control water and dilution water shall be laboratory water meeting the requirements of the EPA manual listed in subsection A or pristine natural water of sufficient quality for good control performance.

6. Effluent samples for whole effluent toxicity testing shall be collected just prior to the chlorination step in the treatment process.

7. The Permittee may choose to conduct a full dilution series test during compliance monitoring in order to determine dose response. In this case, the series must have a minimum of five effluent concentrations and a control. The series of concentrations must include the ACEC.

8. All whole effluent toxicity tests, effluent screening tests, and rapid screening tests that involve hypothesis testing, and do not comply with the acute statistical power standard of 29% as defined in WAC 173-205-020, must be repeated on a fresh sample with an increased number of replicates to increase the power.

S9. CHRONIC TOXICITY

A. Effluent Characterization

The Permittee shall conduct chronic toxicity testing on the final effluent. The two chronic toxicity tests listed below shall be conducted on each sample taken for effluent characterization.

Effluent characterization for acute toxicity shall be conducted quarterly for one year from January 1, 2001, to December 30, 2001, to determine presence and amount of chronic toxicity. The first test shall be conducted no later than February 1, 2001. A written report shall be submitted to the Department within sixty (60) days after the sample date. A final effluent characterization summary report shall be submitted to the Department no later than June 30, 2002. This summary report shall include a tabulated summary of the individual test results and any information on sources of toxicity, toxicity source control, correlation with effluent data, and toxicity treatability which is developed during the period of testing.

The Permittee shall conduct chronic toxicity testing during effluent characterization on a series of at least five concentrations of effluent in order to determine appropriate point estimates. This series of dilutions shall include the ACEC. The Permittee shall compare the ACEC to the control using hypothesis testing at the 0.05 level of significance as described in Appendix H, EPA/600/4-89/001.

Chronic toxicity tests shall be conducted with the following three species and the most recent version of the following protocols:

Saltwater Chronic Toxicity Test Species		Method
Topsmelt or Silverside minnow	*Atherinops affinis* or *Menidia beryllina*	EPA/600/R-95/136 or EPA/600/4-91/003
Mysid shrimp	*Holmesimysis costata* or *Mysidopsis bahia*	EPA/600/R-95/136 or EPA/600/4-91/003

The Permittee shall use the West Coast fish (topsmelt, *Atherinops affinis*) and mysid (*Holmesimysis costata*) for toxicity testing unless the lab cannot obtain a sufficient quantity of a West Coast species in good condition in which case the East Coast fish (silverside minnow, *Menidia beryllina*) or mysid (*Mysidopsis bahia*) may be substituted.

B. Effluent Limit for Chronic Toxicity

After completion of effluent characterization, the Permittee has an effluent limit for chronic toxicity if any test conducted for effluent characterization shows a significant difference between the control and the ACEC at the 0.05 level of significance using hypothesis testing (Appendix H, EPA/600/4-89/001) and shall complete all applicable requirements in subsections C, D, and F.

If no significant difference is shown between the ACEC and the control in any of the chronic toxicity tests, the Permittee has no effluent limit for chronic toxicity and only subsections E and F apply.

The effluent limit for chronic toxicity is no toxicity detected in a test concentration representing the chronic critical effluent concentration (CCEC).

In the event of failure to pass the test described in subsection C of this section for compliance with the effluent limit for chronic toxicity, the Permittee is considered to be in compliance with all permit requirements for chronic whole effluent toxicity as long as the requirements in subsection D are being met to the satisfaction of the Department.

The CCEC means the maximum concentration of effluent allowable at the boundary of the mixing zone assigned in Section S1.B. pursuant to WAC 173-201A-100. The CCEC equals 1.43% effluent.

C. Monitoring for Compliance With an Effluent Limit for Chronic Toxicity

Monitoring to determine compliance with the effluent limit shall be conducted monthly for the remainder of the permit term using each of the species listed in subsection A above on a rotating basis and performed using at a minimum the CCEC, the ACEC, and a control. The Permittee shall schedule the toxicity tests in the order listed in the permit unless the Department notifies the Permittee in writing of another species rotation schedule.

Compliance with the effluent limit for chronic toxicity means no statistically significant difference in response between the control and the test concentration representing the CCEC. The Permittee shall immediately implement subsection D if any chronic toxicity test conducted for compliance monitoring determines a statistically significant difference in response between the control and the CCEC using hypothesis testing at the 0.05 level of significance (Appendix H, EPA/600/4-89/001). If the difference in response between the control and the CCEC is less than 20%, the hypothesis test shall be conducted at the 0.01 level of significance.

In order to establish whether the chronic toxicity limit is eligible for removal from future permits, the Permittee shall also conduct this same hypothesis test (Appendix H, EPA/600/4-89/001) to determine if a statistically significant difference in response exists between the ACEC and the control.

D. Response to Noncompliance With an Effluent Limit for Chronic Toxicity

If a toxicity test conducted for compliance monitoring under subsection C determines a statistically significant difference in response between the CCEC and the control, the Permittee shall begin additional compliance monitoring within one week from the time of receiving the test results. This additional monitoring shall be conducted monthly for three consecutive months using the same test and species as the failed compliance test. Testing shall be conducted using a series of at least five effluent concentrations and a control in order to be able to determine appropriate point estimates. One of these effluent concentrations shall equal the CCEC and be compared statistically to the nontoxic control in order to determine compliance with the effluent limit for chronic toxicity as described in subsection C. The discharger shall return to the original monitoring frequency in subsection C after completion of the additional compliance monitoring.

If the Permittee believes that a test indicating noncompliance will be identified by the Department as an anomalous test result, the Permittee may notify the Department that the compliance test result might be anomalous and that the Permittee intends to take only one additional sample for toxicity testing and wait for notification from the Department before completing the additional monitoring required in this subsection. The notification to the Department shall accompany the report of the compliance test result and identify the reason for considering the compliance test result to be anomalous. The Permittee shall complete all of the additional monitoring required in this subsection as soon as possible after notification by the Department that the compliance test result was not anomalous. If the one additional sample fails to comply with the effluent limit for chronic toxicity, then the Permittee shall proceed without delay to complete all of the additional monitoring required in this subsection. The one additional test result shall replace the compliance test result upon determination by the Department that the compliance test result was anomalous.

If all of the additional compliance monitoring conducted in accordance with this subsection complies with the permit limit, the Permittee shall search all pertinent and recent facility records (operating records, monitoring results, inspection records, spill reports, weather records, production records, raw material purchases, pretreatment records, etc.) and submit a report to the Department on possible causes and preventive measures for the transient toxicity event which triggered the additional compliance monitoring.

If toxicity occurs in violation of the chronic toxicity limit during the additional compliance monitoring, the Permittee shall submit a Toxicity Identification/Reduction Evaluation (TI/RE) plan to the Department within sixty (60) days after test results are final. The TI/RE plan shall be based on WAC 173-205-100(2) and shall be implemented in accordance with WAC 173-205-100(3).

E. Monitoring When There Is No Permit Limit for Chronic Toxicity

The Permittee shall test final effluent once in the last summer and once in the last winter prior to submission of the application for permit renewal. All species used in the initial chronic effluent characterization or substitutes approved by the Department shall be used and results submitted to the Department as a part of the permit renewal application process.

F. Sampling and Reporting Requirements

1. All reports for effluent characterization or compliance monitoring shall be submitted in accordance with the most recent version of Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria,* in regards to format and content. Reports shall contain bench sheets and reference toxicant results for test methods. If the lab provides the toxicity test data on floppy disk for electronic entry into the Department's database, then the Permittee shall send the disk to the Department along with the test report, bench sheets, and reference toxicant results.

2. Testing shall be conducted on 24-hour composite effluent samples. Samples taken for toxicity testing shall be cooled to 4 degrees Celsius while being collected and shall be sent to the lab immediately upon completion. The lab shall begin the toxicity testing as soon as possible but no later than 36 hours after sampling was ended.

3. All samples and test solutions for toxicity testing shall have water quality measurements as specified in Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria,* or most recent version thereof.

4. All toxicity tests shall meet quality assurance criteria and test conditions in the most recent versions of the EPA manual listed in subsection A and the Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria.* If test results are determined to be invalid or anomalous by the Department, testing shall be repeated with freshly collected effluent.

5. Control water and dilution water shall be laboratory water meeting the requirements of the EPA manual listed in subsection A or pristine natural water of sufficient quality for good control performance.

6. Effluent samples for whole effluent toxicity testing shall be collected just prior to the chlorination step in the treatment process.

7. The Permittee may choose to conduct a full dilution series test during compliance monitoring in order to determine dose response. In this case, the series must have a minimum of five effluent concentrations and a control. The series of concentrations must include the ACEC and the CCEC.

8. All whole effluent toxicity tests, effluent screening tests, and rapid screening tests that involve hypothesis testing and do not comply with the chronic statistical power standard of 39% as defined in WAC 173-205-020 must be repeated on a fresh sample with an increased number of replicates to increase the power.

S10. COMBINED SEWER OVERFLOWS

A. Discharge Locations

The following is a list of combined sewer overflows (CSOs), which are occasional point sources of pollutants as a result of precipitation events. Discharges from these sites are prohibited except as a result of and during precipitation events. No authorization is given by this permit for discharge from a CSO that causes adverse impacts that threaten characteristic uses of the receiving water as identified in the Water Quality Standards, Chapter 173-201A WAC.

DISCHARGE NO.	LOCATION	RECEIVING WATER
002 - Alternate Outfall	48° 43' 13" N 122° 30' 55" W	Bellingham Bay
003 - C Street Overflow	48° 45' 03" N 122° 29' 14" W	Bellingham Bay

B. Combined Sewer Overflow Report

By March 31, 2001, and annually thereafter, the Permittee shall submit a CSO Report to the Department for review and approval, which complies with the requirements of WAC 173-245-090(1).

C. Combined Sewer Overflow Reduction Plan Amendment

In conjunction with the application for renewal of this permit, the Permittee shall submit an amendment of its CSO reduction plan to Ecology for review and approval. The amendment shall comply with the requirements of WAC 173-245-090 (2).

S11. SEDIMENT MONITORING (MARINE)

The Permittee shall submit to the Department for review and approval a Sediment Sampling and Analysis Plan for sediment monitoring no later than August 1, 2001. The purpose of the plan is to characterize sediment quality in the vicinity of the Permittee's discharge locations.

Following Department approval of the Sediment Sampling and Analysis Plan, sediments will be collected and analyzed. In a two tiered approach, enough sediment is to be collected for Sediment Management Standards chemical and confirmatory bioassay analyses to be performed on any sample that exceeds the sediment quality standards. The Permittee shall submit to the Department a Sediment Data Report containing the results of the sediment sampling and analysis no later than one year after Department approval of sediment sampling and analysis plan or within three (3) years after permit issuance.

A. Sediment Sampling and Analysis Plan

1. The Permittee shall submit a Sediment Sampling and Analysis Plan following the guidance provided in the Sediment Source Control Standards User Manual, Appendix B: Sediment Sampling and Analysis Plan Appendix (Ecology, 1995).

2. The Sediment Sampling and Analysis Plan shall include between 9 and 18 sample stations in the vicinity of Main Outfall #001. Eight stations shall be located as previously sampled [i.e., four stations at the acute zone boundary (27 feet from diffuser); four stations at the mixing zone boundary (276 feet from diffuser)]; two stations 600 feet north and two stations 600 feet south of the diffuser, respectively. A reference sediment station must also be collected. Collection of an ambient sediment station is optional. All samples are to be analyzed for Sediment Management Standards metals.

3. The Sediment Sampling and Analysis Plan shall include between 9 and 18 stations in the vicinity of Alternate Outfall #002. Sample station locations will be determined after an evaluation of the predominant current direction, bathymetry, etc. A reference sediment station must also be collected. Collection of an ambient sediment station is optional. All samples are to be analyzed for the Sediment Management Standards suite of 47 chemicals.

B. Sediment Data Report

The Permittee shall submit a Sediment Data Report conforming with the approved Sampling and Analysis Plan and the guidance provided in the Sediment Source Control Standards User Manual, Appendix B: Sediment Sampling and Analysis Plan Appendix (Ecology, 1995).

S12. OUTFALL EVALUATION

The Permittee shall inspect the submerged portion of the outfall line and diffuser to document its integrity and continued function, as necessary. If conditions allow for a photographic verification, it shall be included in the report. The inspection report shall be submitted to the Department should the inspection reveals any problems, in which the Permittee shall submit a plan of action to the Department for review and approval within ninety (90) days.

GENERAL CONDITIONS

G1. SIGNATORY REQUIREMENTS

All applications, reports, or information submitted to the Department shall be signed and certified.

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

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

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

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

C. Changes to authorization. If an authorization under paragraph B.2. above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of B.2. must be submitted to the Department prior to or together with any reports, information, or applications to be signed by an authorized representative.

D. Certification. Any person signing a document under this section shall make the following certification:

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

G2. RIGHT OF ENTRY

The Permittee shall allow an authorized representative of the Department, upon the presentation of credentials and such other documents as may be required by law:

A. To enter upon the premises where a discharge is located or where any records must be kept under the terms and conditions of this permit;

B. To have access to and copy at reasonable times any records that must be kept under the terms of the permit;

C. To inspect at reasonable times any monitoring equipment or method of monitoring required in the permit;

D. To inspect at reasonable times any collection, treatment, pollution management, or discharge facilities; and

E. To sample at reasonable times any discharge of pollutants.

G3. PERMIT ACTIONS

This permit shall be subject to modification, suspension, or termination, in whole or in part by the Department for any of the following causes:

A. Violation of any permit term or condition;

B. Obtaining a permit by misrepresentation or failure to disclose all relevant facts;

C. A material change in quantity or type of waste disposal;

D. A material change in the condition of the waters of the state; or

E. Nonpayment of fees assessed pursuant to RCW 90.48.465.

The Department may also modify this permit, including the schedule of compliance or other conditions, if it determines good and valid cause exists, including promulgation or revisions of regulations or new information.

G4. REPORTING A CAUSE FOR MODIFICATION

The Permittee shall submit a new application, or a supplement to the previous application, along with required engineering plans and reports, whenever a material change in the quantity or type of discharge is anticipated which is not specifically authorized by this permit. This application shall be submitted at least sixty (60) days prior to any proposed changes. Submission of this application does not relieve the Permittee of the duty to comply with the existing permit until it is modified or reissued.

G5. PLAN REVIEW REQUIRED

Prior to constructing or modifying any wastewater control facilities, an engineering report and detailed plans and specifications shall be submitted to the Department for approval in accordance with Chapter 173-240 WAC. Engineering reports, plans, and specifications should be submitted at least 180 days prior to the planned start of construction. Facilities shall be constructed and operated in accordance with the approved plans.

G6. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in the permit shall be construed as excusing the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G7. DUTY TO REAPPLY

The Permittee must apply for permit renewal at least one hundred eighty (180) days prior to the specified expiration date of this permit.

G8. REMOVED SUBSTANCES

Collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall not be resuspended or reintroduced to the final effluent stream for discharge to state waters.

G9. TOXIC POLLUTANTS

If any applicable toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Clean Water Act for a toxic pollutant and that standard or prohibition is more stringent than any limitation upon such pollutant in the permit, the Department shall institute proceedings to modify or revoke and reissue the permit to conform to the new toxic effluent standard or prohibition.

G10. OTHER REQUIREMENTS OF 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this permit by reference.

G11. ADDITIONAL MONITORING

The Department may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G12. PAYMENT OF FEES

The Permittee shall submit payment of fees associated with this permit as assessed by the Department. The Department may revoke this permit if the permit fees established under Chapter 173-224 WAC are not paid.

G13. PENALTIES FOR VIOLATING PERMIT CONDITIONS

Any person who is found guilty of willfully violating the terms and conditions of this permit shall be deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit shall incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to ten thousand dollars for every such violation. Each and every such violation shall be a separate and distinct offense, and in case of a continuing violation, every day's continuance shall be and be deemed to be a separate and distinct violation.

FACT SHEET FOR NPDES PERMIT WA-002374-4
CITY OF BELLINGHAM

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INTRODUCTION

The Federal Clean Water Act (FCWA, 1972, and later modifications, 1977, 1981, and 1987) established water quality goals for the navigable (surface) waters of the United States. One of the mechanisms for achieving the goals of the Clean Water Act is the National Pollutant Discharge Elimination System of permits (NPDES permits), which is administered by the Environmental Protection Agency (EPA). The EPA has delegated responsibility to administer the NPDES permit program to the State of Washington on the basis of Chapter 90.48 RCW which defines the Department of Ecology's authority and obligations in administering the wastewater discharge permit program.

The regulations adopted by the State include procedures for issuing permits (Chapter 173-220 WAC), technical criteria for discharges from municipal wastewater treatment facilities (Chapter 173-221 WAC), water quality criteria for surface and ground waters (Chapters 173-201A and 200 WAC), and sediment management standards (Chapter 173-204 WAC). These regulations require that a permit be issued before discharge of wastewater to waters of the state is allowed. The regulations also establish the basis for effluent limitations and other requirements which are to be included in the permit. One of the requirements (WAC 173-220-060) for issuing a permit under the NPDES permit program is the preparation of a draft permit and an accompanying fact sheet. Public notice of the availability of the draft permit is required at least thirty (30) days before the permit is issued (WAC 173-220-050). The fact sheet and draft permit are available for review (see Appendix A--Public Involvement of the fact sheet for more detail on the public notice procedures).

The fact sheet and draft permit have been reviewed by the Permittee. Errors and omissions identified in this review have been corrected before going to public notice. After the public comment period has closed, the Department will summarize the substantive comments and the response to each comment. The summary and response to comments will become part of the file on the permit and parties submitting comments will receive a copy of the Department's response. The fact sheet will not be revised. Comments and the resultant changes to the permit will be summarized in Appendix D--Response to Comments.

GENERAL INFORMATION	
Applicant	City of Bellingham
Facility Name and Address	210 Lottie Street Bellingham, WA 98225
Type of Treatment	Pure Oxygen Activated Sludge Treatment Plant
Discharge Location	Waterbody Name: Bellingham Bay Latitude: 48° 43' 11" N Longitude: 122° 31' 22" W
Water Body ID Number	WA-01-0080

BACKGROUND INFORMATION

The Post Point Pollution Control Plant treats municipal and industrial wastes from the City of Bellingham together with septage from the surrounding communities. The WWTP plant includes a septage receiving facility, three mechanically-cleaned and two manually-cleaned bar screens, influent flow measurement in five parshall flumes, grit chambers, primary clarification, primary effluent pumping, aeration in two high-purity oxygen aeration basins, secondary clarification, disinfection with chlorine, and dechlorination with sodium bisulfite.

The Bellingham Wastewater Treatment Plant receives domestic sewage from residential and commercial activities in the City of Bellingham and Whatcom County W.D. 10. In addition, the WWTP receives industrial wastewater from small commercial activities within the city. The facility is capable of receiving and processing septage from the surrounding communities.

There are combined sewers tributary to the facility and combined sewage (sanitary sewage combined with stormwater) is received and treated at the WWTP. The City of Bellingham has prepared and has already received approval for its combined sewer overflow reduction plan to satisfy requirements of the chapter 173-245 WAC, which is "Submission of Plans and Reports for Construction and Operation of Combined Sewer Overflow Reduction Facilities." The purpose of this chapter is to assure all CSO cities to achieve and, at least, to maintain the *Greatest Reasonable Reduction* of combine sewer overflows at the earliest possible date, and neither cause violations of applicable water quality standards, nor restriction to the characteristic uses of the receiving water, nor accumulation of deposit which exceed sediment criteria or standards; or have an adverse biological effect. When the City submitted their plan for their combined sewer overflow reduction, which was based on previous years, they appeared to be in compliance with the requirement of this chapter, which is on average one overflow per year. However, further review of the City of Bellingham CSO activities revealed that during the past five years (i.e., 1995, 96, 97, 98, 99) the City has exceeded the regulatory limit of an average of one overflow per year. The table below shows the frequency of overflows during the past seven years:

Year	Frequency
1993	0
1994	0
1995	2
1996	2
1997	1
1998	1
1999	4

The overflows during 1999 were due to exceptional stormy season but the volume of each overflow does not appear to be significant in most cases. The City is progressing on either upgrading the capacity of Oak Street pumping station, which is one of the main stations with more frequent overflows, or building a new one. The pumping station is being modeled hydraulically to assess upgrade and retrofit feasibility. This City shall submit to the Department the Combined Sewer Overflow Reduction Plan Amendment once during the permit cycle in accordance with chapter 173-245-090(2) WAC.

The conventional pollutants regulated by the current permit, Biochemical Oxygen Demand 5-day (BOD_5), and Total Suspended Solids (TSS), will still remain in the discharge at reduced levels.

On February 5, 1988, the City of Bellingham entered into a Federal Consent Decree with the State of Washington, Department of Justice, and the Environmental Protection Agency. The Consent Decree No. C87-1621 placed the City of Bellingham on a compliance schedule to attain secondary treatment and also establish interim effluent limits for the wastewater treatment plant.

The compliance schedule required initiating construction no later than January 1, 1991; completing construction no later than July 1, 1993; and attaining secondary treatment no later than December 31, 1993. The City of Bellingham began construction on December 30, 1990. The majority of secondary treatment unit processes were put on-line in early 1993 and the other required remaining compliance dates in the Consent Decree were met in time.

Treatment Processes

The WWTP plant includes a septage receiving facility, three mechanically-cleaned and two manually-cleaned bar screens, influent flow measurement in five parshall flumes, grit chambers, primary clarification, primary effluent pumping, aeration in two high-purity oxygen aeration basins, secondary clarification, disinfection with chlorine, and dechlorination with sodium bisulfite. All wastewater received at the treatment plant receives primary treatment. The WWTP is designed to provide full secondary treatment for all flows up to 37 MGD. Primary effluent in excess of 37 MGD is diverted to the chlorine contact chamber where it is flow blended with secondary effluent prior to discharge. The facility's collection systems receive and transfer combined wastewater.

Discharge Outfall

Dechlorinated, disinfected effluent flows by gravity through a submarine outfall to a 425 foot multi-port diffuser located in Bellingham Bay at an average depth of 76 feet below Mean Lower Low Water (MLLW).

Residual Solids

The treatment facilities remove solids during the treatment of the wastewater at the headworks (grit and screenings), and at the primary and secondary clarifiers, in addition to incidental solids (rags, scum, and other debris) removed as part of the routine maintenance of the equipment. Grit, rags, scum and screenings are drained and disposed of as solid waste at the local landfill. Solids removed from the primary and secondary treatment process are incinerated under a permit from the Whatcom County Health District.

PERMIT STATUS

The previous permit for this facility was issued on June 29, 1993. The previous permit placed effluent limitations on 5-day Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), pH, Fecal Coliform bacteria, and Total Residual Chlorine.

An application for permit renewal was submitted to the Department on November 17, 1997, and accepted by the Department on January 9, 1998.

SUMMARY OF COMPLIANCE WITH THE PREVIOUS PERMIT

During the history of the previous permit, the Permittee has remained in relatively excellent compliance, based on Discharge Monitoring Reports (DMRs) submitted to the Department and inspections conducted by the Department. The following table depicts the Permittee's compliance from January 1, 1995, through December 1, 1999.

Parameters	Influent TSS, Average lbs./day
Number of Violations	2

WASTEWATER CHARACTERIZATION

The concentration of pollutants in the discharge was reported in the NPDES application and in discharge monitoring reports. The effluent is characterized as follows:

Table 1: Wastewater Characterization

Parameters	Influent Annual Average	Effluent Annual Average
Flow – MGD	12.4	12.4
BOD 5 – mg/L	185	8.6
Total Suspended Solids – mg/L	208	6.9
Ammonia as N – mg/L	12.2	No data
TKN – mg/L	17	No data
Nitrate as N – mg/L	1.16	No data
Nitrite as N – mg/L	0.116	No data
Temperature Summer–Winter °F	57.92 – 63.5	No data

The Permittee's Whole Effluent Toxicity (WET) tests failed to indicate any toxicity to the receiving water; however, since the POTW has begun to receive pretreated contaminated ground water, it was decided to repeat WET testing to recharacterize the effluent.

The discharge monitoring report (DMR) reported discharge of heavy metals and total residual chlorine to the receiving water. The effluent maximum discharge during last permit cycle is as shown below:

Parameters – µg/L	Maximum Effluent Concentration
Chlorine	280
Arsenic	15
Nickel	13
Silver	12
Zinc	100
Cadmium	1.4
Lead	7
Chromium	21
Copper	58
Mercury	1

PROPOSED PERMIT LIMITATIONS

Federal and State regulations require that effluent limitations set forth in a NPDES permit must be either technology- or water quality-based. Technology-based limitations for municipal discharges are set by regulation (40 CFR 133, and Chapters 173-220 and 173-221 WAC). Water quality-based limitations are based upon compliance with the Surface Water Quality Standards (Chapter 173-201A WAC), Ground Water Standards (Chapter 173-200 WAC), Sediment Quality Standards (Chapter 173-204 WAC), or the National Toxics Rule (Federal Register, Volume 57, No. 246, Tuesday, December 22, 1992). The most stringent of these types of limits must be chosen for each of the parameters of concern. Each of these types of limits is described in more detail below.

The limits in this permit are based in part on information received in the application. The effluent constituents in the application were evaluated on a technology- and water quality-basis. The limits necessary to meet the rules and regulations of the State of Washington were determined and included in this permit. Ecology does not develop effluent limits for all pollutants that may be reported on the application as present in the effluent. Some pollutants are not treatable at the concentrations reported, are not controllable at the source, are not listed in regulation, and do not have a reasonable potential to cause a water quality violation. If significant changes occur in any constituent, as described in 40 CFR 122.42(a), the Permittee is required to notify the Department of Ecology.

DESIGN CRITERIA

In accordance with WAC 173-220-150 (1)(g), flows or wasteloadings shall not exceed approved design criteria taken from an approved engineering report.

Table 2: Design Standards for Post Point WWTP

Parameter	Design Criteria
Monthly average flow (max. month)	20 MGD
BOD_5 influent loading	25,530 lbs./day
TSS influent loading	27,100 lbs./day

TECHNOLOGY-BASED EFFLUENT LIMITATIONS

Municipal wastewater treatment plants are a category of discharger for which technology-based effluent limits have been promulgated by federal and state regulations. These effluent limitations are given in the Code of Federal Regulations (CFR) 40 CFR Part 133 (federal) and in Chapter 173-221 WAC (state). These regulations are performance standards that constitute all known available and reasonable methods of prevention, control, and treatment for municipal wastewater.

The following technology-based limits for pH, fecal coliform, BOD_5, and TSS, taken from Chapter 173-221 WAC, are:

Table 3: Technology-based Limits

Parameter	Limit
pH	shall be within the range of 6 to 9 standard units.
Fecal Coliform Bacteria	Monthly Geometric Mean = 200 organisms/100 mL Weekly Geometric Mean = 400 organisms/100 mL
BOD_5 (concentration)	Average Monthly Limit is the most stringent of the following: - 30 mg/L - may not exceed fifteen percent (15%) of the average influent concentration Average Weekly Limit = 45 mg/L
TSS (concentration)	Average Monthly Limit is the most stringent of the following: - 30 mg/L - may not exceed fifteen percent (15%) of the average influent concentration Average Weekly Limit = 45 mg/L

The following technology-based mass limits are based on WAC 173-220-130(3)(b) and 173-221-030(11)(b).

Monthly effluent mass loadings (lbs./day) were calculated as the maximum monthly design flow 20 MGD) x concentration limit (30 mg/L) x 8.34 (conversion factor) = mass limit 5004 lbs./day.

The weekly average effluent mass loading is calculated as 1.5 x monthly loading = 7506 lbs./day.

SURFACE WATER QUALITY-BASED EFFLUENT LIMITATIONS

In order to protect existing water quality and preserve the designated beneficial uses of Washington's surface waters, WAC 173-201A-060 states that waste discharge permits shall be conditioned such that the discharge will meet established Surface Water Quality Standards. The Washington State Surface Water Quality Standards (Chapter 173-201A WAC) is a state regulation designed to protect the beneficial uses of the surface waters of the state. Water quality-based effluent limitations may be based on an individual waste load allocation (WLA) or on a WLA developed during a basin-wide total maximum daily loading study (TMDL).

NUMERICAL CRITERIA FOR THE PROTECTION OF AQUATIC LIFE

"Numerical" water quality criteria are numerical values set forth in the State of Washington's Water Quality Standards for Surface Waters (Chapter 173-201A WAC). They specify the levels of pollutants allowed in a receiving water while remaining protective of aquatic life. Numerical criteria set forth in the Water Quality Standards are used along with chemical and physical data for the wastewater and receiving water to derive the effluent limits in the discharge permit. When surface water quality-based limits are more stringent or potentially more stringent than technology-based limitations, they must be used in a permit.

NUMERICAL CRITERIA FOR THE PROTECTION OF HUMAN HEALTH

The state was issued 91 numeric water quality criteria for the protection of human health by the U.S. EPA (EPA 1992). These criteria are designed to protect humans from cancer and other disease and are primarily applicable to fish and shellfish consumption and drinking water from surface waters.

NARRATIVE CRITERIA

In addition to numerical criteria, "narrative" water quality criteria (WAC 173-201A-030) limit toxic, radioactive, or deleterious material concentrations below those which have the potential to adversely affect characteristic water uses, cause acute or chronic toxicity to biota, impair aesthetic values, or adversely affect human health. Narrative criteria protect the specific beneficial uses of all fresh (WAC 173-201A-130) and marine (WAC 173-201A-140) waters in the State of Washington.

ANTIDEGRADATION

The State of Washington's Antidegradation Policy requires that discharges into a receiving water shall not further degrade the existing water quality of the water body. In cases where the natural conditions of a receiving water are of lower quality than the criteria assigned, the natural conditions shall constitute the water quality criteria. Similarly, when the natural conditions of a receiving water are of higher quality than the criteria assigned, the natural conditions shall constitute the water quality criteria. More information on the State Antidegradation Policy can be obtained by referring to WAC 173-201A-070.

The Department has reviewed existing records and is unable to determine if ambient water quality is either higher or lower than the designated classification criteria given in Chapter 173-201A WAC; therefore, the Department will use the designated classification criteria for this water body in the proposed permit. The discharges authorized by this proposed permit should not cause a loss of beneficial uses.

CRITICAL CONDITIONS

Surface water quality-based limits are derived for the waterbody's critical condition, which represents the receiving water and waste discharge condition with the highest potential for adverse impact on the aquatic biota, human health, and existing or characteristic water body uses.

MIXING ZONES

The Water Quality Standards allow the Department of Ecology to authorize mixing zones around a point of discharge in establishing surface water quality-based effluent limits. Both "acute" and "chronic" mixing zones may be authorized for pollutants that can have a toxic effect on the aquatic environment near the point of discharge. The concentration of pollutants at the boundary of these mixing zones may not exceed the numerical criteria for that type of zone. Mixing zones can only be authorized for discharges that are receiving all known, available, and reasonable methods of prevention, control and treatment (AKART) and in accordance with other mixing zone requirements of WAC 173-201A-100.

The National Toxics Rule (EPA, 1992) allows the chronic mixing zone to be used to meet human health criteria.

DESCRIPTION OF THE RECEIVING WATER

The facility discharges to Bellingham Bay, which is designated as a Class A marine receiving water in the vicinity of the outfall. Characteristic uses include the following:

> water supply (domestic, industrial, agricultural); stock watering; fish migration; fish and shellfish rearing, spawning and harvesting; wildlife habitat; primary contact recreation; sport fishing; boating and aesthetic enjoyment; commerce and navigation

Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

SURFACE WATER QUALITY CRITERIA

Applicable criteria are defined in Chapter 173-201A WAC for aquatic biota. In addition, U.S. EPA has promulgated human health criteria for toxic pollutants (EPA 1992). Criteria for this discharge are summarized below:

Fecal Coliforms	100 organisms/100 mL maximum geometric mean
Dissolved Oxygen	8 mg/L minimum
Temperature	18 degrees Celsius maximum or incremental increases above background
pH	6.5 to 8.5 standard units
Turbidity	less than 5 NTUs above background
Toxics	No toxics in toxic amounts (see Appendix C for numeric criteria for toxics of concern for this discharge)

CONSIDERATION OF SURFACE WATER QUALITY-BASED LIMITS FOR NUMERIC CRITERIA

Pollutant concentrations in the proposed discharge exceed water quality criteria with technology-based controls, which the Department has determined to be AKART. A mixing zone is authorized in accordance with the geometric configuration, flow restriction, and other restrictions for mixing zones in Chapter 173-201A WAC and is defined as follows:

The maximum mixing zone allowed to meet the chronic criteria shall not extend in any horizontal direction from the discharge ports for a distance greater than 200 feet, plus the depth of water over the discharge ports measured during MLLW.

The maximum allowable zone of acute criteria exceedance shall not extend 10 percent beyond the dimensions of the chronic mixing zone in any spatial direction.

The dilution factors of effluent to receiving water that occur within these zones have been determined at the critical condition by the use of list models, dye studies used. The dilution factors have been determined to be (from Appendix C):

	Acute	Chronic
Aquatic Life	33.	70
Human Health, Carcinogen		70
Human Health, Non-Carcinogen		70

Pollutants in an effluent may affect the aquatic environment near the point of discharge (near field) or at a considerable distance from the point of discharge (far field). Toxic pollutants, for example, are near-field pollutants--their adverse effects diminish rapidly with mixing in the receiving water. Conversely, a pollutant such as BOD is a far-field pollutant whose adverse effect occurs away from the discharge even after dilution has occurred. Thus, the method of calculating water quality-based effluent limits varies with the point at which the pollutant has its maximum effect.

The derivation of water quality-based limits also takes into account the variability of the pollutant concentrations in both the effluent and the receiving water.

<u>BOD_5</u>--This discharge with technology-based limitations results in a small amount of BOD loading relative to the large amount of dilution occurring in the receiving water at critical conditions. Technology-based limitations will be protective of dissolved oxygen criteria in the receiving water.

<u>Temperature</u>--Under critical conditions there is no predicted violation of the Water Quality Standards for Surface Waters. Therefore, no effluent limitation for temperature was placed in the proposed permit.

<u>pH</u>--Because of the high buffering capacity of marine water, compliance with the technology-based limits of 6 to 9 will assure compliance with the Water Quality Standards for Surface Waters.

<u>Fecal coliform</u>--Under critical conditions there is no predicted violation of the Water Quality Standards for Surface Waters with the technology-based limit. Therefore, the technology-based effluent limitation for fecal coliform bacteria was placed in the proposed permit.

<u>Toxic Pollutants</u>--Federal regulations (40 CFR 122.44) require NPDES permits to contain effluent limits for toxic chemicals in an effluent whenever there is a reasonable potential for those chemicals to exceed the surface water quality criteria. This process occurs concurrently with the derivation of technology-based effluent limits. Facilities with technology-based effluent limits defined in regulation are not exempted from meeting the Water Quality Standards for Surface Waters or from having surface water quality-based effluent limits.

The following toxics were determined to be present in the discharge: chlorine, ammonia, and heavy metals. A reasonable potential analysis (See Appendix C) was conducted on these parameters to determine whether or not effluent limitations would be required in this permit.

The determination of the reasonable potential for chlorine, ammonia, and heavy metals to exceed the water quality criteria was evaluated with procedures given in EPA, 1991 (Appendix C) at the critical condition. The parameters used in the critical condition modeling are as follows: acute dilution factor 33:1, chronic dilution factor 70:1, and zero background for parameters of concern. A determination of reasonable potential using zero for background resulted in no reasonable potential for these pollutants.

WHOLE EFFLUENT TOXICITY

The Water Quality Standards for Surface Waters require that the effluent not cause toxic effects in the receiving waters. Many toxic pollutants cannot be detected by commonly available detection methods. However, toxicity can be measured directly by exposing living organisms to the wastewater in laboratory tests and measuring the response of the organisms. Toxicity tests measure the aggregate toxicity of the whole effluent, and therefore this approach is called whole effluent toxicity (WET) testing. Some WET tests measure acute toxicity and other WET tests measure chronic toxicity.

Acute toxicity tests measure mortality as the significant response to the toxicity of the effluent. Dischargers who monitor their wastewater with acute toxicity tests are providing an indication of the potential lethal effect of the effluent to organisms in the receiving environment.

Chronic toxicity tests measure various sub-lethal toxic responses such as retarded growth or reduced reproduction. Chronic toxicity tests often involve either a complete life cycle test of an organism with an extremely short life cycle or a partial life cycle test on a critical stage of one of a test organism's life cycles. Organism survival is also measured in some chronic toxicity tests.

Accredited WET testing laboratories have the proper WET testing protocols, data requirements, and reporting format. Accredited laboratories are knowledgeable about WET testing and capable of calculating an NOEC, LC_{50}, EC_{50}, IC_{25}, etc. All accredited labs have been provided the most recent version of the Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria,* which is referenced in the permit. Any Permittee interested in receiving a copy of this publication may call the Ecology Publications Distribution Center 360-407-7472 for a copy. Ecology recommends that Permittees send a copy of the acute or chronic toxicity sections(s) of their permits to their laboratory of choice.

An effluent characterization for acute and chronic toxicity was conducted during the previous permit term. In accordance with WAC 173-205-060, the Permittee must repeat this effluent characterization for the following reason:

The Permittee has experienced the addition of a new industrial discharger to the sewage collection and treatment system and cannot demonstrate that the new source is nontoxic or that the pretreatment program and local limits are adequate to control toxicity from the new source. In accordance with WAC 173-205-060(1), the proposed permit requires another effluent characterization for toxicity.

HUMAN HEALTH

Washington's water quality standards now include 91 numeric health-based criteria that must be considered in NPDES permits. These criteria were promulgated for the state by the U.S. EPA in its National Toxics Rule (Federal Register, Volume 57, No. 246, Tuesday, December 22, 1992).

The Department has determined that the effluent is likely to have chemicals of concern for human health. The discharger's high priority status is based on the discharger's status as a major discharger.

A determination of the discharge's potential to cause an exceedance of the water quality standards was conducted as required by 40 CFR 122.44(d). The reasonable potential determination was evaluated with procedures given in the Technical Support Document for Water Quality-Based Toxics Control (EPA/505/2-90-001) and the Department's Permit Writer's Manual (Ecology Publication 92-109, July 1994). The determination indicated that the discharge has no reasonable potential to cause a violation of water quality standards, thus an effluent limit is not warranted.

SEDIMENT QUALITY

The Department has promulgated aquatic sediment quality standards (Sediment Management Standards, Chapter 173-204 WAC) to protect aquatic biota and human health. These standards state that the Department may require Permittees to evaluate the potential for the discharge to cause a violation of applicable standards (WAC 173-204-400).

The Department has determined that this discharge may have the potential to cause a violation of the sediment quality standards based on the results of the August 1996 Sediment Study Report (Spring 1996 sampling) and a review of the facility's January 1995 to December 1999 effluent monitoring data. The sediment monitoring study was completed as part of the NPDES permit issued in 1993. One station exceeded the sediment quality standards for mercury. Confirmatory bioassays were not conducted on this sample. Twelve of thirteen final effluent metals are considered to be heavy metals with the majority found at detectable levels. Effluent monitoring data showed a potential for sediment contamination using a calculation to estimate the contamination associated with the suspended solids.

Based on this review, a condition has been placed in the proposed permit which requires the Permittee to conduct sediment monitoring of metals in the vicinity of the Main Outfall #001 and to add baseline sediment monitoring in the vicinity of Alternate Outfall #002 for the suite of 47 Sediment Management Standards chemicals.

GROUND WATER QUALITY LIMITATIONS

The Department has promulgated Ground Water Quality Standards (Chapter 173-200 WAC) to protect uses of ground water. Permits issued by the Department shall be conditioned in such a manner so as not to allow violations of those standards (WAC 173-200-100).

This Permittee has no discharge to ground and therefore no limitations are required based on potential effects to ground water.

MONITORING REQUIREMENTS

Monitoring, recording, and reporting are required (WAC 173-220-210 and 40 CFR 122.41) to verify that the treatment process is functioning correctly and the effluent limitations are being achieved.

The monitoring schedule is detailed in the proposed permit under Condition S.2. Specified monitoring frequencies take into account the quantity and variability of discharge, the treatment method, past compliance, significance of pollutants, and cost of monitoring. The required monitoring frequency is consistent with agency guidance given in the current version of Ecology's *Permit Writer's Manual* (July 1994) for Activated Sludge Sewage Treatment Plant.

Additional monitoring is required in order to further characterize the effluent. These monitored pollutants could have a significant impact on the quality of the surface water.

LAB ACCREDITATION

With the exception of certain parameters, the permit requires all monitoring data to be prepared by a laboratory registered or accredited under the provisions of Chapter 173-50 WAC, *Accreditation of Environmental Laboratories.* The laboratory at this facility is accredited for BOD, TSS, Fecal Coliform, pH, and Chlorine.

OTHER PERMIT CONDITIONS

REPORTING AND RECORDKEEPING

The conditions of S3. are based on the authority to specify any appropriate reporting and recordkeeping requirements to prevent and control waste discharges (WAC 273-220-210).

PREVENTION OF FACILITY OVERLOADING

Overloading of the treatment plant is a violation of the terms and conditions of the permit. To prevent this from occurring, RCW 90.48.110 and WAC 173-220-150 require the Permittee to take the actions detailed in proposed permit requirement S.4. to plan expansions or modifications before existing capacity is reached and to report and correct conditions that could result in new or increased discharges of pollutants. Condition S.4. restricts the amount of flow.

OPERATION AND MAINTENANCE (O&M)

The proposed permit contains condition S.5. as authorized under RCW 90.48.110, WAC 173-220-150, Chapter 173-230 WAC, and WAC 173-240-080. It is included to ensure proper operation and regular maintenance of equipment, and to ensure that adequate safeguards are taken so that constructed facilities are used to their optimum potential in terms of pollutant capture and treatment.

RESIDUAL SOLIDS CONTROL

To prevent water quality problems, the Permittee is required in permit condition S7. to store and handle all residual solids (grit, screenings, scum, sludge, and other solid waste) in accordance with the requirements of RCW 90.48.080 and State Water Quality Standards.

The final use and disposal of sewage sludge from this facility is regulated by U.S. EPA under 40 CFR 503. The disposal of other solid waste is under the jurisdiction of the Whatcom County Health Department.

Residual solids generated at the plant includes screenings, grit, scum, primary sludge, waste activated sludge, and incinerator ash. Screenings are removed from the screenings conveyor and run through a screening press to dewater them before disposal at the RECOMP solid waste facility. Primary sludge, waste activated sludge, grit and scum are incinerated in the multiple-hearth incinerator and the ash is disposed of at the Bayview Cemetery fill site operated by the City.

PRETREATMENT

Federal and State Pretreatment Program Requirements

Under the terms of the addendum to the "Memorandum of Understanding between Washington Department of Ecology and the United States Environmental Protection Agency, Region 10" (1986), the Department of Ecology (Department) has been delegated authority to administer the Pretreatment Program [i.e., act as the Approval Authority for oversight of delegated Publicly Owned Treatment Works (POTWs)]. Under this delegation of authority, the Department has exercised the option of issuing wastewater discharge permits for significant industrial users discharging to POTWs which have not been delegated authority to issue wastewater discharge permits.

There are a number of functions required by the Pretreatment Program which the Department is delegating to such POTWs because they are in a better position to implement the requirements (e.g., tracking the number and general nature of industrial dischargers to the sewerage system). The requirements for a Pretreatment Program are contained in Title 40, part 403 of the Code of Federal Regulations. Under the requirements of the Pretreatment Program [40 CFR 403.8(f)(1)(iii)], the Department is required to approve, condition, or deny new discharges or a significant increase in the discharge for existing significant industrial users (SIUs) [40 CFR 403.8 (f)(1)(i)].

The Department is responsible for issuing State Waste Discharge Permits to SIUs and other industrial users of the Permittee's sewer system. Industrial dischargers must obtain these permits from the Department prior to the Permittee accepting the discharge [WAC 173-216-110(5)] (Industries discharging wastewater that is similar in character to domestic wastewater are not required to obtain a permit. Such dischargers should contact the Department to determine if a permit is required.) Industrial dischargers need to apply for a State Waste Discharge Permit sixty days prior to commencing discharge. The conditions contained in the permits will include any applicable conditions for categorical discharges, loading limitations included in contracts with the POTW, and other conditions necessary to assure compliance with State water quality standards and biosolids standards.

The Department requires this POTW to fulfill some of the functions required for the Pretreatment Program in the NPDES permit (e.g., tracking the number and general nature of industrial dischargers to the sewage system). The POTW's NPDES permit will require that all SIUs currently discharging to the POTW be identified and notified of the requirement to apply for a wastewater discharge permit from the Department. None of the obligations imposed on the POTW relieve an industrial or commercial discharger of its primary responsibility for obtaining a wastewater discharge permit (if required), including submittal of engineering reports prior to construction or modification of facilities [40 CFR 403.12(j) and WAC 173-216-070 and WAC 173-240-110, et seq.].

Wastewater Permit Required

RCW 90.48 and WAC 173-216-040 require SIUs to obtain a permit prior to discharge of industrial waste to the Permittee's sewerage system. This provision prohibits the POTW from accepting industrial wastewater from any such dischargers without authorization from the Department.

Requirements for Routine Identification and Reporting of Industrial Users

The NPDES permit requires non-delegated POTWs to "take continuous, routine measures to identify all existing, new, and proposed SIUs discharging to the Permittee's sewerage system." Examples of such routine measures include regular review of business tax licenses for existing businesses and review of water billing records and existing connection authorization records. System maintenance personnel can also be diligent during performance of their jobs in identifying and reporting as-yet unidentified industrial dischargers. Local newspapers, telephone directories, and word-of-mouth can also be important sources of information regarding new or existing discharges. The POTW is required to notify an industrial discharger, in writing, of their responsibilities regarding application for a State waste discharge permit and to send a copy of the written notification to the Department. The Department will then take steps to solicit a State waste discharge permit application.

Requirements for Performing an Industrial User Survey

This POTW has the potential to serve significant industrial or commercial users and is required to perform an Industrial User Survey. The goal of this survey is to develop a list of SIUs, and of equal importance, to provide sufficient information about industries which discharge to the POTW, to determine which of them require issuance of State waste discharge permits or other regulatory controls. An Industrial User Survey is an important part of the regulatory process used to prevent interference with treatment processes at the POTW and to prevent the exceedance of water quality standards. The Industrial User Survey also can be used to contribute to the maintenance of sludge quality, so that sludge can be a useful biosolids product rather than an expensive waste problem. An Industrial User Survey is a rigorous method for identifying existing, new, and proposed significant industrial users and potential significant industrial users. A complete listing of methodologies is available in the Department of Ecology guidance document entitled "Conducting an Industrial User Survey."

Duty to Enforce Discharge Prohibitions

This provision prohibits the POTW from authorizing or permitting an industrial discharger to discharge certain types of waste into the sanitary sewer. The first portion of the provision prohibits acceptance of pollutants which cause pass through or interference. The definitions of pass through and interference are in Appendix B of the fact sheet.

The second portion of this provision prohibits the POTW from accepting certain specific types of wastes, namely those which are explosive, flammable, excessively acidic, basic, otherwise corrosive, or obstructive to the system. In addition, wastes with excessive BOD, petroleum-based oils, or which result in toxic gases are prohibited to be discharged. The regulatory basis for these prohibitions is 40 CFR Part 403, with the exception of the pH provisions which are based on WAC 173-216-060.

The third portion of this provision prohibits certain types of discharges unless the POTW receives prior authorization from the Department. The discharges include cooling water in significant volumes, stormwater and other direct inflow sources, and wastewaters significantly affecting system hydraulic loading, which do not require treatment.

Support by the Department for Developing Partial Pretreatment Program by POTW

The Department has committed to providing technical and legal assistance to the Permittee in fulfilling these joint obligations, in particular assistance with developing an adequate sewer use ordinance, notification procedures, enforcement guidelines, and developing local limits and inspection procedures.

COMBINED SEWER OVERFLOWS

In accordance with RCW 90.48.480 and Chapter 173-245 WAC, proposed permit Condition S10.B &C. requires the Permittee to submit an annual Combined Sewer Overflow (CSO) report and to update its CSO reduction plan at the time of permit renewal.

OUTFALL EVALUATION

Proposed permit condition S11. requires the Permittee to conduct an outfall inspection and submit a report detailing the findings of that inspection once per permit cycle. The purpose of the inspection is to determine the condition of the discharge pipe and diffusers and to determine if sediment is accumulating in the vicinity of the outfall.

GENERAL CONDITIONS

General Conditions are based directly on state and federal law and regulations and have been standardized for all individual municipal NPDES permits issued by the Department.

Condition G1 requires responsible officials or their designated representatives to sign submittals to the Department. Condition G2 requires the Permittee to allow the Department to access the treatment system, production facility, and records related to the permit. Condition G3 specifies conditions for modifying, suspending, or terminating the permit. Condition G4 requires the Permittee to apply to the Department prior to increasing or varying the discharge from the levels stated in the permit application. Condition G5 requires the Permittee to construct, modify, and operate the permitted facility in accordance with approved engineering documents. Condition G6 prohibits the Permittee from using the permit as a basis for violating any laws, statutes or regulations. Conditions G7 relates to permit renewal. Condition G8 prohibits the reintroduction of removed substances back into the effluent. Condition G9 states that the Department will modify or revoke and reissue the permit to conform to more stringent toxic effluent standards or prohibitions. Condition G10 incorporates by reference all other requirements of 40 CFR 122.41 and 122.42. Condition G11 notifies the Permittee that additional monitoring requirements may be established by the Department. Condition G12 requires the payment of permit fees. Condition G13 describes the penalties for violating permit conditions.

PERMIT ISSUANCE PROCEDURES

PERMIT MODIFICATIONS

The Department may modify this permit to impose numerical limitations, if necessary, to meet Water Quality Standards, Sediment Quality Standards, or Ground Water Standards, based on new information obtained from sources such as inspections, effluent monitoring, outfall studies, and effluent mixing studies.

The Department may also modify this permit as a result of new or amended state or federal regulations.

RECOMMENDATION FOR PERMIT ISSUANCE

This proposed permit meets all statutory requirements for authorizing a wastewater discharge, including those limitations and conditions believed necessary to protect human health, aquatic life, and the beneficial uses of waters of the State of Washington. The Department proposes that this permit be issued for five (5) years.

REFERENCES FOR TEXT AND APPENDICES

Environmental Protection Agency (EPA)

1992. National Toxics Rule. Federal Register, V. 57, No. 246, Tuesday, December 22, 1992.

1991. Technical Support Document for Water Quality-based Toxics Control. EPA/505/2-90-001.

1988. Technical Guidance on Supplementary Stream Design Conditions for Steady State Modeling. USEPA Office of Water, Washington, D.C.

1985. Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water. EPA/600/6-85/002a.

1983. Water Quality Standards Handbook. USEPA Office of Water, Washington, D.C.

Metcalf and Eddy.

1991. Wastewater Engineering, Treatment, Disposal, and Reuse. Third Edition.

Tsivoglou, E.C., and J.R. Wallace.

1972. Characterization of Stream Reaeration Capacity. EPA-R3-72-012. (Cited in EPA 1985 op.cit.)

Washington State Department of Ecology.

1994. Permit Writer's Manual. Publication Number 92-109

Water Pollution Control Federation.

Wright, R.M., and A.J. McDonnell.

1979. In-stream Deoxygenation Rate Prediction. Journal Environmental Engineering Division, ASCE. 105(EE2). (Cited in EPA 1985 op.cit.)

APPENDIX A--PUBLIC INVOLVEMENT INFORMATION

The Department has tentatively determined to reissue a permit to the applicant listed on page one of this fact sheet. The permit contains conditions and effluent limitations which are described in the rest of this fact sheet.

Public notice of application was published on January 7 and January 14, 1998, in the *Bellingham Herald* to inform the public that an application had been submitted and to invite comment on the reissuance of this permit.

The Department will publish a Public Notice of Draft (PNOD) on June 30, 2000, in The Bellingham Herald publication to inform the public that a draft permit and fact sheet are available for review. Interested persons are invited to submit written comments regarding the draft permit. The draft permit, fact sheet, and related documents are available for inspection and copying between the hours of 8:00 a.m. and 5:00 p.m. weekdays, by appointment, at the regional office listed below. Written comments should be mailed to:

Water Quality Permit Coordinator
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

Any interested party may comment on the draft permit or request a public hearing on this draft permit within the thirty (30) day comment period to the address above. The request for a hearing shall indicate the interest of the party and the reasons why the hearing is warranted. The Department will hold a hearing if it determines there is a significant public interest in the draft permit (WAC 173-220-090). Public notice regarding any hearing will be circulated at least thirty (30) days in advance of the hearing. People expressing an interest in this permit will be mailed an individual notice of hearing (WAC 173-220-100).

The Department will consider all comments received within thirty (30) days from the date of public notice of draft indicated above, in formulating a final determination to issue, revise, or deny the permit. The Department's response to all significant comments is available upon request and will be mailed directly to people expressing an interest in this permit.

Further information may be obtained from the Department by telephone, 425–649-7201, tmil461@ecy.wa.gov, or 425-649-4259 (TDD), or by writing to the address listed above.

This permit and fact sheet were written by Ed Abbasi.

APPENDIX B--GLOSSARY

Acute Toxicity--The lethal effect of a pollutant on an organism that occurs within a short period of time, usually 48 to 96 hours.

AKART--An acronym for "all known, available, and reasonable methods of prevention, control, and treatment."

Ambient Water Quality--The existing environmental condition of the water in a receiving water body.

Ammonia--Ammonia is produced by the breakdown of nitrogenous materials in wastewater. Ammonia is toxic to aquatic organisms, exerts an oxygen demand, and contributes to eutrophication. It also increases the amount of chlorine needed to disinfect wastewater.

Average Monthly Discharge Limitation--The highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month (except in the case of fecal coliform). The daily discharge is calculated as the average measurement of the pollutant over the day.

Average Weekly Discharge Limitation--The highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week. The daily discharge is calculated as the average measurement of the pollutant over the day.

Best Management Practices (BMPs)--Schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the State. BMPs include treatment systems, operating procedures, and practices to control: plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. BMPs may be further categorized as operational, source control, erosion and sediment control, and treatment BMPs.

BOD_5--Determining the Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of organic material present in an effluent that is utilized by bacteria. The BOD_5 is used in modeling to measure the reduction of dissolved oxygen in a receiving water after effluent is discharged. Stress caused by reduced dissolved oxygen levels makes organisms less competitive and less able to sustain their species in the aquatic environment. Although BOD is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

Bypass--The intentional diversion of waste streams from any portion of a treatment facility.

Chlorine--Chlorine is used to disinfect wastewaters of pathogens harmful to human health. It is also extremely toxic to aquatic life.

Chronic Toxicity--The effect of a pollutant on an organism over a relatively long time, often 1/10 of an organism's lifespan or more. Chronic toxicity can measure survival, reproduction or growth rates, or other parameters to measure the toxic effects of a compound or combination of compounds.

Clean Water Act (CWA)--The Federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, 97-117; USC 1251 et seq.

Combined Sewer Overflow (CSO)--The event during which excess combined sewage flow caused by inflow is discharged from a combined sewer, rather than conveyed to the sewage treatment plant because either the capacity of the treatment plant or the combined sewer is exceeded.

Compliance Inspection - Without Sampling--A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations.

Compliance Inspection - With Sampling--A site visit to accomplish the purpose of a Compliance Inspection - Without Sampling and as a minimum, sampling, and analysis for all parameters with limits in the permit to ascertain compliance with those limits; and, for municipal facilities, sampling of influent to ascertain compliance with the percent removal requirement. Additional sampling may be conducted.

Composite Sample--A mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing a minimum of four discrete samples. May be "time-composite" (collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increased while maintaining a constant time interval between the aliquots).

Construction Activity--Clearing, grading, excavation, and any other activity which disturbs the surface of the land. Such activities may include road building, construction of residential houses, office buildings, or industrial buildings, and demolition activity.

Critical Condition--The time during which the combination of receiving water and waste discharge conditions have the highest potential for causing toxicity in the receiving water environment. This situation usually occurs when the flow within a water body is low, thus, its ability to dilute effluent is reduced.

Dilution Factor--A measure of the amount of mixing of effluent and receiving water that occurs at the boundary of the mixing zone. Expressed as the inverse of the effluent fraction, e.g., a dilution factor of 10 means the effluent comprises 10% by volume and the receiving water 90%.

Engineering Report--A document which thoroughly examines the engineering and administrative aspects of a particular domestic or industrial wastewater facility. The report shall contain the appropriate information required in WAC 173-240-060 or 173-240-130.

Fecal Coliform Bacteria--Fecal coliform bacteria are used as indicators of pathogenic bacteria in the effluent that are harmful to humans. Pathogenic bacteria in wastewater discharges are controlled by disinfecting the wastewater. The presence of high numbers of fecal coliform bacteria in a water body can indicate the recent release of untreated wastewater and/or the presence of animal feces.

Grab Sample--A single sample or measurement taken at a specific time or over as short period of time as is feasible.

Industrial User--A discharger of wastewater to the sanitary sewer which is not sanitary wastewater or is not equivalent to sanitary wastewater in character.

Industrial Wastewater--Water or liquid-carried waste from industrial or commercial processes, as distinct from domestic wastewater. These wastes may result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operations such as feed lots, poultry houses, or dairies. The term includes contaminated storm water and, also, leachate from solid waste facilities.

Infiltration and Inflow (I/I)--"Infiltration" means the addition of ground water into a sewer through joints, the sewer pipe material, cracks, and other defects. "Inflow" means the addition of precipitation-caused drainage from roof drains, yard drains, basement drains, street catch basins, etc., into a sewer.

Interference--A discharge which, alone or in conjunction with a discharge or discharges from other sources, both:

- Inhibits or disrupts the POTW, its treatment processes or operations, or its sludge processes, use or disposal; and
- Therefore is a cause of a violation of any requirement of the POTW's NPDES permit. (including an increase in the magnitude or duration of a violation) or of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent State or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) [including title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including State regulations contained in any State sludge management plan prepared pursuant to subtitle D of the SWDA], sludge regulations appearing in 40 CFR Part 507, the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act.

Major Facility--A facility discharging to surface water with an EPA rating score of >80 points based on such factors as flow volume, toxic pollutant potential, and public health impact.

Maximum Daily Discharge Limitation--The highest allowable daily discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. The daily discharge is calculated as the average measurement of the pollutant over the day.

Method Detection Level (MDL)--The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is above zero and is determined from analysis of a sample in a given matrix containing the analyte.

Minor Facility--A facility discharging to surface water with an EPA rating score of < 80 points based on such factors as flow volume, toxic pollutant potential, and public health impact.

Mixing Zone--A volume that surrounds an effluent discharge within which water quality criteria may be exceeded. The area of the authorized mixing zone is specified in a facility's permit and follows procedures outlined in State regulations (Chapter 173-201A WAC).

National Pollutant Discharge Elimination System (NPDES)--The NPDES (Section 402 of the Clean Water Act) is the Federal wastewater permitting system for discharges to navigable waters of the United States. Many states, including the State of Washington, have been delegated the authority to issue these permits. NPDES permits issued by Washington State permit writers are joint NPDES/State permits issued under both State and Federal laws.

Pass Through--A discharge which exits the POTW into waters of the State in quantities or concentrations which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation), or which is a cause of a violation of State water quality standards.

pH--The pH of a liquid measures its acidity or alkalinity. A pH of 7 is defined as neutral, and large variations above or below this value are considered harmful to most aquatic life.

Quantitation Level (QL)--A calculated value five times the MDL (method detection level).

Significant Industrial User (SIU)--

1. All industrial users subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; and
2. Any other industrial user that: discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, non-contact cooling, and boiler blow-down wastewater); contributes a process wastestream that makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the Control Authority* on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement [in accordance with 40 CFR 403.8(f)(6)].

Upon finding that the industrial user meeting the criteria in paragraph 2, above, has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the Control Authority* may at any time, on its own initiative or in response to a petition received from an industrial user or POTW, and in accordance with 40 CFR 403.8(f)(6), determine that such industrial user is not a significant industrial user.

*The term "Control Authority" refers to the Washington State Department of Ecology in the case of non-delegated POTWs or to the POTW in the case of delegated POTWs.

State Waters--Lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, wetlands, and all other surface waters and watercourses within the jurisdiction of the state of Washington.

Stormwater--That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility.

Technology-based Effluent Limit--A permit limit that is based on the ability of a treatment method to reduce the pollutant.

Total Suspended Solids (TSS)--Total suspended solids are the particulate materials in an effluent. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

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

Water Quality-based Effluent Limit--A limit on the concentration or mass of an effluent parameter that is intended to prevent the concentration of that parameter from exceeding its water quality criterion after it is discharged into a receiving water.

APPENDIX C--TECHNICAL CALCULATIONS

Several of the Excel® spreadsheet tools used to evaluate a discharger's ability to meet Washington State water quality standards can be found on the Department's homepage at http.www:wa.gov.ecology.

REASONABLE POTENTIAL CALCULATION FOR PROTECTION OF HUMAN HEALTH

Revised 3/00

Parameter	Ambient Concentration (Geometric Mean) ug/L	Water Quality Criteria for Protection of Human Health ug/L	Max concentration at edge of chronic mixing zone. ug/L	LIMIT REQ'D?	Expected Number of Compliance Samples per Month	AVERAGE MONTHLY EFFLUENT LIMIT ug/L	MAXIMUM DAILY EFFLUENT LIMIT ug/L	Estimated Percentile at 95% Confidence	Pn	Max effluent conc. measured ug/L	Coeff Variation CV	S	# of samples from which # in col K was taken n	Multiplier	Calculated 50th percentile Effluent Conc. (When n>10)	Dilution Factor
MERCURY	0.00	0.15	0.01	NO	4.00	NONE	NONE	0.50	0.93	1.00	0.60	0.6	44	0.43	0.55	70.0
ARSENIC	0.00	0.14	0.14	NO	4.00	NONE	NONE	0.50	0.93	15.00	0.60	0.6	44	0.43	9.77	70.0

This spreadsheet calculates the reasonable potential to exceed state water quality standards for a small number of samples. The procedure and calculations are done per the procedure in Technical Support Document for Water Quality-based Toxics Control, U.S. EPA, March 1991 (EPA/505/2-90-001) on page 56. User input columns are shown with red headings. Corrected formulas in col G and H on 5/98 (GB)

CALCULATIONS

Parameter	Metal Criteria Translator as decimal Acute	Metal Criteria Translator as decimal Chronic	Ambient Concentration (metals as dissolved) ug/L	State Water Quality Standard Acute ug/L	State Water Quality Standard Chronic ug/L	Max concentration at edge of... Acute Mixing Zone ug/L	Max concentration at edge of... Chronic Mixing Zone ug/L	LIMIT REQ'D?	Effluent percentile value	Pn	Max effluent conc. measured (metals as total recoverable) ug/L	Coeff Variation CV	s	# of samples n	Multiplier	Acute Dil'n Factor	Chronic Dil'n Factor	COMMENTS
Chlorine				13.00	7.50	4.15	1.96	NO	0.95	1.00	280.00	0.60	0.55	1800.00	0.49	33.00	70.00	Therer is no reasonable potential to violate water quality criteria. However, the chlorine limits inserted in the permit are based on the plant past performance and previous permit.
NH3-N				52980.00	7960.00	805.89	379.92	NO	0.95	0.95	26300.00	0.60	0.55	56.00	1.01	33.00	70.00	
Asenic				69.60	36.00	0.49	0.23	NO	0.95	0.93	15.00	0.60	0.55	44.00	1.08	33.00	70.00	
Nickle	0.99	0.99		74.00	8.20	0.42	0.20	NO	0.95	0.93	13.00	0.60	0.55	44.00	1.08	33.00	70.00	
Silver	0.89	1.00		1.90	100.00	0.35	0.18	NO	0.95	0.93	12.00	0.60	0.55	44.00	1.08	33.00	70.00	
Zinc	0.95	0.95		90.00	81.00	3.09	1.46	NO	0.95	0.93	100.00	0.60	0.55	44.00	1.08	33.00	70.00	
Cadmium	0.99	0.93		42.00	9.30	0.05	0.02	NO	0.95	0.93	1.40	0.60	0.55	44.00	1.08	33.00	70.00	
Lead	0.95	0.95		210.00	8.10	0.22	0.10	NO	0.95	0.93	7.00	0.60	0.55	44.00	1.08	33.00	70.00	
Chromium	0.89	0.99		1100.00	50.00	0.68	0.32	NO	0.95	0.93	21.00	0.60	0.55	44.00	1.08	33.00	70.00	
Copper	0.83	0.83		4.80	3.10	1.57	0.74	NO	0.99	0.93	58.00	0.60	0.55	44.00	1.08	33.00	70.00	
Mercury	0.85	0.01		1.80	0.025	0.03	0.00	NO	0.95	0.93	1.00	0.60	0.55	44.00	1.08	33.00	70.00	

Calculation of seawater fraction of un-ionized ammonia from Hampson (1977). Un-ionized ammonia criteria for salt water are from EPA 440/5-88-004.

Based on Lotus File NH3SALT.WK1 Revised 19-Oct-93

INPUT	
1. Temperature (deg C):	5.0
2. pH:	7.5
3. Salinity (g/Kg):	20.0
OUTPUT	
1. Pressure (atm; EPA criteria assumes 1 atm):	1.0
2. Molal Ionic Strength (not valid if >0.85):	0.407
3. pKa8 at 25 deg C (Whitfield model "B"):	9.292
4. Percent of Total Ammonia Present as Unionized:	0.361%
5. Unionized ammonia criteria (mg un-ionized NH3 per liter) from EPA 440/5-88-004	
Acute:	0.233
Chronic:	0.035
6. Total Ammonia Criteria (mg/L as NH3)	
Acute:	64.46
Chronic:	9.68
7. Total Ammonia Criteria (mg/L as NH3-N)	
Acute:	52.98
Chronic:	7.96

APPENDIX D--RESPONSES TO COMMENTS

We received few comments from three entities, the City of Bellingham, Resources for Sustainable Communities, and the United States Environmental Protection Agency. After thoroughly reviewing the comments, the following are our response. We have also attached the original comments herewith.

CITY OF BELLINGHAM

Design Criteria and Mixing Zone Analysis

The state laws and regulations prohibit the Department of Ecology to issue a NPDES permit that is not in conformation with the approved engineering report. Chapter 173 – 220 WAC, which is the regulations on NPDES permit issuance, section 150 (1)(g) reads in part "...Where design criteria has been established, the Permittee shall not allow flows or waste loadings to exceed approved design criteria, or approved revision thereto." If the operational capacities, and the resulting dilution factors, are higher than what was already approved by the Department, a new revised engineering report, or an amendment to the existing engineering report, may be resubmitted to the Department for review and approval. The revised engineering report must show all the appropriate engineering and sizing calculations and the resulting dilution factors. The report shall meet the requirements for engineering report submittals and be in accordance with WAC 173-240. To facilitate your efforts, we have attached a procedure from the Department of Ecology Water Quality Program, Criteria for Sewage Works Design manual, section G1-5.4.2, called "Facility Rerating Procedure" for your review and consideration. The Department will revise the NPDES permit after the engineering report was approved to incorporate the new revised design criteria and dilution factors.

Wastewater Characterization and Whole Effluent Toxicity

The result of the latest wastewater toxicity characterization indicated need for acute and chronic toxicity limits. However, it was inconclusive whether failure was due to lack of appropriate pH control at the laboratory, or else. The reason for requiring new characterization was primarily due to this fact. However, under state law, chapter 173-205-060(1) WAC, Whole Effluent Toxicity Testing and Limits, when a POTW receives pretreated wastewater from industries identified under 40 CFR part 403, Appendix C, such as petroleum refining, a new characterization can be sought. This regulation applies to the POTWs that have conclusively passed the characterization testing and have not been given any toxicity limits. The results of the City of Bellingham characterization testing was inconclusive, therefore, repeating the effluent characterization was the only logical choice.

Weekly Average Mass Emission Limits

In accordance with chapter 173-221, Wastewater Discharge Standards and Effluent Limitations, section 30-11(a), the weekly average is 1.5 times the value of the monthly average calculated. In case of the City of Bellingham, the monthly average was calculated as (maximum month flow) *(technology effluent concentration limits)*(conversion factor), and the weekly average limit was calculated as 1.5 times the monthly average limit as prescribed by the aforementioned WAC.

Sediment Sampling and Analysis Plan

Concerning the sediment sampling and analysis plan, the Department of Ecology, Sediment Management Unit, called for the sediment sampling and analysis of the plant outfalls and will eventually review and approve the sediment sampling and analysis plan. I understand your argument on outfall 002. However, the proposed permit requires you to develop a sampling plan for various outfalls where you can (and you must) argue and discuss thoroughly the merits and demerits of various outfalls sampling. I assure you unless it is deemed necessary; the Department of Ecology will not require sediment sampling and analysis of any outfall.

Thank you for your comments.

RESOURCES FOR SUSTAINABLE COMMUNITIES

Discharge Limitations

Water Quality Based Limits, Technology Based Limits, and Performance Based Limits

Biological processes such as sewage treatment plants are usually subject to high variability. The variability in the process is an important and a defining factor that must be considered in design and in establishment of the performance-based limits. The higher the variance, larger the treatment processes, and higher the performance based limits. Therefore, establishing a performance-based limit for facilities with high variance may lead to large limits, which, in many instances, may appear to be higher than the highest achieved in the past. The United States Environmental Protection Agency (USEPA) studied many well-run sewage treatment facilities throughout the United States and established the technology-based effluent limits for conventional pollutants (i.e., monthly and weekly average limits for BOD & TSS). The purpose of the study was to establish the facilities long-term capabilities, and to assure that these limits are environmentally safe and technologically and economically achievable without exerting extra burden on public. In addition, USEPA established treatment standards based on *All Known Available and Reasonable Technology* (AKART). These standards are based on best available technologies that are economically and reasonably achievable.

Secondly, we need to consider what harm excessive BOD may do to the receiving water. If the technology-based limits for BOD causes dissolve oxygen suppression of the receiving, the limits should be reduced and set based on more stringent water quality-based criteria; otherwise, technology-based effluent limits should be retained. In the case of the City of Bellingham, this discharge with technology-based limitations results in a small amount of BOD loading relative to the large amount of dilution occurring in the receiving water at critical conditions. Technology-based limitations will be protective of dissolved oxygen criteria in the receiving water and will not cause dissolve oxygen suppression of the receiving water.

pH

The dilution attained at the boundaries of the chronic mixing zone is about 70:1. Considering massive buffering capacity of the receiving marine water and attainable dilution, the technology-based limits can be safely assumed to be protective of the water quality.

Monitoring Requirements

Metal and Priority Sampling

Evaluation of the effluent heavy metals concentration indicated that the effluent has no reasonable potential to violate water quality standards. However, heavy metal and priority pollutants quarterly sampling and monitoring schedules were included in the proposed permit to assure these pollutants frequent and regular monitoring and reporting.

Ammonia

The ammonia has been and is being monitored by the City of Bellingham on a regular basis for the plant process controls. We did receive the results of these samplings and we did evaluate the effluent ammonia concentration to assess its reasonable potential to violate water quality criteria. Our evaluation indicated that there is no reasonable potential for the ammonia to exceed water quality standards at the level reported. The proposed permit will not contain ammonia sampling and monitoring schedules.

Thank you for your comments.

THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA)

The City of Bellingham has prepared and has already received approval for its Combined Sewer Overflow Reduction Plan. The City of Bellingham submitted this report to the Department of Ecology to satisfy requirements of the chapter 173-245 WAC, which is "Submission of Plans and Reports for Construction and Operation of Combined Sewer Overflow Reduction Facilities." The purpose of this chapter is to assure all CSO cities to achieve and, at least, to maintain the *Greatest Reasonable Reduction* of combine sewer overflows at the earliest possible date, and neither cause violations of applicable water quality standards, nor restriction to the characteristic uses of the receiving water, nor accumulation of deposit which exceed sediment criteria or standards; or have an adverse biological effect. This chapter defines the *Greatest Reasonable Reduction* as control of CSO's such that an average of one untreated discharge may occur per year. When the City submitted their plan for their combined sewer overflow reduction, which was based on previous years, they appeared to be in compliance with the requirement of this chapter, which is on average one overflow per year. However, further review of the City of Bellingham CSO activities revealed that during the past five years (95, 96, 97, 98, 99) the City has exceeded the regulatory limit of one overflow per year. The table below shows the frequency of overflows during the past seven years:

1993	0
1994	0
1995	2
1996	2
1997	1
1998	1
1999	4

The overflows during 1999 were due to exceptional stormy season but the volume of each overflow does not appear to be significant in most cases. The City is progressing on either upgrading the capacity of one of the main pumping station with more frequent overflows, or building a new one. The pumping station is being modeled hydraulically to assess upgrade and retrofit feasibility. We have included to the proposed permit the Combined Sewer Overflow Reduction Plan Amendment, which was inadvertently excluded from the draft permit. This report must be submitted to the Department once during the permit cycle in accordance with chapter 173-245 -090(2) WAC.

This permit prohibits discharges from the CSO outfalls except as a result of and during precipitation events. This permit does not grant any authorization to the City of Bellingham to discharge from a CSO outfall that causes adverse impacts that threaten characteristic uses of the receiving water as identified in the water quality standards, chapter 173-201A WAC.

The recommended nine minimum control guidelines, developed by USEPA's, is an excellent and systematic approach for reducing and controlling of pollution from CSO outfalls. However, chapter 173-245 WAC encompasses many aspects of this guidelines, and therefore, requiring the City of Bellingham to comply with another similar sets of requirements and reporting may not be justifiable.

Thank you for your comments.

Appendix F

DEMOGRAPHIC ANALYSIS DATA

Scenario 1 Population Summary

Taz #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
1	0.0	0.0	0.0	0.0	0.0	243.9	255.1	283.0	299.7	310.9	243.9	255.1	283.0	299.7	310.9
2	27.0	27.2	27.7	28.0	28.2	0.0	0.0	0.0	0.0	0.0	27.0	27.2	27.7	28.0	28.2
3	663.0	724.8	879.3	972.0	1,033.8	0.0	0.0	0.0	0.0	0.0	663.0	724.8	879.3	972.0	1,033.8
4	0.0	0.0	0.0	0.0	0.0	52.0	53.2	56.2	58.0	59.2	52.0	53.2	56.2	58.0	59.2
5	137.0	137.4	138.4	139.0	139.4	0.0	0.0	0.0	0.0	0.0	137.0	137.4	138.4	139.0	139.4
6	76.0	160.8	372.8	500.0	584.8	369.9	694.3	1,505.2	1,991.7	2,316.1	445.9	855.1	1,878.0	2,491.7	2,900.9
7	5.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.0
8	610.0	738.8	1,060.8	1,254.0	1,382.8	0.0	0.0	0.0	0.0	0.0	610.0	738.8	1,060.8	1,254.0	1,382.8
9	184.0	187.4	195.9	201.0	204.4	0.0	0.0	0.0	0.0	0.0	184.0	187.4	195.9	201.0	204.4
10	15.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0	0.0	0.0	15.0	15.0	15.0	15.0	15.0
11	244.0	284.8	386.8	448.0	488.8	0.0	0.0	0.0	0.0	0.0	244.0	284.8	386.8	448.0	488.8
12	0.0	0.0	0.0	0.0	0.0	86.9	91.5	102.9	109.7	114.3	86.9	91.5	102.9	109.7	114.3
13	7.0	7.8	9.8	11.0	11.8	0.0	0.0	0.0	0.0	0.0	7.0	7.8	9.8	11.0	11.8
14	830.0	857.4	925.9	967.0	994.4	207.0	214.0	231.5	242.0	249.0	1,037.0	1,071.4	1,157.4	1,209.0	1,243.4
15	19.0	20.4	23.9	26.0	27.4	15.0	16.0	18.5	20.0	21.0	34.0	36.4	42.4	46.0	48.4
16	426.0	530.0	790.0	946.0	1,050.0	0.0	0.0	0.0	0.0	0.0	426.0	530.0	790.0	946.0	1,050.0
17	70.0	71.4	74.9	77.0	78.4	0.0	0.0	0.0	0.0	0.0	70.0	71.4	74.9	77.0	78.4
18	224.0	230.4	246.4	256.0	262.4	223.0	229.6	246.1	256.0	262.6	447.0	460.0	492.5	512.0	525.0
19	16.0	29.6	63.6	84.0	97.6	0.0	0.0	0.0	0.0	0.0	16.0	29.6	63.6	84.0	97.6
20	19.0	42.2	100.2	135.0	158.2	101.9	129.9	199.8	241.7	269.7	120.9	172.1	300.0	376.7	427.9
21	0.0	0.0	0.0	0.0	0.0	99.9	125.1	188.0	225.7	250.9	99.9	125.1	188.0	225.7	250.9
22	126.0	131.4	144.9	153.0	158.4	570.9	576.9	591.8	600.7	606.7	696.9	708.3	736.7	753.7	765.1
23	306.0	351.2	464.2	532.0	577.2	0.0	0.0	0.0	0.0	0.0	306.0	351.2	464.2	532.0	577.2
24	41.0	41.2	41.7	42.0	42.2	0.0	0.0	0.0	0.0	0.0	41.0	41.2	41.7	42.0	42.2
25	0.0	0.0	0.0	0.0	0.0	1,769.0	1,716.2	1,584.2	1,505.0	1,452.2	1,769.0	1,716.2	1,584.2	1,505.0	1,452.2
26	23.0	44.0	96.5	128.0	149.0	159.9	227.9	397.8	499.7	567.7	182.9	271.9	494.3	627.7	716.7
27	0.0	0.0	0.0	0.0	0.0	213.9	229.5	268.4	291.7	307.3	213.9	229.5	268.4	291.7	307.3
28	6.0	6.6	8.1	9.0	9.6	0.0	0.0	0.0	0.0	0.0	6.0	6.6	8.1	9.0	9.6
29	8.0	8.4	9.4	10.0	10.4	10.0	10.2	10.7	11.0	11.2	18.0	18.6	20.1	21.0	21.6
30	1,131.0	1,156.2	1,219.2	1,257.0	1,282.2	0.0	0.0	0.0	0.0	0.0	1,131.0	1,156.2	1,219.2	1,257.0	1,282.2
31	154.0	154.4	155.4	156.0	156.4	0.0	0.0	0.0	0.0	0.0	154.0	154.4	155.4	156.0	156.4
32	61.0	148.6	367.6	499.0	586.6	0.0	0.0	0.0	0.0	0.0	61.0	148.6	367.6	499.0	586.6
33	21.0	29.6	51.1	64.0	72.6	0.0	0.0	0.0	0.0	0.0	21.0	29.6	51.1	64.0	72.6
34	313.0	505.4	986.4	1,275.0	1,467.4	0.0	0.0	0.0	0.0	0.0	313.0	505.4	986.4	1,275.0	1,467.4
35	0.0	0.0	0.0	0.0	0.0	1,649.0	1,654.6	1,668.6	1,677.0	1,682.6	1,649.0	1,654.6	1,668.6	1,677.0	1,682.6
36	531.0	532.2	535.2	537.0	538.2	0.0	0.0	0.0	0.0	0.0	531.0	532.2	535.2	537.0	538.2
37	826.0	842.6	884.1	909.0	925.6	446.0	454.8	476.8	490.0	498.8	1,272.0	1,297.4	1,360.9	1,399.0	1,424.4
38	14.0	14.0	14.0	14.0	14.0	0.0	0.0	0.0	0.0	0.0	14.0	14.0	14.0	14.0	14.0
39	34.0	34.2	34.7	35.0	35.2	0.0	0.0	0.0	0.0	0.0	34.0	34.2	34.7	35.0	35.2
40	331.0	343.2	373.7	392.0	404.2	0.0	0.0	0.0	0.0	0.0	331.0	343.2	373.7	392.0	404.2
41	45.0	45.2	45.7	46.0	46.2	0.0	0.0	0.0	0.0	0.0	45.0	45.2	45.7	46.0	46.2
42	614.0	618.6	630.1	637.0	641.6	0.0	0.0	0.0	0.0	0.0	614.0	618.6	630.1	637.0	641.6
43	253.0	258.2	271.2	279.0	284.2	0.0	0.0	0.0	0.0	0.0	253.0	258.2	271.2	279.0	284.2

Scenario 1 Population Summary

Taz #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
44	704.0	709.2	722.2	730.0	735.2	0.0	0.0	0.0	0.0	0.0	704.0	709.2	722.2	730.0	735.2
45	559.0	648.2	871.2	1,005.0	1,094.2	0.0	0.0	0.0	0.0	0.0	559.0	648.2	871.2	1,005.0	1,094.2
46	356.0	376.4	427.4	458.0	478.4	420.9	426.3	439.7	447.7	453.1	776.9	802.7	867.1	905.7	931.5
47	2.0	2.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	2.0
48	380.0	382.4	388.4	392.0	394.4	0.0	0.0	0.0	0.0	0.0	380.0	382.4	388.4	392.0	394.4
49	7.0	41.0	126.0	177.0	211.0	0.0	0.0	0.0	0.0	0.0	7.0	41.0	126.0	177.0	211.0
50	147.0	148.0	150.5	152.0	153.0	123.0	123.8	125.8	127.0	127.8	270.0	271.8	276.3	279.0	280.8
51	323.0	338.8	378.3	402.0	417.8	0.0	0.0	0.0	0.0	0.0	323.0	338.8	378.3	402.0	417.8
52	392.0	404.8	436.8	456.0	468.8	0.0	0.0	0.0	0.0	0.0	392.0	404.8	436.8	456.0	468.8
53	352.0	355.0	362.5	367.0	370.0	0.0	0.0	0.0	0.0	0.0	352.0	355.0	362.5	367.0	370.0
54	658.0	662.0	672.0	678.0	682.0	0.0	0.0	0.0	0.0	0.0	658.0	662.0	672.0	678.0	682.0
55	1,131.0	1,138.8	1,158.3	1,170.0	1,177.8	0.0	0.0	0.0	0.0	0.0	1,131.0	1,138.8	1,158.3	1,170.0	1,177.8
56	201.0	201.8	203.8	205.0	205.8	0.0	0.0	0.0	0.0	0.0	201.0	201.8	203.8	205.0	205.8
57	268.0	271.8	281.3	287.0	290.8	0.0	0.0	0.0	0.0	0.0	268.0	271.8	281.3	287.0	290.8
58	522.0	526.4	537.4	544.0	548.4	0.0	0.0	0.0	0.0	0.0	522.0	526.4	537.4	544.0	548.4
59	86.0	86.2	86.7	87.0	87.2	0.0	0.0	0.0	0.0	0.0	86.0	86.2	86.7	87.0	87.2
60	8.0	13.6	27.6	36.0	41.6	0.0	0.0	0.0	0.0	0.0	8.0	13.6	27.6	36.0	41.6
61	1,044.0	1,054.4	1,080.4	1,096.0	1,106.4	0.0	0.0	0.0	0.0	0.0	1,044.0	1,054.4	1,080.4	1,096.0	1,106.4
62	307.0	321.0	356.0	377.0	391.0	0.0	0.0	0.0	0.0	0.0	307.0	321.0	356.0	377.0	391.0
63	783.0	808.2	871.2	909.0	934.2	0.0	0.0	0.0	0.0	0.0	783.0	808.2	871.2	909.0	934.2
64	1,976.6	1,837.5	1,489.8	1,281.2	1,142.1	0.0	0.0	0.0	0.0	0.0	1,976.6	1,837.5	1,489.8	1,281.2	1,142.1
65	2,867.6	2,934.3	3,101.1	3,201.2	3,267.9	0.0	0.0	0.0	0.0	0.0	2,867.6	2,934.3	3,101.1	3,201.2	3,267.9
66	1,190.0	1,208.2	1,253.7	1,281.0	1,299.2	0.0	0.0	0.0	0.0	0.0	1,190.0	1,208.2	1,253.7	1,281.0	1,299.2
67	5.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.0
68	329.0	331.4	337.4	341.0	343.4	0.0	0.0	0.0	0.0	0.0	329.0	331.4	337.4	341.0	343.4
69	473.0	474.6	478.6	481.0	482.6	0.0	0.0	0.0	0.0	0.0	473.0	474.6	478.6	481.0	482.6
70	510.0	513.6	522.6	528.0	531.6	0.0	0.0	0.0	0.0	0.0	510.0	513.6	522.6	528.0	531.6
71	185.0	186.4	189.9	192.0	193.4	0.0	0.0	0.0	0.0	0.0	185.0	186.4	189.9	192.0	193.4
72	18.0	18.2	18.7	19.0	19.2	18.0	18.2	18.7	19.0	19.2	36.0	36.4	37.4	38.0	38.4
73	194.0	195.8	200.3	203.0	204.8	0.0	0.0	0.0	0.0	0.0	194.0	195.8	200.3	203.0	204.8
74	838.0	844.6	861.1	871.0	877.6	0.0	0.0	0.0	0.0	0.0	838.0	844.6	861.1	871.0	877.6
75	59.0	87.0	157.0	199.0	227.0	0.0	0.0	0.0	0.0	0.0	59.0	87.0	157.0	199.0	227.0
76	909.0	916.4	934.9	946.0	953.4	0.0	0.0	0.0	0.0	0.0	909.0	916.4	934.9	946.0	953.4
77	10.0	10.0	10.0	10.0	10.0	0.0	0.0	0.0	0.0	0.0	10.0	10.0	10.0	10.0	10.0
78	42.0	42.2	42.7	43.0	43.2	0.0	0.0	0.0	0.0	0.0	42.0	42.2	42.7	43.0	43.2
79	52.0	52.2	52.7	53.0	53.2	0.0	0.0	0.0	0.0	0.0	52.0	52.2	52.7	53.0	53.2
80	276.0	277.8	282.3	285.0	286.8	0.0	0.0	0.0	0.0	0.0	276.0	277.8	282.3	285.0	286.8
81	100.0	100.6	102.1	103.0	103.6	0.0	0.0	0.0	0.0	0.0	100.0	100.6	102.1	103.0	103.6
82	170.0	172.0	177.0	180.0	182.0	0.0	0.0	0.0	0.0	0.0	170.0	172.0	177.0	180.0	182.0
83	13.0	13.0	13.0	13.0	13.0	0.0	0.0	0.0	0.0	0.0	13.0	13.0	13.0	13.0	13.0
84	333.0	336.4	344.9	350.0	353.4	0.0	0.0	0.0	0.0	0.0	333.0	336.4	344.9	350.0	353.4
85	194.0	195.4	198.9	201.0	202.4	0.0	0.0	0.0	0.0	0.0	194.0	195.4	198.9	201.0	202.4
86	2,650.6	2,521.1	2,197.4	2,003.2	1,873.7	0.0	0.0	0.0	0.0	0.0	2,650.6	2,521.1	2,197.4	2,003.2	1,873.7
87	1,183.6	1,029.3	643.6	412.2	257.9	0.0	0.0	0.0	0.0	0.0	1,183.6	1,029.3	643.6	412.2	257.9

Scenario 1 Population Summary

Taz #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
88	2,155.6	2,012.7	1,655.5	1,441.2	1,298.3	0.0	0.0	0.0	0.0	0.0	2,155.6	2,012.7	1,655.5	1,441.2	1,298.3
89	985.0	993.8	1,015.8	1,029.0	1,037.8	0.0	0.0	0.0	0.0	0.0	985.0	993.8	1,015.8	1,029.0	1,037.8
90	0.0	13.6	47.6	68.0	81.6	0.0	0.0	0.0	0.0	0.0	0.0	13.6	47.6	68.0	81.6
91	43.0	149.8	416.8	577.0	683.8	0.0	0.0	0.0	0.0	0.0	43.0	149.8	416.8	577.0	683.8
92	247.0	250.6	259.6	265.0	268.6	0.0	0.0	0.0	0.0	0.0	247.0	250.6	259.6	265.0	268.6
93	922.0	937.2	975.2	998.0	1,013.2	614.0	624.0	649.0	664.0	674.0	1,536.0	1,561.2	1,624.2	1,662.0	1,687.2
94	445.0	456.8	486.3	504.0	515.8	0.0	0.0	0.0	0.0	0.0	445.0	456.8	486.3	504.0	515.8
95	245.0	521.4	1,212.4	1,627.0	1,903.4	0.0	0.0	0.0	0.0	0.0	245.0	521.4	1,212.4	1,627.0	1,903.4
96	20.0	20.0	20.0	20.0	20.0	0.0	0.0	0.0	0.0	0.0	20.0	20.0	20.0	20.0	20.0
97	56.0	56.2	56.7	57.0	57.2	0.0	0.0	0.0	0.0	0.0	56.0	56.2	56.7	57.0	57.2
98	305.0	317.0	347.0	365.0	377.0	0.0	0.0	0.0	0.0	0.0	305.0	317.0	347.0	365.0	377.0
99	48.0	59.0	86.5	103.0	114.0	0.0	0.0	0.0	0.0	0.0	48.0	59.0	86.5	103.0	114.0
100	29.0	40.0	67.5	84.0	95.0	0.0	0.0	0.0	0.0	0.0	29.0	40.0	67.5	84.0	95.0
101	0.0	6.8	23.8	34.0	40.8	0.0	0.0	0.0	0.0	0.0	0.0	6.8	23.8	34.0	40.8
102	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
104	913.0	916.8	926.3	932.0	935.8	0.0	0.0	0.0	0.0	0.0	913.0	916.8	926.3	932.0	935.8
105	834.0	842.2	862.7	875.0	883.2	0.0	0.0	0.0	0.0	0.0	834.0	842.2	862.7	875.0	883.2
106	296.0	299.0	306.5	311.0	314.0	0.0	0.0	0.0	0.0	0.0	296.0	299.0	306.5	311.0	314.0
107	104.0	104.2	104.7	105.0	105.2	0.0	0.0	0.0	0.0	0.0	104.0	104.2	104.7	105.0	105.2
108	0.0	5.8	20.3	29.0	34.8	0.0	0.0	0.0	0.0	0.0	0.0	5.8	20.3	29.0	34.8
109	53.0	85.8	167.8	217.0	249.8	0.0	0.0	0.0	0.0	0.0	53.0	85.8	167.8	217.0	249.8
110	122.0	155.0	237.5	287.0	320.0	0.0	0.0	0.0	0.0	0.0	122.0	155.0	237.5	287.0	320.0
111	121.0	132.4	160.9	178.0	189.4	0.0	0.0	0.0	0.0	0.0	121.0	132.4	160.9	178.0	189.4
112	1.0	12.0	39.5	56.0	67.0	0.0	0.0	0.0	0.0	0.0	1.0	12.0	39.5	56.0	67.0
113	124.0	157.0	239.5	289.0	322.0	0.0	0.0	0.0	0.0	0.0	124.0	157.0	239.5	289.0	322.0
114	58.0	80.0	135.0	168.0	190.0	0.0	0.0	0.0	0.0	0.0	58.0	80.0	135.0	168.0	190.0
115	3.0	35.8	117.8	167.0	199.8	0.0	0.0	0.0	0.0	0.0	3.0	35.8	117.8	167.0	199.8
116	0.0	10.8	37.8	54.0	64.8	0.0	0.0	0.0	0.0	0.0	0.0	10.8	37.8	54.0	64.8
117	48.0	59.0	86.5	103.0	114.0	0.0	0.0	0.0	0.0	0.0	48.0	59.0	86.5	103.0	114.0
118	232.0	265.2	348.2	398.0	431.2	0.0	0.0	0.0	0.0	0.0	232.0	265.2	348.2	398.0	431.2
119	114.0	125.4	153.9	171.0	182.4	0.0	0.0	0.0	0.0	0.0	114.0	125.4	153.9	171.0	182.4
120	55.0	60.4	73.9	82.0	87.4	0.0	0.0	0.0	0.0	0.0	55.0	60.4	73.9	82.0	87.4
121	0.0	0.0	0.0	0.0	0.0	503.0	509.2	524.7	534.0	540.2	503.0	509.2	524.7	534.0	540.2
122	51.0	116.4	279.9	378.0	443.4	0.0	0.0	0.0	0.0	0.0	51.0	116.4	279.9	378.0	443.4
123	4.0	416.4	1,447.4	2,066.0	2,478.4	0.0	0.0	0.0	0.0	0.0	4.0	416.4	1,447.4	2,066.0	2,478.4
124	226.0	228.0	233.0	236.0	238.0	0.0	0.0	0.0	0.0	0.0	226.0	228.0	233.0	236.0	238.0
125	331.0	332.4	335.9	338.0	339.4	0.0	0.0	0.0	0.0	0.0	331.0	332.4	335.9	338.0	339.4
126	188.0	188.6	190.1	191.0	191.6	0.0	0.0	0.0	0.0	0.0	188.0	188.6	190.1	191.0	191.6
127	261.0	270.2	293.2	307.0	316.2	0.0	0.0	0.0	0.0	0.0	261.0	270.2	293.2	307.0	316.2
128	35.0	35.2	35.7	36.0	36.2	0.0	0.0	0.0	0.0	0.0	35.0	35.2	35.7	36.0	36.2
129	1,516.0	1,679.0	2,086.5	2,331.0	2,494.0	0.0	0.0	0.0	0.0	0.0	1,516.0	1,679.0	2,086.5	2,331.0	2,494.0
130	78.0	84.8	101.8	112.0	118.8	379.9	391.3	419.7	436.7	448.1	457.9	476.1	521.5	548.7	566.9
131	28.0	28.2	28.7	29.0	29.2	0.0	0.0	0.0	0.0	0.0	28.0	28.2	28.7	29.0	29.2

Scenario 1 Population Summary

Taz #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
132	156.0	189.2	272.2	322.0	355.2	0.0	0.0	0.0	0.0	0.0	156.0	189.2	272.2	322.0	355.2
133	787.0	824.0	916.5	972.0	1,009.0	0.0	0.0	0.0	0.0	0.0	787.0	824.0	916.5	972.0	1,009.0
134	905.0	917.4	948.4	967.0	979.4	0.0	0.0	0.0	0.0	0.0	905.0	917.4	948.4	967.0	979.4
135	0.0	0.0	0.0	0.0	0.0	854.9	866.7	896.1	913.7	925.5	854.9	866.7	896.1	913.7	925.5
136	1,382.0	1,422.6	1,524.1	1,585.0	1,625.6	0.0	0.0	0.0	0.0	0.0	1,382.0	1,422.6	1,524.1	1,585.0	1,625.6
137	475.0	479.8	491.8	499.0	503.8	0.0	0.0	0.0	0.0	0.0	475.0	479.8	491.8	499.0	503.8
138	5.0	47.8	154.8	219.0	261.8	0.0	0.0	0.0	0.0	0.0	5.0	47.8	154.8	219.0	261.8
139	72.0	72.2	72.7	73.0	73.2	0.0	0.0	0.0	0.0	0.0	72.0	72.2	72.7	73.0	73.2
140	126.0	144.8	191.8	220.0	238.8	0.0	0.0	0.0	0.0	0.0	126.0	144.8	191.8	220.0	238.8
141	542.0	544.6	551.1	555.0	557.6	0.0	0.0	0.0	0.0	0.0	542.0	544.6	551.1	555.0	557.6
142	451.0	455.2	465.7	472.0	476.2	0.0	0.0	0.0	0.0	0.0	451.0	455.2	465.7	472.0	476.2
143	688.0	697.2	720.2	734.0	743.2	0.0	0.0	0.0	0.0	0.0	688.0	697.2	720.2	734.0	743.2
144	126.0	174.6	296.1	369.0	417.6	0.0	0.0	0.0	0.0	0.0	126.0	174.6	296.1	369.0	417.6
145	3,636.0	3,652.6	3,694.1	3,719.0	3,735.6	0.0	0.0	0.0	0.0	0.0	3,636.0	3,652.6	3,694.1	3,719.0	3,735.6
146	50.0	50.8	52.8	54.0	54.8	0.0	0.0	0.0	0.0	0.0	50.0	50.8	52.8	54.0	54.8
147	2,549.0	2,579.4	2,655.4	2,701.0	2,731.4	0.0	0.0	0.0	0.0	0.0	2,549.0	2,579.4	2,655.4	2,701.0	2,731.4
148	575.0	589.4	625.4	647.0	661.4	0.0	0.0	0.0	0.0	0.0	575.0	589.4	625.4	647.0	661.4
149	243.0	244.0	246.5	248.0	249.0	0.0	0.0	0.0	0.0	0.0	243.0	244.0	246.5	248.0	249.0
150	397.0	410.8	445.3	466.0	479.8	0.0	0.0	0.0	0.0	0.0	397.0	410.8	445.3	466.0	479.8
151	249.0	298.6	422.6	497.0	546.6	0.0	0.0	0.0	0.0	0.0	249.0	298.6	422.6	497.0	546.6
152	0.0	0.0	0.0	0.0	0.0	520.9	725.3	1,236.2	1,542.7	1,747.1	520.9	725.3	1,236.2	1,542.7	1,747.1
153	749.0	934.0	1,396.5	1,674.0	1,859.0	730.9	879.7	1,251.6	1,474.7	1,623.5	1,479.9	1,813.7	2,648.1	3,148.7	3,482.5
154	56.0	56.2	56.7	57.0	57.2	0.0	0.0	0.0	0.0	0.0	56.0	56.2	56.7	57.0	57.2
155	675.0	678.6	687.6	693.0	696.6	0.0	0.0	0.0	0.0	0.0	675.0	678.6	687.6	693.0	696.6
156	844.0	875.0	952.5	999.0	1,030.0	0.0	0.0	0.0	0.0	0.0	844.0	875.0	952.5	999.0	1,030.0
157	717.0	729.8	761.8	781.0	793.8	0.0	0.0	0.0	0.0	0.0	717.0	729.8	761.8	781.0	793.8
158	489.0	504.0	541.5	564.0	579.0	0.0	0.0	0.0	0.0	0.0	489.0	504.0	541.5	564.0	579.0
159	486.0	488.0	493.0	496.0	498.0	0.0	0.0	0.0	0.0	0.0	486.0	488.0	493.0	496.0	498.0
160	836.0	849.8	884.3	905.0	918.8	0.0	0.0	0.0	0.0	0.0	836.0	849.8	884.3	905.0	918.8
161	673.0	689.2	729.7	754.0	770.2	0.0	0.0	0.0	0.0	0.0	673.0	689.2	729.7	754.0	770.2
162	79.0	81.8	88.8	93.0	95.8	0.0	0.0	0.0	0.0	0.0	79.0	81.8	88.8	93.0	95.8
163	247.0	445.2	940.7	1,238.0	1,436.2	0.0	0.0	0.0	0.0	0.0	247.0	445.2	940.7	1,238.0	1,436.2
164	940.0	955.4	993.9	1,017.0	1,032.4	0.0	0.0	0.0	0.0	0.0	940.0	955.4	993.9	1,017.0	1,032.4
165	521.0	536.2	574.2	597.0	612.2	0.0	0.0	0.0	0.0	0.0	521.0	536.2	574.2	597.0	612.2
166	34.0	127.6	361.6	502.0	595.6	0.0	0.0	0.0	0.0	0.0	34.0	127.6	361.6	502.0	595.6
167	241.0	248.6	267.6	279.0	286.6	0.0	0.0	0.0	0.0	0.0	241.0	248.6	267.6	279.0	286.6
168	422.0	434.0	464.0	482.0	494.0	0.0	0.0	0.0	0.0	0.0	422.0	434.0	464.0	482.0	494.0
169	561.0	574.4	607.9	628.0	641.4	0.0	0.0	0.0	0.0	0.0	561.0	574.4	607.9	628.0	641.4
170	809.0	1,026.2	1,569.2	1,895.0	2,112.2	0.0	0.0	0.0	0.0	0.0	809.0	1,026.2	1,569.2	1,895.0	2,112.2
171	362.0	368.4	384.4	394.0	400.4	0.0	0.0	0.0	0.0	0.0	362.0	368.4	384.4	394.0	400.4
172	419.0	421.8	428.8	433.0	435.8	0.0	0.0	0.0	0.0	0.0	419.0	421.8	428.8	433.0	435.8
173	646.0	675.0	747.5	791.0	820.0	0.0	0.0	0.0	0.0	0.0	646.0	675.0	747.5	791.0	820.0
174	70.0	95.6	159.6	198.0	223.6	0.0	0.0	0.0	0.0	0.0	70.0	95.6	159.6	198.0	223.6
214	1,733.0	1,778.4	1,891.9	1,960.0	2,005.4	0.0	0.0	0.0	0.0	0.0	1,733.0	1,778.4	1,891.9	1,960.0	2,005.4

Scenario 1 Population Summary

Taz #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
215	76.0	82.8	99.8	110.0	116.8	0.0	0.0	0.0	0.0	0.0	76.0	82.8	99.8	110.0	116.8
216	111.0	120.8	145.3	160.0	169.8	0.0	0.0	0.0	0.0	0.0	111.0	120.8	145.3	160.0	169.8
220	64.0	65.4	68.9	71.0	72.4	10.0	10.0	10.0	10.0	10.0	74.0	75.4	78.9	81.0	82.4
266	0.0	0.0	0.0	0.0	0.0	158.9	948.7	2,923.1	4,107.7	4,897.5	158.9	948.7	2,923.1	4,107.7	4,897.5
271	0.0	0.0	0.0	0.0	0.0	180.0	182.0	187.0	190.0	192.0	180.0	182.0	187.0	190.0	192.0
272	0.0	0.0	0.0	0.0	0.0	212.9	318.3	581.7	739.7	845.1	212.9	318.3	581.7	739.7	845.1
341	0.0	0.0	0.0	0.0	0.0	67.0	66.0	63.5	62.0	61.0	67.0	66.0	63.5	62.0	61.0
342	0.0	0.0	0.0	0.0	0.0	206.0	209.6	218.6	224.0	227.6	206.0	209.6	218.6	224.0	227.6
346	446.0	768.4	1,574.4	2,058.0	2,380.4	430.9	679.5	1,300.9	1,673.7	1,922.3	876.9	1,447.9	2,875.3	3,731.7	4,302.7
347	25.0	48.4	106.9	142.0	165.4	543.9	973.3	2,046.7	2,690.7	3,120.1	568.9	1,021.7	2,153.6	2,832.7	3,285.5
Total	69,260	73,144	82,853	88,678	92,562	12,194	14,631	20,722	24,377	26,814	81,454	87,774	103,575	113,055	119,375

Summary:

	2002	2006	2016	2022	2026
CL	69260	73144	82853	88678	92562
UGA	12194	14631	20722	24377	26814
Total	81454	87774	103575	113055	119375

Scenario 1 Employment Summary

TAZ #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
1	8.0	9.6	13.6	16.0	17.6	73.0	87.2	122.7	144.0	158.2	81.0	96.8	136.3	160.0	175.8
2	178.0	189.0	216.5	233.0	244.0	0.0	0.0	0.0	0.0	0.0	178.0	189.0	216.5	233.0	244.0
3	270.0	305.0	392.5	445.0	480.0	0.0	0.0	0.0	0.0	0.0	270.0	305.0	392.5	445.0	480.0
4	0.0	0.0	0.0	0.0	0.0	1,136.0	1,184.4	1,305.4	1,378.0	1,426.4	1,136.0	1,184.4	1,305.4	1,378.0	1,426.4
5	914.0	1,128.2	1,663.7	1,985.0	2,199.2	0.0	0.0	0.0	0.0	0.0	914.0	1,128.2	1,663.7	1,985.0	2,199.2
6	408.0	462.4	598.4	680.0	734.4	0.0	0.0	0.0	0.0	0.0	408.0	462.4	598.4	680.0	734.4
7	58.0	65.4	83.9	95.0	102.4	0.0	0.0	0.0	0.0	0.0	58.0	65.4	83.9	95.0	102.4
8	200.0	221.8	276.3	309.0	330.8	0.0	0.0	0.0	0.0	0.0	200.0	221.8	276.3	309.0	330.8
9	59.0	155.4	396.4	541.0	637.4	0.0	0.0	0.0	0.0	0.0	59.0	155.4	396.4	541.0	637.4
10	494.0	540.8	657.8	728.0	774.8	0.0	0.0	0.0	0.0	0.0	494.0	540.8	657.8	728.0	774.8
11	22.0	26.0	36.0	42.0	46.0	0.0	0.0	0.0	0.0	0.0	22.0	26.0	36.0	42.0	46.0
12	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.3	0.0	0.0	1.0	0.8	0.3	0.0	0.0
13	361.0	430.2	603.2	707.0	776.2	0.0	0.0	0.0	0.0	0.0	361.0	430.2	603.2	707.0	776.2
14	32.0	37.4	50.9	59.0	64.4	145.0	169.4	230.4	267.0	291.4	177.0	206.8	281.3	326.0	355.8
15	67.0	129.0	284.0	377.0	439.0	53.0	101.8	223.8	297.0	345.8	120.0	230.8	507.8	674.0	784.8
16	141.0	176.0	263.5	316.0	351.0	0.0	0.0	0.0	0.0	0.0	141.0	176.0	263.5	316.0	351.0
17	142.0	178.4	269.4	324.0	360.4	0.0	0.0	0.0	0.0	0.0	142.0	178.4	269.4	324.0	360.4
18	0.0	0.0	0.0	0.0	0.0	8.0	9.0	11.5	13.0	14.0	8.0	9.0	11.5	13.0	14.0
19	201.0	248.0	365.5	436.0	483.0	0.0	0.0	0.0	0.0	0.0	201.0	248.0	365.5	436.0	483.0
20	9.0	10.4	13.9	16.0	17.4	18.0	20.2	25.7	29.0	31.2	27.0	30.6	39.6	45.0	48.6
21	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	6.0	4.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	4.8	1.8	0.0	0.0
23	1,423.0	1,523.2	1,773.7	1,924.0	2,024.2	0.0	0.0	0.0	0.0	0.0	1,423.0	1,523.2	1,773.7	1,924.0	2,024.2
24	1,831.0	2,291.6	3,443.1	4,134.0	4,594.6	0.0	0.0	0.0	0.0	0.0	1,831.0	2,291.6	3,443.1	4,134.0	4,594.6
25	0.0	0.0	0.0	0.0	0.0	352.0	397.0	509.5	577.0	622.0	352.0	397.0	509.5	577.0	622.0
26	238.0	257.0	304.5	333.0	352.0	0.0	0.0	0.0	0.0	0.0	238.0	257.0	304.5	333.0	352.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	2.0	21.8	71.3	101.0	120.8	0.0	0.0	0.0	0.0	0.0	2.0	21.8	71.3	101.0	120.8
29	53.0	59.8	76.8	87.0	93.8	53.0	59.8	76.8	87.0	93.8	106.0	119.6	153.6	174.0	187.6
30	427.0	496.2	669.2	773.0	842.2	0.0	0.0	0.0	0.0	0.0	427.0	496.2	669.2	773.0	842.2
31	95.0	107.2	137.7	156.0	168.2	0.0	0.0	0.0	0.0	0.0	95.0	107.2	137.7	156.0	168.2
32	11.0	63.8	195.8	275.0	327.8	0.0	0.0	0.0	0.0	0.0	11.0	63.8	195.8	275.0	327.8
33	86.0	92.6	109.1	119.0	125.6	0.0	0.0	0.0	0.0	0.0	86.0	92.6	109.1	119.0	125.6
34	19.0	73.2	208.7	290.0	344.2	0.0	0.0	0.0	0.0	0.0	19.0	73.2	208.7	290.0	344.2
35	0.0	0.0	0.0	0.0	0.0	25.0	24.0	21.5	20.0	19.0	25.0	24.0	21.5	20.0	19.0
36	17.0	18.8	23.3	26.0	27.8	0.0	0.0	0.0	0.0	0.0	17.0	18.8	23.3	26.0	27.8
37	13.0	19.2	34.7	44.0	50.2	7.0	10.2	18.2	23.0	26.2	20.0	29.4	52.9	67.0	76.4
38	232.0	259.8	329.3	371.0	398.8	0.0	0.0	0.0	0.0	0.0	232.0	259.8	329.3	371.0	398.8
39	12.0	13.4	16.9	19.0	20.4	0.0	0.0	0.0	0.0	0.0	12.0	13.4	16.9	19.0	20.4
40	567.0	644.2	837.2	953.0	1,030.2	0.0	0.0	0.0	0.0	0.0	567.0	644.2	837.2	953.0	1,030.2
41	22.0	25.4	33.9	39.0	42.4	0.0	0.0	0.0	0.0	0.0	22.0	25.4	33.9	39.0	42.4

Scenario 1 Employment Summary

TAZ #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
42	266.0	316.8	443.8	520.0	570.8	0.0	0.0	0.0	0.0	0.0	266.0	316.8	443.8	520.0	570.8
43	15.0	16.8	21.3	24.0	25.8	0.0	0.0	0.0	0.0	0.0	15.0	16.8	21.3	24.0	25.8
44	130.0	145.8	185.3	209.0	224.8	0.0	0.0	0.0	0.0	0.0	130.0	145.8	185.3	209.0	224.8
45	451.0	476.8	541.3	580.0	605.8	0.0	0.0	0.0	0.0	0.0	451.0	476.8	541.3	580.0	605.8
46	5.0	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	9.0	9.0	9.0	9.0	9.0
47	1,886.0	2,131.0	2,743.5	3,111.0	3,356.0	0.0	0.0	0.0	0.0	0.0	1,886.0	2,131.0	2,743.5	3,111.0	3,356.0
48	498.0	576.0	771.0	888.0	966.0	0.0	0.0	0.0	0.0	0.0	498.0	576.0	771.0	888.0	966.0
49	536.0	654.4	950.4	1,128.0	1,246.4	0.0	0.0	0.0	0.0	0.0	536.0	654.4	950.4	1,128.0	1,246.4
50	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0
51	42.0	52.0	77.0	92.0	102.0	0.0	0.0	0.0	0.0	0.0	42.0	52.0	77.0	92.0	102.0
52	17.0	15.8	12.8	11.0	9.8	0.0	0.0	0.0	0.0	0.0	17.0	15.8	12.8	11.0	9.8
53	9.0	9.8	11.8	13.0	13.8	0.0	0.0	0.0	0.0	0.0	9.0	9.8	11.8	13.0	13.8
54	220.0	231.8	261.3	279.0	290.8	0.0	0.0	0.0	0.0	0.0	220.0	231.8	261.3	279.0	290.8
55	50.0	58.6	80.1	93.0	101.6	0.0	0.0	0.0	0.0	0.0	50.0	58.6	80.1	93.0	101.6
56	132.0	157.2	220.2	258.0	283.2	0.0	0.0	0.0	0.0	0.0	132.0	157.2	220.2	258.0	283.2
57	37.0	40.4	48.9	54.0	57.4	0.0	0.0	0.0	0.0	0.0	37.0	40.4	48.9	54.0	57.4
58	17.0	18.2	21.2	23.0	24.2	0.0	0.0	0.0	0.0	0.0	17.0	18.2	21.2	23.0	24.2
59	145.0	224.6	423.6	543.0	622.6	0.0	0.0	0.0	0.0	0.0	145.0	224.6	423.6	543.0	622.6
60	0.0	10.4	36.4	52.0	62.4	0.0	0.0	0.0	0.0	0.0	0.0	10.4	36.4	52.0	62.4
61	25.0	24.6	23.6	23.0	22.6	0.0	0.0	0.0	0.0	0.0	25.0	24.6	23.6	23.0	22.6
62	27.0	58.6	137.6	185.0	216.6	63.0	140.4	333.9	450.0	527.4	90.0	199.0	471.5	635.0	744.0
63	91.0	107.0	147.0	171.0	187.0	0.0	0.0	0.0	0.0	0.0	91.0	107.0	147.0	171.0	187.0
64	40.0	50.4	76.4	92.0	102.4	0.0	0.0	0.0	0.0	0.0	40.0	50.4	76.4	92.0	102.4
65	297.0	373.6	565.1	680.0	756.6	0.0	0.0	0.0	0.0	0.0	297.0	373.6	565.1	680.0	756.6
66	104.0	125.6	179.6	212.0	233.6	0.0	0.0	0.0	0.0	0.0	104.0	125.6	179.6	212.0	233.6
67	79.0	95.6	137.1	162.0	178.6	0.0	0.0	0.0	0.0	0.0	79.0	95.6	137.1	162.0	178.6
68	6.0	7.0	9.5	11.0	12.0	0.0	0.0	0.0	0.0	0.0	6.0	7.0	9.5	11.0	12.0
69	419.0	510.2	738.2	875.0	966.2	0.0	0.0	0.0	0.0	0.0	419.0	510.2	738.2	875.0	966.2
70	17.0	15.0	10.0	7.0	5.0	0.0	0.0	0.0	0.0	0.0	17.0	15.0	10.0	7.0	5.0
71	18.0	20.2	25.7	29.0	31.2	0.0	0.0	0.0	0.0	0.0	18.0	20.2	25.7	29.0	31.2
72	206.0	238.6	320.1	369.0	401.6	206.0	238.4	319.4	368.0	400.4	412.0	477.0	639.5	737.0	802.0
73	80.0	102.0	157.0	190.0	212.0	0.0	0.0	0.0	0.0	0.0	80.0	102.0	157.0	190.0	212.0
74	39.0	33.2	18.7	10.0	4.2	0.0	0.0	0.0	0.0	0.0	39.0	33.2	18.7	10.0	4.2
75	361.0	407.8	524.8	595.0	641.8	0.0	0.0	0.0	0.0	0.0	361.0	407.8	524.8	595.0	641.8
76	253.0	303.4	429.4	505.0	555.4	0.0	0.0	0.0	0.0	0.0	253.0	303.4	429.4	505.0	555.4
77	151.0	186.4	274.9	328.0	363.4	0.0	0.0	0.0	0.0	0.0	151.0	186.4	274.9	328.0	363.4
78	497.0	574.2	767.2	883.0	960.2	0.0	0.0	0.0	0.0	0.0	497.0	574.2	767.2	883.0	960.2
79	170.0	147.4	90.9	57.0	34.4	0.0	0.0	0.0	0.0	0.0	170.0	147.4	90.9	57.0	34.4
80	73.0	62.6	36.6	21.0	10.6	0.0	0.0	0.0	0.0	0.0	73.0	62.6	36.6	21.0	10.6
81	236.0	245.8	270.3	285.0	294.8	0.0	0.0	0.0	0.0	0.0	236.0	245.8	270.3	285.0	294.8
82	39.0	44.8	59.3	68.0	73.8	0.0	0.0	0.0	0.0	0.0	39.0	44.8	59.3	68.0	73.8
83	246.0	275.4	348.9	393.0	422.4	0.0	0.0	0.0	0.0	0.0	246.0	275.4	348.9	393.0	422.4

Scenario 1 Employment Summary

TAZ #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
84	6.0	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0	0.0	6.0	6.0	6.0	6.0	6.0
85	159.0	194.0	281.5	334.0	369.0	0.0	0.0	0.0	0.0	0.0	159.0	194.0	281.5	334.0	369.0
86	1,557.0	1,743.8	2,210.8	2,491.0	2,677.8	0.0	0.0	0.0	0.0	0.0	1,557.0	1,743.8	2,210.8	2,491.0	2,677.8
87	123.0	150.8	220.3	262.0	289.8	0.0	0.0	0.0	0.0	0.0	123.0	150.8	220.3	262.0	289.8
88	15.0	16.0	18.5	20.0	21.0	0.0	0.0	0.0	0.0	0.0	15.0	16.0	18.5	20.0	21.0
89	25.0	26.6	30.6	33.0	34.6	0.0	0.0	0.0	0.0	0.0	25.0	26.6	30.6	33.0	34.6
90	235.0	275.8	377.8	439.0	479.8	0.0	0.0	0.0	0.0	0.0	235.0	275.8	377.8	439.0	479.8
91	434.0	506.0	686.0	794.0	866.0	0.0	0.0	0.0	0.0	0.0	434.0	506.0	686.0	794.0	866.0
92	21.0	25.2	35.7	42.0	46.2	0.0	0.0	0.0	0.0	0.0	21.0	25.2	35.7	42.0	46.2
93	51.0	60.8	85.3	100.0	109.8	0.0	0.0	0.0	0.0	0.0	51.0	60.8	85.3	100.0	109.8
94	282.0	322.4	423.4	484.0	524.4	0.0	0.0	0.0	0.0	0.0	282.0	322.4	423.4	484.0	524.4
95	198.0	217.4	265.9	295.0	314.4	0.0	0.0	0.0	0.0	0.0	198.0	217.4	265.9	295.0	314.4
96	62.0	56.6	43.1	35.0	29.6	0.0	0.0	0.0	0.0	0.0	62.0	56.6	43.1	35.0	29.6
97	22.0	24.2	29.7	33.0	35.2	0.0	0.0	0.0	0.0	0.0	22.0	24.2	29.7	33.0	35.2
98	728.0	830.2	1,085.7	1,239.0	1,341.2	0.0	0.0	0.0	0.0	0.0	728.0	830.2	1,085.7	1,239.0	1,341.2
99	24.0	31.2	49.2	60.0	67.2	0.0	0.0	0.0	0.0	0.0	24.0	31.2	49.2	60.0	67.2
100	154.0	204.2	329.7	405.0	455.2	0.0	0.0	0.0	0.0	0.0	154.0	204.2	329.7	405.0	455.2
101	191.0	203.4	234.4	253.0	265.4	0.0	0.0	0.0	0.0	0.0	191.0	203.4	234.4	253.0	265.4
102	301.0	349.0	469.0	541.0	589.0	0.0	0.0	0.0	0.0	0.0	301.0	349.0	469.0	541.0	589.0
103	372.0	426.2	561.7	643.0	697.2	0.0	0.0	0.0	0.0	0.0	372.0	426.2	561.7	643.0	697.2
104	258.0	314.6	456.1	541.0	597.6	0.0	0.0	0.0	0.0	0.0	258.0	314.6	456.1	541.0	597.6
105	27.0	31.2	41.7	48.0	52.2	0.0	0.0	0.0	0.0	0.0	27.0	31.2	41.7	48.0	52.2
106	105.0	119.2	154.7	176.0	190.2	0.0	0.0	0.0	0.0	0.0	105.0	119.2	154.7	176.0	190.2
107	187.0	177.8	154.8	141.0	131.8	0.0	0.0	0.0	0.0	0.0	187.0	177.8	154.8	141.0	131.8
108	230.0	265.4	353.9	407.0	442.4	0.0	0.0	0.0	0.0	0.0	230.0	265.4	353.9	407.0	442.4
109	1,112.0	1,446.6	2,283.1	2,785.0	3,119.6	0.0	0.0	0.0	0.0	0.0	1,112.0	1,446.6	2,283.1	2,785.0	3,119.6
110	648.0	847.4	1,345.9	1,645.0	1,844.4	0.0	0.0	0.0	0.0	0.0	648.0	847.4	1,345.9	1,645.0	1,844.4
111	219.0	287.2	457.7	560.0	628.2	0.0	0.0	0.0	0.0	0.0	219.0	287.2	457.7	560.0	628.2
112	200.0	264.0	424.0	520.0	584.0	0.0	0.0	0.0	0.0	0.0	200.0	264.0	424.0	520.0	584.0
113	313.0	410.4	653.9	800.0	897.4	0.0	0.0	0.0	0.0	0.0	313.0	410.4	653.9	800.0	897.4
114	122.0	156.6	243.1	295.0	329.6	0.0	0.0	0.0	0.0	0.0	122.0	156.6	243.1	295.0	329.6
115	279.0	368.2	591.2	725.0	814.2	0.0	0.0	0.0	0.0	0.0	279.0	368.2	591.2	725.0	814.2
116	60.0	80.0	130.0	160.0	180.0	0.0	0.0	0.0	0.0	0.0	60.0	80.0	130.0	160.0	180.0
117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
118	135.0	179.0	289.0	355.0	399.0	0.0	0.0	0.0	0.0	0.0	135.0	179.0	289.0	355.0	399.0
119	27.0	37.0	62.0	77.0	87.0	0.0	0.0	0.0	0.0	0.0	27.0	37.0	62.0	77.0	87.0
120	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0
121	0.0	0.0	0.0	0.0	0.0	16.0	27.4	55.9	73.0	84.4	16.0	27.4	55.9	73.0	84.4
122	815.0	1,083.0	1,753.0	2,155.0	2,423.0	0.0	0.0	0.0	0.0	0.0	815.0	1,083.0	1,753.0	2,155.0	2,423.0
123	363.0	448.4	661.9	790.0	875.4	0.0	0.0	0.0	0.0	0.0	363.0	448.4	661.9	790.0	875.4
124	145.0	164.4	212.9	242.0	261.4	0.0	0.0	0.0	0.0	0.0	145.0	164.4	212.9	242.0	261.4
125	28.0	31.6	40.6	46.0	49.6	0.0	0.0	0.0	0.0	0.0	28.0	31.6	40.6	46.0	49.6

Scenario 1 Employment Summary

TAZ #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
126	33.0	35.8	42.8	47.0	49.8	0.0	0.0	0.0	0.0	0.0	33.0	35.8	42.8	47.0	49.8
127	14.0	15.4	18.9	21.0	22.4	0.0	0.0	0.0	0.0	0.0	14.0	15.4	18.9	21.0	22.4
128	421.0	488.6	657.6	759.0	826.6	0.0	0.0	0.0	0.0	0.0	421.0	488.6	657.6	759.0	826.6
129	25.0	33.6	55.1	68.0	76.6	0.0	0.0	0.0	0.0	0.0	25.0	33.6	55.1	68.0	76.6
130	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	20.0	20.0	20.0	20.0	20.0
131	2.0	10.4	31.4	44.0	52.4	0.0	0.0	0.0	0.0	0.0	2.0	10.4	31.4	44.0	52.4
132	107.0	145.6	242.1	300.0	338.6	0.0	0.0	0.0	0.0	0.0	107.0	145.6	242.1	300.0	338.6
133	113.0	127.8	164.8	187.0	201.8	0.0	0.0	0.0	0.0	0.0	113.0	127.8	164.8	187.0	201.8
134	46.0	44.4	40.4	38.0	36.4	0.0	0.0	0.0	0.0	0.0	46.0	44.4	40.4	38.0	36.4
135	0.0	0.0	0.0	0.0	0.0	17.0	21.2	31.7	38.0	42.2	17.0	21.2	31.7	38.0	42.2
136	36.0	35.4	33.9	33.0	32.4	0.0	0.0	0.0	0.0	0.0	36.0	35.4	33.9	33.0	32.4
137	63.0	71.0	91.0	103.0	111.0	0.0	0.0	0.0	0.0	0.0	63.0	71.0	91.0	103.0	111.0
138	644.0	786.6	1,143.1	1,357.0	1,499.6	0.0	0.0	0.0	0.0	0.0	644.0	786.6	1,143.1	1,357.0	1,499.6
139	44.0	53.4	76.9	91.0	100.4	0.0	0.0	0.0	0.0	0.0	44.0	53.4	76.9	91.0	100.4
140	91.0	113.6	170.1	204.0	226.6	0.0	0.0	0.0	0.0	0.0	91.0	113.6	170.1	204.0	226.6
141	273.0	308.8	398.3	452.0	487.8	0.0	0.0	0.0	0.0	0.0	273.0	308.8	398.3	452.0	487.8
142	3.0	3.4	4.4	5.0	5.4	0.0	0.0	0.0	0.0	0.0	3.0	3.4	4.4	5.0	5.4
143	2.0	2.2	2.7	3.0	3.2	0.0	0.0	0.0	0.0	0.0	2.0	2.2	2.7	3.0	3.2
144	99.0	116.2	159.2	185.0	202.2	0.0	0.0	0.0	0.0	0.0	99.0	116.2	159.2	185.0	202.2
145	31.0	517.2	1,732.7	2,462.0	2,948.2	0.0	0.0	0.0	0.0	0.0	31.0	517.2	1,732.7	2,462.0	2,948.2
146	2.0	2.2	2.7	3.0	3.2	0.0	0.0	0.0	0.0	0.0	2.0	2.2	2.7	3.0	3.2
147	59.0	71.4	102.4	121.0	133.4	0.0	0.0	0.0	0.0	0.0	59.0	71.4	102.4	121.0	133.4
148	64.0	70.6	87.1	97.0	103.6	0.0	0.0	0.0	0.0	0.0	64.0	70.6	87.1	97.0	103.6
149	399.0	493.8	730.8	873.0	967.8	0.0	0.0	0.0	0.0	0.0	399.0	493.8	730.8	873.0	967.8
150	161.0	181.2	231.7	262.0	282.2	0.0	0.0	0.0	0.0	0.0	161.0	181.2	231.7	262.0	282.2
151	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
152	0.0	0.0	0.0	0.0	0.0	9.0	10.2	13.2	15.0	16.2	9.0	10.2	13.2	15.0	16.2
153	54.0	60.2	75.7	85.0	91.2	47.0	52.4	65.9	74.0	79.4	101.0	112.6	141.6	159.0	170.6
154	336.0	369.8	454.3	505.0	538.8	0.0	0.0	0.0	0.0	0.0	336.0	369.8	454.3	505.0	538.8
155	168.0	218.6	345.1	421.0	471.6	0.0	0.0	0.0	0.0	0.0	168.0	218.6	345.1	421.0	471.6
156	99.0	109.0	134.0	149.0	159.0	0.0	0.0	0.0	0.0	0.0	99.0	109.0	134.0	149.0	159.0
157	16.0	15.4	13.9	13.0	12.4	0.0	0.0	0.0	0.0	0.0	16.0	15.4	13.9	13.0	12.4
158	93.0	112.4	160.9	190.0	209.4	0.0	0.0	0.0	0.0	0.0	93.0	112.4	160.9	190.0	209.4
159	71.0	100.4	173.9	218.0	247.4	0.0	0.0	0.0	0.0	0.0	71.0	100.4	173.9	218.0	247.4
160	0.0	0.8	2.8	4.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.8	4.0	4.8
161	49.0	56.4	74.9	86.0	93.4	0.0	0.0	0.0	0.0	0.0	49.0	56.4	74.9	86.0	93.4
162	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
163	812.0	972.8	1,374.8	1,616.0	1,776.8	0.0	0.0	0.0	0.0	0.0	812.0	972.8	1,374.8	1,616.0	1,776.8
164	2.0	8.2	23.7	33.0	39.2	0.0	0.0	0.0	0.0	0.0	2.0	8.2	23.7	33.0	39.2
165	30.0	33.0	40.5	45.0	48.0	0.0	0.0	0.0	0.0	0.0	30.0	33.0	40.5	45.0	48.0
166	244.0	273.4	346.9	391.0	420.4	0.0	0.0	0.0	0.0	0.0	244.0	273.4	346.9	391.0	420.4
167	21.0	23.6	30.1	34.0	36.6	0.0	0.0	0.0	0.0	0.0	21.0	23.6	30.1	34.0	36.6

Scenario 1 Employment Summary

TAZ #	2002 CL	2006 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2016 Total	2022 Total	2026 Total
168	14.0	19.6	33.6	42.0	47.6	0.0	0.0	0.0	0.0	0.0	14.0	19.6	33.6	42.0	47.6
169	30.0	31.6	35.6	38.0	39.6	0.0	0.0	0.0	0.0	0.0	30.0	31.6	35.6	38.0	39.6
170	25.0	29.0	39.0	45.0	49.0	0.0	0.0	0.0	0.0	0.0	25.0	29.0	39.0	45.0	49.0
171	1.0	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.3	0.0	0.0
172	10.0	8.8	5.8	4.0	2.8	0.0	0.0	0.0	0.0	0.0	10.0	8.8	5.8	4.0	2.8
173	106.0	121.8	161.3	185.0	200.8	0.0	0.0	0.0	0.0	0.0	106.0	121.8	161.3	185.0	200.8
174	14.0	15.8	20.3	23.0	24.8	0.0	0.0	0.0	0.0	0.0	14.0	15.8	20.3	23.0	24.8
214	53.0	68.0	105.5	128.0	143.0	0.0	0.0	0.0	0.0	0.0	53.0	68.0	105.5	128.0	143.0
215	7.0	7.6	9.1	10.0	10.6	0.0	0.0	0.0	0.0	0.0	7.0	7.6	9.1	10.0	10.6
216	2.0	2.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	2.0
220	5.0	5.2	5.7	6.0	6.2	0.0	0.0	0.0	0.0	0.0	5.0	5.2	5.7	6.0	6.2
266	0.0	0.0	0.0	0.0	0.0	56.0	59.6	68.6	74.0	77.6	56.0	59.6	68.6	74.0	77.6
271	0.0	0.0	0.0	0.0	0.0	55.0	55.6	57.1	58.0	58.6	55.0	55.6	57.1	58.0	58.6
272	291.0	305.0	340.0	361.0	375.0	0.0	0.0	0.0	0.0	0.0	291.0	305.0	340.0	361.0	375.0
341	0.0	0.0	0.0	0.0	0.0	10.0	9.0	6.5	5.0	4.0	10.0	9.0	6.5	5.0	4.0
342	0.0	0.0	0.0	0.0	0.0	49.0	47.2	42.7	40.0	38.2	49.0	47.2	42.7	40.0	38.2
346	189.0	229.8	331.8	393.0	433.8	58.0	70.6	102.1	121.0	133.6	247.0	300.4	433.9	514.0	567.4
347	30.0	26.6	18.1	13.0	9.6	0.0	0.0	0.0	0.0	0.0	30.0	26.6	18.1	13.0	9.6
Total	32,297	38,784	55,001	64,731	71,218	2,472	2,811	3,658	4,166	4,505	34,769	41,595	58,659	68,897	75,723

Summary:

	2002	2006	2016	2022	2026
CL	32,297	38,784	55,001	64,731	71,218
UGA	2,472	2,811	3,658	4,166	4,505
Total	34,769	41,595	58,659	68,897	75,723

Scenario 2 - Population

Taz #	2002 CL	2006 CL	2012 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2012 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2012 Total	2016 Total	2022 Total	2026 Total
1	0	0	0	0	0	0	244	255	255	297	300	311	244	255	255	297	300	311
2	27	27	28	28	28	28	0	0	0	0	0	0	27	27	28	28	28	28
3	663	725	818	879	972	1,034	0	0	0	0	0	0	663	725	818	879	972	1,034
4	0	0	0	0	0	0	52	53	55	56	58	59	52	53	55	56	58	59
5	137	137	138	138	139	139	0	0	0	0	0	0	137	137	138	138	139	139
6	76	157	173	399	480	561	370	678	740	1,603	1,912	2,220	446	835	913	2,003	2,392	2,781
7	5	5	5	5	5	5	0	0	0	0	0	0	5	5	5	5	5	5
8	610	719	1,045	1,154	1,154	1,263	0	0	0	0	0	0	610	719	1,045	1,154	1,154	1,263
9	184	187	193	196	201	204	0	0	0	0	0	0	184	187	193	196	201	204
10	15	15	15	15	15	15	0	0	0	0	0	0	15	15	15	15	15	15
11	244	285	346	387	448	489	0	0	0	0	0	0	244	285	346	387	448	489
12	0	0	0	0	0	0	87	91	98	103	110	114	87	91	98	103	110	114
13	7	8	9	10	11	12	0	0	0	0	0	0	7	8	9	10	11	12
14	830	857	899	926	967	994	207	214	225	232	242	249	1,037	1,071	1,123	1,157	1,209	1,243
15	19	20	23	24	26	27	15	16	18	19	20	21	34	36	40	42	46	48
16	426	530	904	925	946	1,050	0	0	0	0	0	0	426	530	904	925	946	1,050
17	70	71	74	75	77	78	0	0	0	0	0	0	70	71	74	75	77	78
18	224	230	240	246	256	262	223	230	240	246	256	263	447	460	480	493	512	525
19	16	30	50	64	84	98	0	0	0	0	0	0	16	30	50	64	84	98
20	19	57	64	169	207	244	102	156	166	316	370	424	121	212	230	486	577	668
21	0	0	0	0	0	0	100	125	130	201	226	251	100	125	130	201	226	251
22	126	131	140	145	153	158	571	577	586	592	601	607	697	708	725	737	754	765
23	306	351	419	464	532	577	0	0	0	0	0	0	306	351	419	464	532	577
24	41	41	42	42	42	42	0	0	0	0	0	0	41	41	42	42	42	42
25	0	0	0	0	0	0	1,769	1,716	1,637	1,584	1,505	1,452	1,769	1,716	1,637	1,584	1,505	1,452
26	23	52	58	140	169	198	160	260	280	559	659	759	183	312	338	699	828	957
27	0	0	0	0	0	0	214	229	233	276	292	307	214	229	233	276	292	307
28	6	7	8	8	9	10	0	0	0	0	0	0	6	7	8	8	9	10
29	8	8	9	9	10	10	10	10	11	11	11	11	18	19	20	20	21	22
30	1,131	1,156	1,194	1,219	1,257	1,282	0	0	0	0	0	0	1,131	1,156	1,194	1,219	1,257	1,282
31	154	154	155	155	156	156	0	0	0	0	0	0	154	154	155	155	156	156
32	61	149	464	481	499	587	0	0	0	0	0	0	61	149	464	481	499	587
33	21	30	43	51	64	73	0	0	0	0	0	0	21	30	43	51	64	73
34	313	505	794	986	1,275	1,467	0	0	0	0	0	0	313	505	794	986	1,275	1,467
35	0	0	0	0	0	0	1,649	1,655	1,663	1,669	1,677	1,683	1,649	1,655	1,663	1,669	1,677	1,683
36	531	532	534	535	537	538	0	0	0	0	0	0	531	532	534	535	537	538
37	826	843	868	884	909	926	446	455	468	477	490	499	1,272	1,297	1,336	1,361	1,399	1,424
38	14	14	14	14	14	14	0	0	0	0	0	0	14	14	14	14	14	14
39	34	34	35	35	35	35	0	0	0	0	0	0	34	34	35	35	35	35
40	331	343	362	374	392	404	0	0	0	0	0	0	331	343	362	374	392	404
41	45	45	46	46	46	46	0	0	0	0	0	0	45	45	46	46	46	46
42	614	619	626	630	637	642	0	0	0	0	0	0	614	619	626	630	637	642
43	253	258	266	271	279	284	0	0	0	0	0	0	253	258	266	271	279	284
44	704	709	717	722	730	735	0	0	0	0	0	0	704	709	717	722	730	735
45	559	648	782	871	1,005	1,094	0	0	0	0	0	0	559	648	782	871	1,005	1,094
46	356	376	407	427	458	478	421	426	434	440	448	453	777	803	841	867	906	931
47	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2	2
48	380	382	386	388	392	394	0	0	0	0	0	0	380	382	386	388	392	394
49	7	41	92	126	177	211	0	0	0	0	0	0	7	41	92	126	177	211
50	147	148	150	151	152	153	123	124	125	126	127	128	270	272	275	276	279	281
51	323	339	363	378	402	418	0	0	0	0	0	0	323	339	363	378	402	418
52	392	405	424	437	456	469	0	0	0	0	0	0	392	405	424	437	456	469
53	352	355	360	363	367	370	0	0	0	0	0	0	352	355	360	363	367	370
54	658	662	668	672	678	682	0	0	0	0	0	0	658	662	668	672	678	682
55	1,131	1,139	1,151	1,158	1,170	1,178	0	0	0	0	0	0	1,131	1,139	1,151	1,158	1,170	1,178
56	201	202	203	204	205	206	0	0	0	0	0	0	201	202	203	204	205	206
57	268	272	278	281	287	291	0	0	0	0	0	0	268	272	278	281	287	291

Scenario 2 - Population

Taz #	2002 CL	2006 CL	2012 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2012 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2012 Total	2016 Total	2022 Total	2026 Total
58	522	526	533	537	544	548	0	0	0	0	0	0	522	526	533	537	544	548
59	86	86	87	87	87	87	0	0	0	0	0	0	86	86	87	87	87	87
60	8	14	22	28	36	42	0	0	0	0	0	0	8	14	22	28	36	42
61	1,044	1,054	1,070	1,080	1,096	1,106	0	0	0	0	0	0	1,044	1,054	1,070	1,080	1,096	1,106
62	307	321	342	356	377	391	0	0	0	0	0	0	307	321	342	356	377	391
63	783	808	846	871	909	934	0	0	0	0	0	0	783	808	846	871	909	934
64	1,977	1,838	1,629	1,490	1,281	1,142	0	0	0	0	0	0	1,977	1,838	1,629	1,490	1,281	1,142
65	2,868	2,934	3,034	3,101	3,201	3,268	0	0	0	0	0	0	2,868	2,934	3,034	3,101	3,201	3,268
66	1,190	1,208	1,236	1,254	1,281	1,299	0	0	0	0	0	0	1,190	1,208	1,236	1,254	1,281	1,299
67	5	5	5	5	5	5	0	0	0	0	0	0	5	5	5	5	5	5
68	329	331	335	337	341	343	0	0	0	0	0	0	329	331	335	337	341	343
69	473	475	477	479	481	483	0	0	0	0	0	0	473	475	477	479	481	483
70	510	514	519	523	528	532	0	0	0	0	0	0	510	514	519	523	528	532
71	185	186	189	190	192	193	0	0	0	0	0	0	185	186	189	190	192	193
72	18	18	19	19	19	19	18	18	19	19	19	19	36	36	37	37	38	38
73	194	196	199	200	203	205	0	0	0	0	0	0	194	196	199	200	203	205
74	838	845	855	861	871	878	0	0	0	0	0	0	838	845	855	861	871	878
75	59	87	129	157	199	227	0	0	0	0	0	0	59	87	129	157	199	227
76	909	916	928	935	946	953	0	0	0	0	0	0	909	916	928	935	946	953
77	10	10	10	10	10	10	0	0	0	0	0	0	10	10	10	10	10	10
78	42	42	43	43	43	43	0	0	0	0	0	0	42	42	43	43	43	43
79	52	52	53	53	53	53	0	0	0	0	0	0	52	52	53	53	53	53
80	276	278	281	282	285	287	0	0	0	0	0	0	276	278	281	282	285	287
81	100	101	102	102	103	104	0	0	0	0	0	0	100	101	102	102	103	104
82	170	172	175	177	180	182	0	0	0	0	0	0	170	172	175	177	180	182
83	13	13	13	13	13	13	0	0	0	0	0	0	13	13	13	13	13	13
84	333	336	342	345	350	353	0	0	0	0	0	0	333	336	342	345	350	353
85	194	195	198	199	201	202	0	0	0	0	0	0	194	195	198	199	201	202
86	2,651	2,521	2,327	2,197	2,003	1,874	0	0	0	0	0	0	2,651	2,521	2,327	2,197	2,003	1,874
87	1,184	1,029	798	644	412	258	0	0	0	0	0	0	1,184	1,029	798	644	412	258
88	2,156	2,013	1,798	1,656	1,441	1,298	0	0	0	0	0	0	2,156	2,013	1,798	1,656	1,441	1,298
89	985	994	1,007	1,016	1,029	1,038	0	0	0	0	0	0	985	994	1,007	1,016	1,029	1,038
90	0	14	14	14	68	82	0	0	0	0	0	0	0	14	14	14	68	82
91	43	43	43	43	43	43	0	0	0	0	0	0	43	43	43	43	43	43
92	247	251	256	260	265	269	0	0	0	0	0	0	247	251	256	260	265	269
93	922	937	960	975	998	1,013	614	624	639	649	664	674	1,536	1,561	1,599	1,624	1,662	1,687
94	445	457	475	486	504	516	0	0	0	0	0	0	445	457	475	486	504	516
95	245	521	798	1,351	1,627	1,903	0	0	0	0	0	0	245	521	798	1,351	1,627	1,903
96	20	20	20	20	20	20	0	0	0	0	0	0	20	20	20	20	20	20
97	56	56	57	57	57	57	0	0	0	0	0	0	56	56	57	57	57	57
98	305	317	335	347	365	377	0	0	0	0	0	0	305	317	335	347	365	377
99	48	59	76	87	103	114	0	0	0	0	0	0	48	59	76	87	103	114
100	29	40	57	68	84	95	0	0	0	0	0	0	29	40	57	68	84	95
101	0	0	0	0	1,048	1,523	0	0	0	0	0	0	0	0	0	0	1,048	1,523
102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
104	913	917	923	926	932	936	0	0	0	0	0	0	913	917	923	926	932	936
105	834	842	855	863	875	883	0	0	0	0	0	0	834	842	855	863	875	883
106	296	299	304	307	311	314	0	0	0	0	0	0	296	299	304	307	311	314
107	104	104	105	105	105	105	0	0	0	0	0	0	104	104	105	105	105	105
108	0	6	15	20	29	35	0	0	0	0	0	0	0	6	15	20	29	35
109	53	91	148	185	242	280	0	0	0	0	0	0	53	91	148	185	242	280
110	122	160	217	255	312	350	0	0	0	0	0	0	122	160	217	255	312	350
111	121	132	150	161	178	189	0	0	0	0	0	0	121	132	150	161	178	189
112	1	12	29	40	56	67	0	0	0	0	0	0	1	12	29	40	56	67
113	124	162	219	257	314	352	0	0	0	0	0	0	124	162	219	257	314	352
114	58	85	126	153	193	220	0	0	0	0	0	0	58	85	126	153	193	220
115	3	41	98	135	192	230	0	0	0	0	0	0	3	41	98	135	192	230

Scenario 2 - Population

Taz #	2002 CL	2006 CL	2012 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2012 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2012 Total	2016 Total	2022 Total	2026 Total
116	0	16	40	55	79	95	0	0	0	0	0	0	0	16	40	55	79	95
117	48	59	76	87	103	114	0	0	0	0	0	0	48	59	76	87	103	114
118	232	265	315	348	398	431	0	0	0	0	0	0	232	265	315	348	398	431
119	114	125	143	154	171	182	0	0	0	0	0	0	114	125	143	154	171	182
120	55	60	69	74	82	87	0	0	0	0	0	0	55	60	69	74	82	87
121	0	0	0	0	0	0	503	509	519	525	534	540	503	509	519	525	534	540
122	51	121	375	389	403	473	0	0	0	0	0	0	51	121	375	389	403	473
123	4	4	4	4	1,586	4,269	0	0	0	0	0	0	4	4	4	4	1,586	4,269
124	226	228	231	233	236	238	0	0	0	0	0	0	226	228	231	233	236	238
125	331	332	335	336	338	339	0	0	0	0	0	0	331	332	335	336	338	339
126	188	189	190	190	191	192	0	0	0	0	0	0	188	189	190	190	191	192
127	261	270	284	293	307	316	0	0	0	0	0	0	261	270	284	293	307	316
128	35	35	36	36	36	36	0	0	0	0	0	0	35	35	36	36	36	36
129	1,516	1,679	1,924	2,087	2,331	2,494	0	0	0	0	0	0	1,516	1,679	1,924	2,087	2,331	2,494
130	78	85	95	102	112	119	380	391	408	420	437	448	458	476	503	521	549	567
131	28	28	29	29	29	29	0	0	0	0	0	0	28	28	29	29	29	29
132	156	194	252	290	347	385	0	0	0	0	0	0	156	194	252	290	347	385
133	787	824	880	917	972	1,009	0	0	0	0	0	0	787	824	880	917	972	1,009
134	905	917	936	948	967	979	0	0	0	0	0	0	905	917	936	948	967	979
135	0	0	0	0	0	0	855	867	884	896	914	925	855	867	884	896	914	925
136	1,382	1,423	1,484	1,524	1,585	1,626	0	0	0	0	0	0	1,382	1,423	1,484	1,524	1,585	1,626
137	475	480	487	492	499	504	0	0	0	0	0	0	475	480	487	492	499	504
138	5	48	112	155	219	262	0	0	0	0	0	0	5	48	112	155	219	262
139	72	72	73	73	73	73	0	0	0	0	0	0	72	72	73	73	73	73
140	126	145	173	192	220	239	0	0	0	0	0	0	126	145	173	192	220	239
141	542	545	549	551	555	558	0	0	0	0	0	0	542	545	549	551	555	558
142	451	455	462	466	472	476	0	0	0	0	0	0	451	455	462	466	472	476
143	688	697	711	720	734	743	0	0	0	0	0	0	688	697	711	720	734	743
144	126	175	248	296	369	418	0	0	0	0	0	0	126	175	248	296	369	418
145	3,636	3,653	3,678	3,694	3,719	3,736	0	0	0	0	0	0	3,636	3,653	3,678	3,694	3,719	3,736
146	50	51	52	53	54	55	0	0	0	0	0	0	50	51	52	53	54	55
147	2,549	2,579	2,625	2,655	2,701	2,731	0	0	0	0	0	0	2,549	2,579	2,625	2,655	2,701	2,731
148	575	589	611	625	647	661	0	0	0	0	0	0	575	589	611	625	647	661
149	243	244	246	247	248	249	0	0	0	0	0	0	243	244	246	247	248	249
150	397	411	432	445	466	480	0	0	0	0	0	0	397	411	432	445	466	480
151	249	299	373	423	497	547	0	0	0	0	0	0	249	299	373	423	497	547
152	0	0	0	0	0	0	521	685	718	817	1,343	1,507	521	685	718	817	1,343	1,507
153	749	955	1,120	1,615	1,780	1,987	731	898	1,032	1,434	1,568	1,736	1,480	1,854	2,153	3,050	3,349	3,722
154	56	56	57	57	57	57	0	0	0	0	0	0	56	56	57	57	57	57
155	675	679	684	688	693	697	0	0	0	0	0	0	675	679	684	688	693	697
156	844	875	922	953	999	1,030	0	0	0	0	0	0	844	875	922	953	999	1,030
157	717	730	749	762	781	794	0	0	0	0	0	0	717	730	749	762	781	794
158	489	504	527	542	564	579	0	0	0	0	0	0	489	504	527	542	564	579
159	486	488	491	493	496	498	0	0	0	0	0	0	486	488	491	493	496	498
160	836	850	871	884	905	919	0	0	0	0	0	0	836	850	871	884	905	919
161	673	689	714	730	754	770	0	0	0	0	0	0	673	689	714	730	754	770
162	79	82	86	89	93	96	0	0	0	0	0	0	79	82	86	89	93	96
163	247	365	649	814	838	956	0	0	0	0	0	0	247	365	649	814	838	956
164	940	955	979	994	1,017	1,032	0	0	0	0	0	0	940	955	979	994	1,017	1,032
165	521	536	559	574	597	612	0	0	0	0	0	0	521	536	559	574	597	612
166	34	128	352	483	502	596	0	0	0	0	0	0	34	128	352	483	502	596
167	241	249	260	268	279	287	0	0	0	0	0	0	241	249	260	268	279	287
168	422	434	452	464	482	494	0	0	0	0	0	0	422	434	452	464	482	494
169	561	574	595	608	628	641	0	0	0	0	0	0	561	574	595	608	628	641
170	809	1,026	1,461	1,678	1,895	2,112	0	0	0	0	0	0	809	1,026	1,461	1,678	1,895	2,112
171	362	368	378	384	394	400	0	0	0	0	0	0	362	368	378	384	394	400
172	419	422	426	429	433	436	0	0	0	0	0	0	419	422	426	429	433	436
173	646	675	719	748	791	820	0	0	0	0	0	0	646	675	719	748	791	820

Scenario 2 - Population

Taz #	2002 CL	2006 CL	2012 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2012 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2012 Total	2016 Total	2022 Total	2026 Total
174	70	96	134	160	198	224	0	0	0	0	0	0	70	96	134	160	198	224
214	1,733	1,778	1,847	1,892	1,960	2,005	0	0	0	0	0	0	1,733	1,778	1,847	1,892	1,960	2,005
215	76	83	93	100	110	117	0	0	0	0	0	0	76	83	93	100	110	117
216	111	121	136	145	160	170	0	0	0	0	0	0	111	121	136	145	160	170
220	64	65	68	69	71	72	10	10	10	10	10	10	74	75	78	79	81	82
266	0	0	0	0	0	0	159	949	949	1,738	4,108	4,897	159	949	949	1,738	4,108	4,897
271	0	0	0	0	0	0	180	182	185	187	190	192	180	182	185	187	190	192
272	0	0	0	0	0	0	213	318	476	582	740	845	213	318	476	582	740	845
341	0	0	0	0	0	0	67	66	65	64	62	61	67	66	65	64	62	61
342	0	0	0	0	0	0	206	210	215	219	224	228	206	210	215	219	224	228
346	446	768	2,058	2,058	2,058	2,380	431	679	1,674	1,674	1,674	1,922	877	1,448	3,732	3,732	3,732	4,303
347	25	48	105	133	142	165	544	973	2,004	2,519	2,691	3,120	569	1,022	2,108	2,652	2,833	3,285
Total	69,260	72,597	78,948	82,660	88,577	94,542	12,194	14,651	17,158	20,557	24,478	26,935	81,454	87,248	96,107	103,217	113,055	121,477

Scenario 2 Summary Table:

	2002	2006	2012	2016	2022	2026
CL	69,260	72,597	78,948	82,660	88,577	95,072
UGA	12,194	14,651	17,158	20,557	24,478	26,935
Total	81,454	87,248	96,107	103,217	113,055	122,007

Scenario 2 - Employment

TAZ #	2002 CL	2006 CL	2012 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2012 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2012 Total	2016 Total	2022 Total	2026 Total
1	8	10	10	17	16	18	73	87	87	155	144	158	81	97	97	172	160	176
2	178	189	210	223	233	244	0	0	0	0	0	0	178	189	210	223	233	244
3	270	305	371	414	445	480	0	0	0	0	0	0	270	305	371	414	445	480
4	0	0	0	0	0	0	1,136	1,184	1,275	1,336	1,378	1,426	1,136	1,184	1,275	1,336	1,378	1,426
5	914	1,128	1,530	1,798	1,985	2,199	0	0	0	0	0	0	914	1,128	1,530	1,798	1,985	2,199
6	408	462	476	666	680	734	0	0	0	0	0	0	408	462	476	666	680	734
7	58	65	79	89	95	102	0	0	0	0	0	0	58	65	79	89	95	102
8	200	222	304	331	309	331	0	0	0	0	0	0	200	222	304	331	309	331
9	59	155	336	457	541	637	0	0	0	0	0	0	59	155	336	457	541	637
10	494	541	629	687	728	775	0	0	0	0	0	0	494	541	629	687	728	775
11	22	26	34	39	42	46	0	0	0	0	0	0	22	26	34	39	42	46
12	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0
13	361	430	560	646	707	776	0	0	0	0	0	0	361	430	560	646	707	776
14	32	37	48	54	59	64	145	169	215	246	267	291	177	207	263	300	326	356
15	67	129	245	323	377	439	53	102	193	254	297	346	120	231	439	577	674	785
16	141	176	334	342	316	351	0	0	0	0	0	0	141	176	334	342	316	351
17	142	178	247	292	324	360	0	0	0	0	0	0	142	178	247	292	324	360
18	0	0	0	0	0	0	8	9	11	12	13	14	8	9	11	12	13	14
19	201	248	336	395	436	483	0	0	0	0	0	0	201	248	336	395	436	483
20	9	10	11	16	16	17	18	20	21	28	29	31	27	31	32	44	45	49
21	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
22	6	5	3	1	0	0	0	0	0	0	0	0	6	5	3	1	0	0
23	1,423	1,523	1,711	1,836	1,924	2,024	0	0	0	0	0	0	1,423	1,523	1,711	1,836	1,924	2,024
24	1,831	2,292	3,155	3,731	4,134	4,595	0	0	0	0	0	0	1,831	2,292	3,155	3,731	4,134	4,595
25	0	0	0	0	0	0	352	397	481	538	577	622	352	397	481	538	577	622
26	238	257	262	328	333	352	0	0	0	0	0	0	238	257	262	328	333	352
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	2	22	59	84	101	121	0	0	0	0	0	0	2	22	59	84	101	121
29	53	60	73	81	87	94	53	60	73	81	87	94	106	120	145	162	174	188
30	427	496	626	712	773	842	0	0	0	0	0	0	427	496	626	712	773	842
31	95	107	130	145	156	168	0	0	0	0	0	0	95	107	130	145	156	168
32	11	64	301	315	275	328	0	0	0	0	0	0	11	64	301	315	275	328
33	86	93	105	113	119	126	0	0	0	0	0	0	86	93	105	113	119	126
34	19	73	175	243	290	344	0	0	0	0	0	0	19	73	175	243	290	344
35	0	0	0	0	0	0	25	24	22	21	20	19	25	24	22	21	20	19
36	17	19	22	24	26	28	0	0	0	0	0	0	17	19	22	24	26	28
37	13	19	31	39	44	50	7	10	16	20	23	26	20	29	47	59	67	76
38	232	260	312	347	371	399	0	0	0	0	0	0	232	260	312	347	371	399
39	12	13	16	18	19	20	0	0	0	0	0	0	12	13	16	18	19	20
40	567	644	789	885	953	1,030	0	0	0	0	0	0	567	644	789	885	953	1,030
41	22	25	32	36	39	42	0	0	0	0	0	0	22	25	32	36	39	42
42	266	317	412	476	520	571	0	0	0	0	0	0	266	317	412	476	520	571
43	15	17	20	22	24	26	0	0	0	0	0	0	15	17	20	22	24	26
44	130	146	175	195	209	225	0	0	0	0	0	0	130	146	175	195	209	225
45	451	477	525	557	580	606	0	0	0	0	0	0	451	477	525	557	580	606
46	5	5	5	5	5	5	4	4	4	4	4	4	9	9	9	9	9	9
47	1,886	2,131	2,590	2,897	3,111	3,356	0	0	0	0	0	0	1,886	2,131	2,590	2,897	3,111	3,356
48	498	576	722	820	888	966	0	0	0	0	0	0	498	576	722	820	888	966
49	536	654	876	1,024	1,128	1,246	0	0	0	0	0	0	536	654	876	1,024	1,128	1,246
50	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1

Scenario 2 - Employment

TAZ #	2002 CL	2006 CL	2012 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2012 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2012 Total	2016 Total	2022 Total	2026 Total
51	42	52	71	83	92	102	0	0	0	0	0	0	42	52	71	83	92	102
52	17	16	14	12	11	10	0	0	0	0	0	0	17	16	14	12	11	10
53	9	10	11	12	13	14	0	0	0	0	0	0	9	10	11	12	13	14
54	220	232	254	269	279	291	0	0	0	0	0	0	220	232	254	269	279	291
55	50	59	75	85	93	102	0	0	0	0	0	0	50	59	75	85	93	102
56	132	157	204	236	258	283	0	0	0	0	0	0	132	157	204	236	258	283
57	37	40	47	51	54	57	0	0	0	0	0	0	37	40	47	51	54	57
58	17	18	20	22	23	24	0	0	0	0	0	0	17	18	20	22	23	24
59	145	225	374	473	543	623	0	0	0	0	0	0	145	225	374	473	543	623
60	0	10	30	43	52	62	0	0	0	0	0	0	0	10	30	43	52	62
61	25	25	24	23	23	23	0	0	0	0	0	0	25	25	24	23	23	23
62	27	59	118	157	185	217	63	140	286	382	450	527	90	199	403	540	635	744
63	91	107	137	157	171	187	0	0	0	0	0	0	91	107	137	157	171	187
64	40	50	70	83	92	102	0	0	0	0	0	0	40	50	70	83	92	102
65	297	374	517	613	680	757	0	0	0	0	0	0	297	374	517	613	680	757
66	104	126	166	193	212	234	0	0	0	0	0	0	104	126	166	193	212	234
67	79	96	127	147	162	179	0	0	0	0	0	0	79	96	127	147	162	179
68	6	7	9	10	11	12	0	0	0	0	0	0	6	7	9	10	11	12
69	419	510	681	795	875	966	0	0	0	0	0	0	419	510	681	795	875	966
70	17	15	11	9	7	5	0	0	0	0	0	0	17	15	11	9	7	5
71	18	20	24	27	29	31	0	0	0	0	0	0	18	20	24	27	29	31
72	206	239	300	340	369	402	206	238	299	340	368	400	412	477	599	680	737	802
73	80	102	143	171	190	212	0	0	0	0	0	0	80	102	143	171	190	212
74	39	33	22	15	10	4	0	0	0	0	0	0	39	33	22	15	10	4
75	361	408	496	554	595	642	0	0	0	0	0	0	361	408	496	554	595	642
76	253	303	398	461	505	555	0	0	0	0	0	0	253	303	398	461	505	555
77	151	186	253	297	328	363	0	0	0	0	0	0	151	186	253	297	328	363
78	497	574	719	815	883	960	0	0	0	0	0	0	497	574	719	815	883	960
79	170	147	105	77	57	34	0	0	0	0	0	0	170	147	105	77	57	34
80	73	63	43	30	21	11	0	0	0	0	0	0	73	63	43	30	21	11
81	236	246	264	276	285	295	0	0	0	0	0	0	236	246	264	276	285	295
82	39	45	56	63	68	74	0	0	0	0	0	0	39	45	56	63	68	74
83	246	275	331	367	393	422	0	0	0	0	0	0	246	275	331	367	393	422
84	6	6	6	6	6	6	0	0	0	0	0	0	6	6	6	6	6	6
85	159	194	260	303	334	369	0	0	0	0	0	0	159	194	260	303	334	369
86	1,557	1,744	2,094	2,328	2,491	2,678	0	0	0	0	0	0	1,557	1,744	2,094	2,328	2,491	2,678
87	123	151	203	238	262	290	0	0	0	0	0	0	123	151	203	238	262	290
88	15	16	18	19	20	21	0	0	0	0	0	0	15	16	18	19	20	21
89	25	27	30	32	33	35	0	0	0	0	0	0	25	27	30	32	33	35
90	235	276	276	276	439	480	0	0	0	0	0	0	235	276	276	276	439	480
91	434	506	506	506	794	866	0	0	0	0	0	0	434	506	506	506	794	866
92	21	25	33	38	42	46	0	0	0	0	0	0	21	25	33	38	42	46
93	51	61	79	91	100	110	0	0	0	0	0	0	51	61	79	91	100	110
94	282	322	398	449	484	524	0	0	0	0	0	0	282	322	398	449	484	524
95	198	217	242	290	295	314	0	0	0	0	0	0	198	217	242	290	295	314
96	62	57	46	40	35	30	0	0	0	0	0	0	62	57	46	40	35	30
97	22	24	28	31	33	35	0	0	0	0	0	0	22	24	28	31	33	35
98	728	830	1,022	1,150	1,239	1,341	0	0	0	0	0	0	728	830	1,022	1,150	1,239	1,341
99	24	31	45	54	60	67	0	0	0	0	0	0	24	31	45	54	60	67
100	154	204	298	361	405	455	0	0	0	0	0	0	154	204	298	361	405	455
101	191	203	203	203	253	265	0	0	0	0	0	0	191	203	203	203	253	265

Scenario 2 - Employment

TAZ #	2002 CL	2006 CL	2012 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2012 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2012 Total	2016 Total	2022 Total	2026 Total
102	301	349	439	439	541	589	0	0	0	0	0	0	301	349	439	439	541	589
103	372	426	528	596	643	697	0	0	0	0	0	0	372	426	528	596	643	697
104	258	315	421	491	541	598	0	0	0	0	0	0	258	315	421	491	541	598
105	27	31	39	44	48	52	0	0	0	0	0	0	27	31	39	44	48	52
106	105	119	146	164	176	190	0	0	0	0	0	0	105	119	146	164	176	190
107	187	178	161	149	141	132	0	0	0	0	0	0	187	178	161	149	141	132
108	230	265	332	376	407	442	0	0	0	0	0	0	230	265	332	376	407	442
109	1,112	1,447	2,074	2,492	2,785	3,120	0	0	0	0	0	0	1,112	1,447	2,074	2,492	2,785	3,120
110	648	847	1,221	1,471	1,645	1,844	0	0	0	0	0	0	648	847	1,221	1,471	1,645	1,844
111	219	287	415	500	560	628	0	0	0	0	0	0	219	287	415	500	560	628
112	200	264	384	464	520	584	0	0	0	0	0	0	200	264	384	464	520	584
113	313	410	593	715	800	897	0	0	0	0	0	0	313	410	593	715	800	897
114	122	157	221	265	295	330	0	0	0	0	0	0	122	157	221	265	295	330
115	279	368	535	647	725	814	0	0	0	0	0	0	279	368	535	647	725	814
116	60	80	118	143	160	180	0	0	0	0	0	0	60	80	118	143	160	180
117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
118	135	179	262	317	355	399	0	0	0	0	0	0	135	179	262	317	355	399
119	27	37	56	68	77	87	0	0	0	0	0	0	27	37	56	68	77	87
120	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
121	0	0	0	0	0	0	16	27	49	63	73	84	16	27	49	63	73	84
122	815	1,083	2,289	2,356	2,155	2,423	0	0	0	0	0	0	815	1,083	2,289	2,356	2,155	2,423
123	363	448	448	448	790	875	0	0	0	0	0	0	363	448	448	448	790	875
124	145	164	201	225	242	261	0	0	0	0	0	0	145	164	201	225	242	261
125	28	32	38	43	46	50	0	0	0	0	0	0	28	32	38	43	46	50
126	33	36	41	45	47	50	0	0	0	0	0	0	33	36	41	45	47	50
127	14	15	18	20	21	22	0	0	0	0	0	0	14	15	18	20	21	22
128	421	489	615	700	759	827	0	0	0	0	0	0	421	489	615	700	759	827
129	25	34	50	60	68	77	0	0	0	0	0	0	25	34	50	60	68	77
130	10	10	10	10	10	10	10	10	10	10	10	10	20	20	20	20	20	20
131	2	10	26	37	44	52	0	0	0	0	0	0	2	10	26	37	44	52
132	107	146	218	266	300	339	0	0	0	0	0	0	107	146	218	266	300	339
133	113	128	156	174	187	202	0	0	0	0	0	0	113	128	156	174	187	202
134	46	44	41	39	38	36	0	0	0	0	0	0	46	44	41	39	38	36
135	0	0	0	0	0	0	17	21	29	34	38	42	17	21	29	34	38	42
136	36	35	34	34	33	32	0	0	0	0	0	0	36	35	34	34	33	32
137	63	71	86	96	103	111	0	0	0	0	0	0	63	71	86	96	103	111
138	644	787	1,054	1,232	1,357	1,500	0	0	0	0	0	0	644	787	1,054	1,232	1,357	1,500
139	44	53	71	83	91	100	0	0	0	0	0	0	44	53	71	83	91	100
140	91	114	156	184	204	227	0	0	0	0	0	0	91	114	156	184	204	227
141	273	309	376	421	452	488	0	0	0	0	0	0	273	309	376	421	452	488
142	3	3	4	5	5	5	0	0	0	0	0	0	3	3	4	5	5	5
143	2	2	3	3	3	3	0	0	0	0	0	0	2	2	3	3	3	3
144	99	116	148	170	185	202	0	0	0	0	0	0	99	116	148	170	185	202
145	31	517	1,429	2,037	2,462	2,948	0	0	0	0	0	0	31	517	1,429	2,037	2,462	2,948
146	2	2	3	3	3	3	0	0	0	0	0	0	2	2	3	3	3	3
147	59	71	95	110	121	133	0	0	0	0	0	0	59	71	95	110	121	133
148	64	71	83	91	97	104	0	0	0	0	0	0	64	71	83	91	97	104
149	399	494	672	790	873	968	0	0	0	0	0	0	399	494	672	790	873	968
150	161	181	219	244	262	282	0	0	0	0	0	0	161	181	219	244	262	282
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
152	0	0	0	0	0	0	9	10	11	11	15	16	9	10	11	11	15	16

Scenario 2 - Employment

TAZ #	2002 CL	2006 CL	2012 CL	2016 CL	2022 CL	2026 CL	2002 UGA	2006 UGA	2012 UGA	2016 UGA	2022 UGA	2026 UGA	2002 Total	2006 Total	2012 Total	2016 Total	2022 Total	2026 Total
153	54	60	66	85	85	91	47	52	58	74	74	79	101	113	124	159	159	171
154	336	370	433	475	505	539	0	0	0	0	0	0	336	370	433	475	505	539
155	168	219	313	377	421	472	0	0	0	0	0	0	168	219	313	377	421	472
156	99	109	128	140	149	159	0	0	0	0	0	0	99	109	128	140	149	159
157	16	15	14	14	13	12	0	0	0	0	0	0	16	15	14	14	13	12
158	93	112	149	173	190	209	0	0	0	0	0	0	93	112	149	173	190	209
159	71	100	156	192	218	247	0	0	0	0	0	0	71	100	156	192	218	247
160	0	1	2	3	4	5	0	0	0	0	0	0	0	1	2	3	4	5
161	49	56	70	80	86	93	0	0	0	0	0	0	49	56	70	80	86	93
162	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
163	812	973	1,455	1,737	1,616	1,777	0	0	0	0	0	0	812	973	1,455	1,737	1,616	1,777
164	2	8	20	28	33	39	0	0	0	0	0	0	2	8	20	28	33	39
165	30	33	39	42	45	48	0	0	0	0	0	0	30	33	39	42	45	48
166	244	273	362	413	391	420	0	0	0	0	0	0	244	273	362	413	391	420
167	21	24	28	32	34	37	0	0	0	0	0	0	21	24	28	32	34	37
168	14	20	30	37	42	48	0	0	0	0	0	0	14	20	30	37	42	48
169	30	32	35	37	38	40	0	0	0	0	0	0	30	32	35	37	38	40
170	25	29	39	44	45	49	0	0	0	0	0	0	25	29	39	44	45	49
171	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
172	10	9	7	5	4	3	0	0	0	0	0	0	10	9	7	5	4	3
173	106	122	151	171	185	201	0	0	0	0	0	0	106	122	151	171	185	201
174	14	16	19	21	23	25	0	0	0	0	0	0	14	16	19	21	23	25
214	53	68	96	115	128	143	0	0	0	0	0	0	53	68	96	115	128	143
215	7	8	9	9	10	11	0	0	0	0	0	0	7	8	9	9	10	11
216	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2	2
220	5	5	6	6	6	6	0	0	0	0	0	0	5	5	6	6	6	6
266	0	0	0	0	0	0	56	60	60	64	74	78	56	60	60	64	74	78
271	0	0	0	0	0	0	55	56	57	57	58	59	55	56	57	57	58	59
272	291	305	331	349	361	375	0	0	0	0	0	0	291	305	331	349	361	375
341	0	0	0	0	0	0	10	9	7	6	5	4	10	9	7	6	5	4
342	0	0	0	0	0	0	49	47	44	42	40	38	49	47	44	42	40	38
346	189	230	434	434	393	434	58	71	134	134	121	134	247	300	567	567	514	567
347	30	27	16	11	13	10	0	0	0	0	0	0	30	27	16	11	13	10
Total	32,297	38,784	51,725	59,406	64,731	71,218	2,472	2,811	3,442	3,913	4,166	4,505	34,769	41,595	55,166	63,319	68,897	75,723

Scenario 2 Summary Table:

	2002	2006	2012	2016	2022	2026
CL	32,297	38,784	51,725	59,406	64,731	71,218
UGA	2,472	2,811	3,442	3,913	4,166	4,505
Total	34,769	41,595	55,166	63,319	68,897	75,723

Changes made for Scenario 2:
* 2006 populations are generally based on a straight line interpolation between 2002 and 2022. Exceptions are noted in the table below.

* 2026 populations are generally a straight line extrapolation from 2002 to 2022. Exceptions are noted in the table below.

TAZ	Growth Rate			Comment
	2006-2012	2012-2016	2016-2022	
1	0%	95%	5%	
6	5%	70%	25%	100 people were moved from TAZ 6 to TAZ 20 in 2022.
8	75%	25%	0%	100 people were moved from TAZ 8 to TAZ 20 in 2022.
16	90%	5%	5%	
20	5%	70%	25%	200 people were moved to TAZ 20 from TAZ 6 and 8 in 2022.
21	5%	70%	25%	
26	5%	70%	25%	200 people were moved to TAZ 26 from TAZ 163 in 2022.
27	5%	70%	25%	
32	90%	5%	5%	
90	0%	0%	100%	
91	0%	0%	0%	1) TAZ 91 has already reached build out, all growth (534 people) was moved to TAZ 123.
				2) 2006 population was reduced to 43 because all growth was moved to TAZ 123.
95	25%	50%	25%	
101	0%	0%	100%	1) 1014 people were moved to TAZ 101 from TAZ 123. The growth for TAZ 101 and 123 was added together, then divided evenly between those two TAZs.
				2) 2006 population was reduced to 0. No development has occurred yet.
102	37.5%	0%	62.5%	
109	37.5%	25%	37.5%	25 people were moved to TAZ 109 from TAZ 163. See comment for TAZ 163.
110	37.5%	25%	37.5%	25 people were moved to TAZ 110 from TAZ 163. See comment for TAZ 163.
113	37.5%	25%	37.5%	25 people were moved to TAZ 113 from TAZ 163. See comment for TAZ 163.
114	37.5%	25%	37.5%	25 people were moved to TAZ 114 from TAZ 163. See comment for TAZ 163.
115	37.5%	25%	37.5%	25 people were moved to TAZ 115 from TAZ 163. See comment for TAZ 163.
116	37.5%	25%	37.5%	25 people were moved to TAZ 116 from TAZ 163. See comment for TAZ 163.
122	90%	5%	5%	25 people were moved to TAZ 122 from TAZ 163. See comment for TAZ 163.
123	0%	0%	100%	1) 1014 people were moved from TAZ 123 to TAZ 101, and 534 people were moved to TAZ 123 from TAZ 91, resulting in a reduction of 480 people from TAZ 123. See note for TAZ 101.
				2) 2006 population was reduced to 4. No development has occurred yet.
				3) 2026 population was set at 4269, as this is the expected buildout.
132	37.5%	25.0%	37.5%	25 people were moved to TAZ 132 from TAZ 163. See comment for TAZ 163.
152	5%	15%	80%	200 people were moved from TAZ 152 to TAZ 153.
153	20%	60%	20%	200 people were moved from TAZ 153 to TAZ 152.
163	60%	35%	5%	400 people were moved out of TAZ 163 and evenly divided among TAZs 109, 110, 113, 114, 115, 116, 122, and 132.
166	60%	35%	5%	
170	50%	25%	25%	
266	0%	25%	75%	
346	100%	0%	0%	
347	60%	30%	10%	

Appendix G

INDUSTRIAL DISCHARGES

Table G.1 Industrial Users to the City of Bellingham
Comprehensive Sewer Plan
City of Bellingham

Industry[1]	Flow, gpd[1]	BOD, mg/L[2]	BOD, ppd[3,4]	TSS, mg/L[2]	TSS, ppd[3]
Arrowac Fisheries	18,001	784	118	364	55
Bellingham Cold Storage	44,787	332	124	149	56
Bornstein Seafood Inc.	21,967	632	116	245	45
Home Port Seafoods	11,980	820	82	420	42
Icicle Seafoods Inc Surimi	71,030	610	361	89	53
King & Prince Seafood Corp	17,132	787	112	346	49
Mt Baker Products	947	NM	NM	NM	NM
Olympic Pipeline Co.	2,342	NM	NM	NM	NM
Portionables Inc.	31,119	3,338	866	627	163
Q Sea Specialty Services LLC	19,722	483	79	190	31
Trans Ocean Products Inc.	85,075	1,665	1181	167	118
Trident Seafood Bellingham	49,361	517	213	274	113
WA DFW Bellingham Hatchery	1,078	1	0.01		
Yamato Engine Specialist	1,474	NM	NM	NM	NM

Notes:

NM= not measured.

(1) The August 2008 Agency Review Draft of the Comprehensive Sewer Plan included a list of industries assumed to be contributing flows and loads to the Post Point WWTP. Since that report, several of these industries have been found to not contribute, and have been removed from Table G.1.

(2) Data reported as average values from 2003 through 2007 from the Washington State Department of Ecology Water Quality Permit Compliance Data database. Data collected as grab samples and data from multiple monitoring points were averaged together and zero values were ignored.

(3) Calculated from the average reported flow and concentration values.

(4) The calculated BOD loads represent an estimate for the average annual industrial load between 2003 and 2007. A maximum month BOD peaking factor of 1.14 was applied to the industrial BOD load contribution to determine the maximum month BOD load.

Appendix H

FLOW AND LOAD PROJECTIONS

Table H.1 Population Estimates
Comprehensive Sewer Plan
City of Bellingham

Year	City Limits	% Sewered	Sewed City Limits	UGA	% Sewered	Sewered UGA	Total Sewered	LWWSD
1998	65,791	86%	56,581	9,737	47%	4,532	61,113	9,190
1999	66,757	86%	57,411	10,351	47%	4,818	62,229	9,190
2000	67,592	86%	58,129	10,966	47%	5,104	63,233	9,190
2001	68,426	86%	58,846	11,580	47%	5,390	64,236	9,190
2002	69,260	86%	59,564	12,194	47%	5,676	65,240	9,190
2003	70,094	86%	60,281	12,808	47%	5,962	66,243	9,190
2004	70,929	87%	61,430	13,423	49%	6,560	67,990	9,190
2005	71,763	87%	62,590	14,037	51%	7,186	69,776	9,419
2006	72,597	88%	63,759	14,651	54%	7,841	71,600	9,649
2007	73,656	88%	65,137	15,069	56%	8,415	73,552	9,878
2008	74,714	89%	66,528	15,487	58%	9,008	75,536	10,107
2009	75,773	90%	67,932	15,905	60%	9,621	77,553	10,336
2010	76,831	90%	69,348	16,322	63%	10,253	79,601	10,566
2011	77,890	91%	70,778	16,740	65%	10,904	81,682	10,795
2012	78,948	91%	72,220	17,158	67%	11,575	83,796	11,024
2013	79,876	92%	73,555	18,008	70%	12,567	86,123	11,254
2014	80,804	93%	74,902	18,858	72%	13,598	88,500	11,483
2015	81,732	93%	76,260	19,707	74%	14,669	90,929	11,712
2016	82,660	94%	77,629	20,557	77%	15,779	93,408	11,942
2017	83,646	95%	79,064	21,211	79%	16,774	95,838	12,171
2018	84,632	95%	80,511	21,864	81%	17,799	98,310	12,400
2019	85,619	96%	81,970	22,518	84%	18,854	100,825	12,630
2020	86,605	96%	83,442	23,171	86%	19,940	103,382	12,859
2021	87,591	97%	84,925	23,825	88%	21,056	105,981	13,088
2022	88,577	98%	86,420	24,478	91%	22,202	108,623	13,318
2023	90,201	98%	88,554	24,867	93%	23,133	111,687	13,547
2024	91,825	99%	90,707	25,257	95%	24,083	114,789	13,776
2025	93,448	99%	92,879	25,646	98%	25,050	117,929	14,006
2026	95,072	100%	95,072	26,035	100%	26,035	121,107	14,235

Table H.2 Flow Projections
Comprehensive Sewer Plan
City of Bellingham

Year	ADWF	AAF	MMF	MDF	PHF
2005	10.2	11.8	17.9	52.9	67.3
2006	10.5	12.8	20.3	53.4	67.9
2007	10.8	13.2	21.0	54.0	68.6
2008	11.1	13.6	21.6	54.5	69.2
2009	11.5	14.1	22.2	55.1	69.9
2010	11.8	14.5	22.9	55.6	70.5
2011	12.1	14.9	23.5	56.1	71.1
2012	12.6	15.4	24.4	56.7	71.8
2013	12.9	15.9	25.1	57.2	72.4
2014	13.3	16.3	25.8	57.7	73.0
2015	13.7	16.8	26.5	58.3	73.7
2016	14.0	17.2	27.3	58.8	74.3
2017	14.4	17.6	27.9	59.4	75.0
2018	14.7	18.0	28.5	59.9	75.6
2019	15.0	18.4	29.1	60.4	76.2
2020	15.3	18.8	29.7	61.0	76.9
2021	15.7	19.2	30.4	61.5	77.5
2022	16.0	19.6	31.0	62.0	78.1
2023	16.4	20.1	31.8	62.6	78.8
2024	16.8	20.7	32.7	63.1	79.4
2025	17.3	21.2	33.5	63.7	80.1
2026	17.7	21.7	34.3	64.2	80.7

Note:

All flows presented in mgd.

Table H.3	Load Projections Comprehensive Sewer Plan City of Bellingham					
	BOD, ppd			TSS, ppd		
Year	**AA**	**MM**	**MD**	**AA**	**MM**	**MD**
2005	20,200	23,000	42,100	22,600	26,300	64,700
2006	20,700	23,700	43,300	23,200	27,100	66,500
2007	21,400	24,400	44,600	23,900	27,900	68,500
2008	22,000	25,100	46,000	24,600	28,700	70,600
2009	22,700	25,900	47,300	25,300	29,500	72,600
2010	23,300	26,600	48,700	26,000	30,400	74,700
2011	24,000	27,400	50,100	26,800	31,200	76,800
2012	24,800	28,300	51,800	27,700	32,300	79,400
2013	25,500	29,100	53,300	28,500	33,200	81,700
2014	26,300	30,000	54,800	29,300	34,200	84,000
2015	27,000	30,800	56,400	30,100	35,100	86,300
2016	27,800	31,700	57,900	30,900	36,100	88,700
2017	28,400	32,400	59,200	31,600	36,900	90,700
2018	29,000	33,100	60,600	32,300	37,700	92,700
2019	29,600	33,800	61,900	33,000	38,600	94,800
2020	30,300	34,500	63,200	33,800	39,400	96,900
2021	31,000	35,300	64,600	34,500	40,300	99,000
2022	31,600	36,100	66,000	35,300	41,200	101,200
2023	32,400	37,000	67,700	36,200	42,200	103,800
2024	33,300	37,900	69,500	37,100	43,300	106,500
2025	34,100	38,900	71,200	38,100	44,400	109,200
2026	35,000	39,900	73,000	39,000	45,500	111,900

Appendix I

COLLECTION SYSTEM MODEL CALIBRATION

City of Bellingham

Comprehensive Sewer Plan

APPENDIX I - Technical Memorandum

COLLECTION SYSTEM MODEL CALIBRATION

March 2007

CITY OF BELLINGHAM

COMPREHENSIVE SEWER PLAN

APPENDIX I - TECHNICAL MEMORANDUM

COLLECTION SYSTEM MODEL CALIBRATION

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COLLECTION SYSTEM MODEL CALIBRATION

1.0 INTRODUCTION

A collection system model was used to evaluate performance of the City of Bellingham's collection system during dry and wet weather conditions, and to plan future improvements. The purpose of this technical memorandum (TM) is to summarize the collection system model calibration procedure and report the results of the calibration. This TM provides background on H2OMAP Sewer model that was created by IDModeling and the updates made to that model, describes available rain and flow data, and details the dry weather flow (DWF) and wet weather flow (WWF) calibration procedures.

2.0 BACKGROUND

IDModeling created a model of the collection system using H2OMAP Sewer software by MWH Soft. The model construction process and preliminary calibration was described in two Technical Memoranda developed by IDModeling:

- Final TM No. 1, Model Development, Construction, and QA/QC, October 9, 2006.
- Final TM No. 2, Sewer Model Loading, Peaking, and Calibration, October 9, 2006.

The H2OMAP Sewer model of the Bellingham collection system was delivered to Carollo Engineers for further enhancements and comprehensive calibration to both dry weather flows (DWFs) based on Traffic Analysis Zone (TAZ) data and wet weather flows (WWFs) based on monitored rain events.

The model constructed by IDModeling adequately represented the structure of the system (including manholes, pipes, connectivity, pump stations, etc.) based on the data available at that time. Many pipe inverts, and manhole rim elevations were unavailable, so IDModeling interpolated these elevations based on available data. Some of the pump stations were also simplified. Further details on this process can be found in TM No. 1 listed above.

IDModeling also performed a preliminary calibration to DWFs based on land use data provided from the city's parcel information. The land use data were converted to population estimates based on gallon/capita/acre data taken from the 1998 EarthTech report. Employment data were extracted from a recent InfoUSA database. Diurnal peaking factors from the 1998 EarthTech report were used to peak the average dry weather flows (ADWFs) generated from the above databases. Details on this procedure can be found in TM No. 2 listed above.

Although the ADWFs generated by the above databases may be accurate, these databases only exist for current conditions. For current and future population and employment numbers, the modeling was based on the population values presented in the Comprehensive Plan. Also, it appears the use of the 1998 diurnal peaking factors noted above along with the pump station simplifications, caused inaccuracies in modeled hourly DWFs. Examples of the hourly DWF graphs produced using the original IDM model can be found in Attachment A.

In addition, no WWF calibration was completed as part of the study documented in the IDModeling Final Technical Memoranda. It was therefore necessary to calibrate the model for DWF and WWF conditions. As part of the calibration process, the model structure was updated to better represent the operation of the collection system. These updates included the following:

- Converting the pump station operations to inflow=outflow for extended period modeling.
- Added Combined Sewer Overflow (CSO) outfall.
- Changes Manning loss coefficient to 0.013 for all gravity pipes.
- Changed Hazen-Williams coefficient to 120.
- Reversed pipe inverts on one adverse pressurized gravity main, PINELS-PINE.
- Converted Manning's loss coefficient to Haven-Williams loss coefficient for some forcemains
- Added headloss coefficients to manholes – see Performance Criteria TM for details.
- Adjusted elevations of some manholes to match City-provided data.

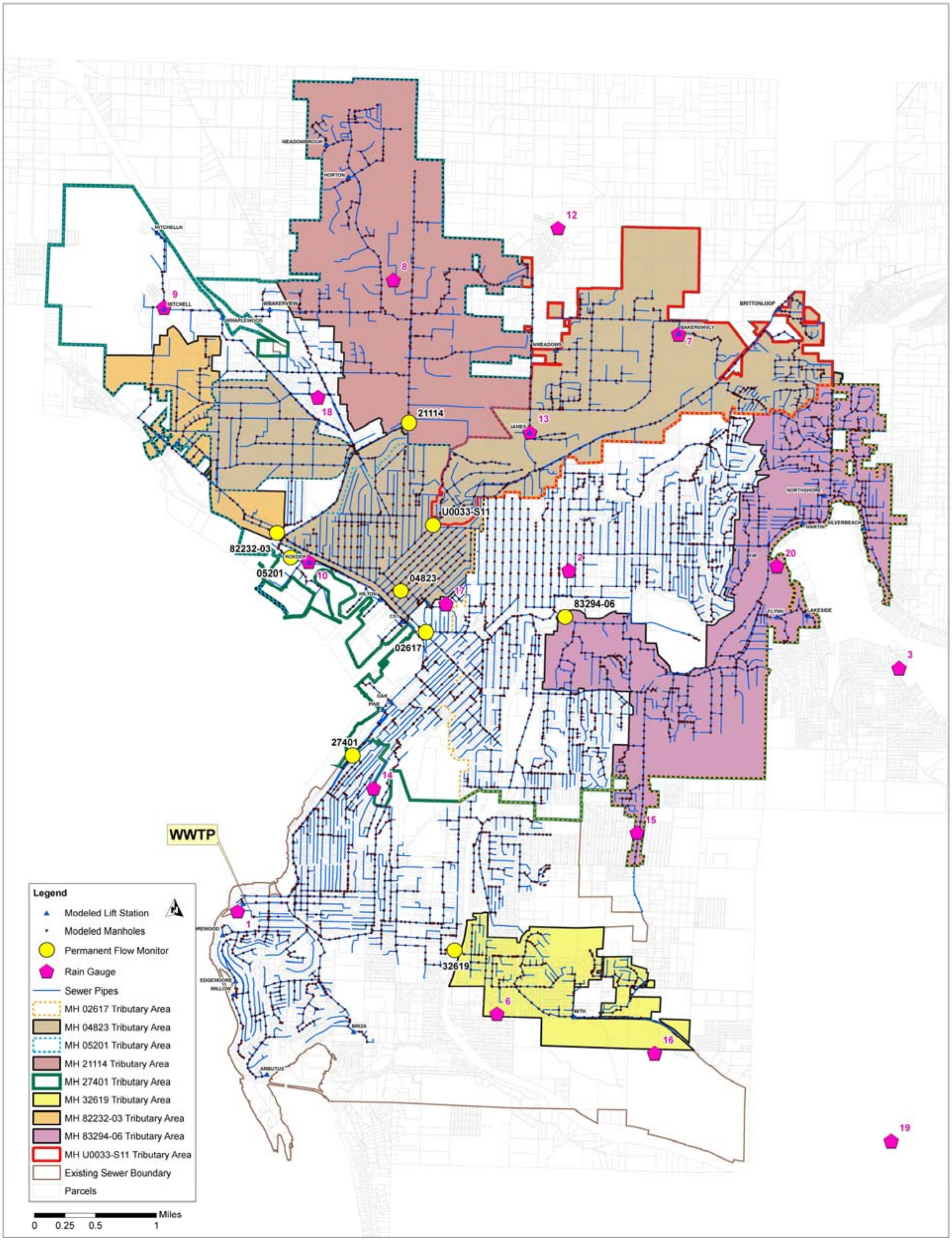
The model currently contains 3744 junctions, 3758 pipes, 28 pump stations, 1 overflow, and 1 outfall point.

3.0 AVAILABLE DATA

Measured rainfall and flow data from November 2004, January 2005, and April 2005 were used to calibrate the model to infiltration and inflow (I/I). September 2005 flow data were chosen to calibrate to DWF because it represented a recent period with little rainfall.

3.1 Rainfall

Rainfall data from 14 rain gauges within the City's sewered area were used. The location of each of these gauges is shown on Figure 1. These gauges recorded data at 10-minute intervals, which were aggregated to hourly intervals for use in the model calibration. These rain gauges are owned and maintained by the City.



FLOW METER AND RAIN GAUGE LOCATIONS

FIGURE 1

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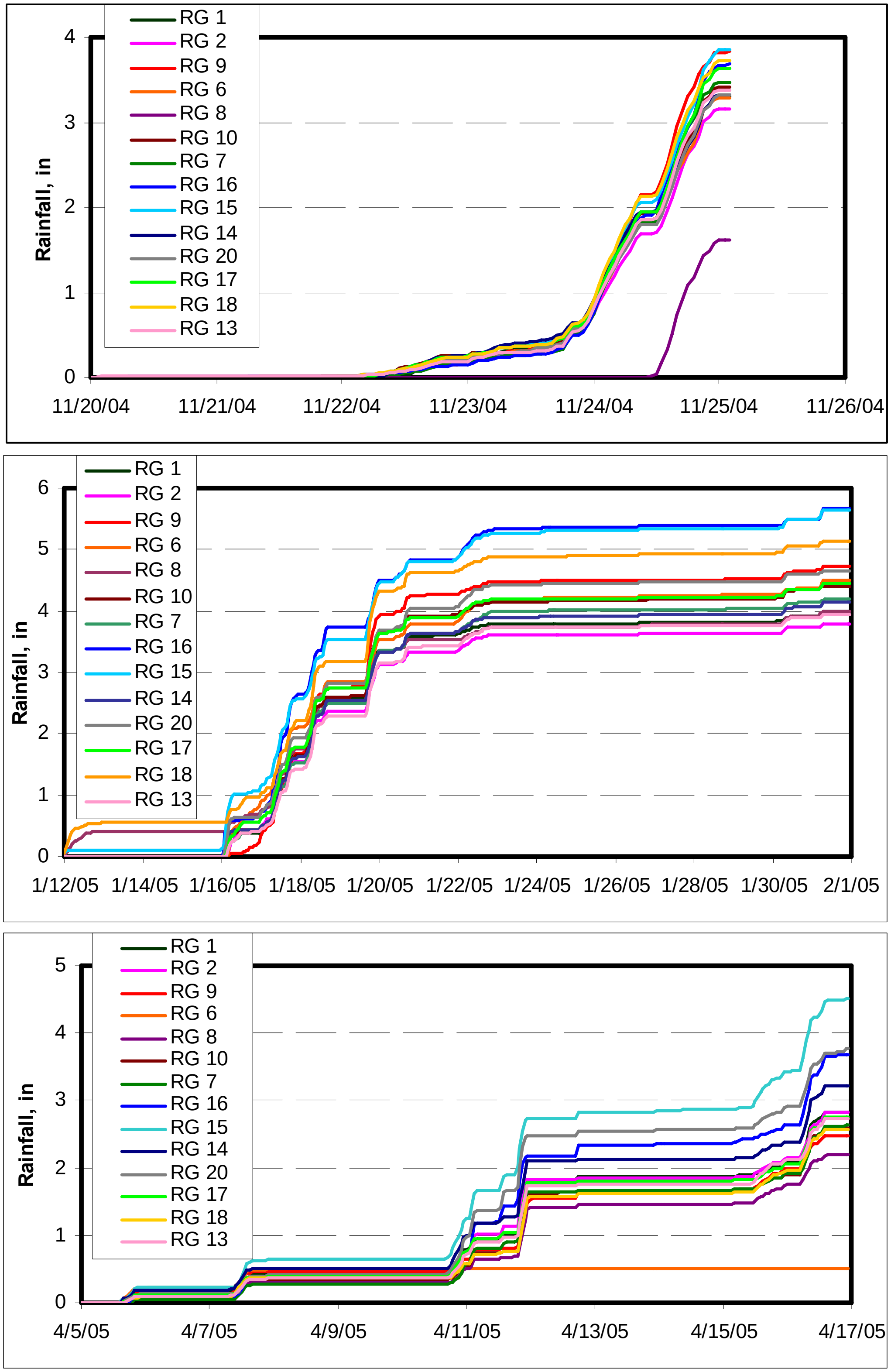
Figure 2 illustrates the cumulative rainfall plots for three rainfall events. For the 11-day period in November 2004 (11/20 - 11/30/04), all the rain gauges except one (RG. 8) recorded total rainfalls of between 3.2 and 3.9 inches. Rain gauge RG 8 was considered inaccurate as the gauge appeared to stop measuring rain during the period and was therefore not used. For the 20-day period in January 2005 (1/12 - 1/31/05), rainfall at the fourteen gauges was recorded between 3.8 and 5.7 inches. For the 13-day period in April 2005 (4/5 - 4/17/05), all the rain gauges except one (RG 6) measured between 2.2 and 4.5 inches. Rain gauge RG 6 was considered inaccurate and was not used. Table 1 summarizes the peak intensities and total rainfall recorded at the rain gauges for the three events that are used for model calibration.

Table 1 Measured Rainfall Statistics
Comprehensive Sewer Plan
City of Bellingham

Rain Gauge	11/20 – 11/30/04		1/12 – 1/31/05		4/5 – 4/17/05	
	Peak Intensity (in/hr)	Total Volume (in)	Peak Intensity (in/hr)	Total Volume (in)	Peak Intensity (in/hr)	Total Volume (in)
RG 1	0.17	3.72	0.19	3.98	0.25	2.83
RG 2	0.22	3.50	0.19	3.80	0.23	2.82
RG 6	0.22	3.82	0.18	4.50	N/A	N/A
RG 7	0.23	3.92	0.22	4.19	0.28	2.63
RG 8	N/A	N/A	0.19	3.99	0.23	2.19
RG 9	0.22	4.24	0.29	4.73	0.20	2.47
RG 10	0.21	3.87	0.28	4.41	0.25	2.59
RG 13	0.20	3.77	0.21	3.93	0.25	2.74
RG 14	0.18	3.75	0.20	4.14	0.25	3.22
RG 15	0.24	4.39	0.30	5.65	0.28	4.52
RG 16	0.23	4.29	0.35	5.68	0.30	3.69
RG 17	0.23	4.05	0.23	4.45	0.23	2.76
RG 18	0.19	4.15	0.31	5.13	0.25	2.58
RG 20	0.20	3.78	0.18	4.66	0.34	3.77
Min	0.17	3.50	0.18	3.80	0.20	2.19
Max	0.24	4.39	0.35	5.68	0.34	4.52



CUMULATIVE RAINFALL FOR THE WET WEATHER CALIBRATION EVENTS

FIGURE 2

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COMPREHENSIVE SEWER PLAN

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3.2 Flow

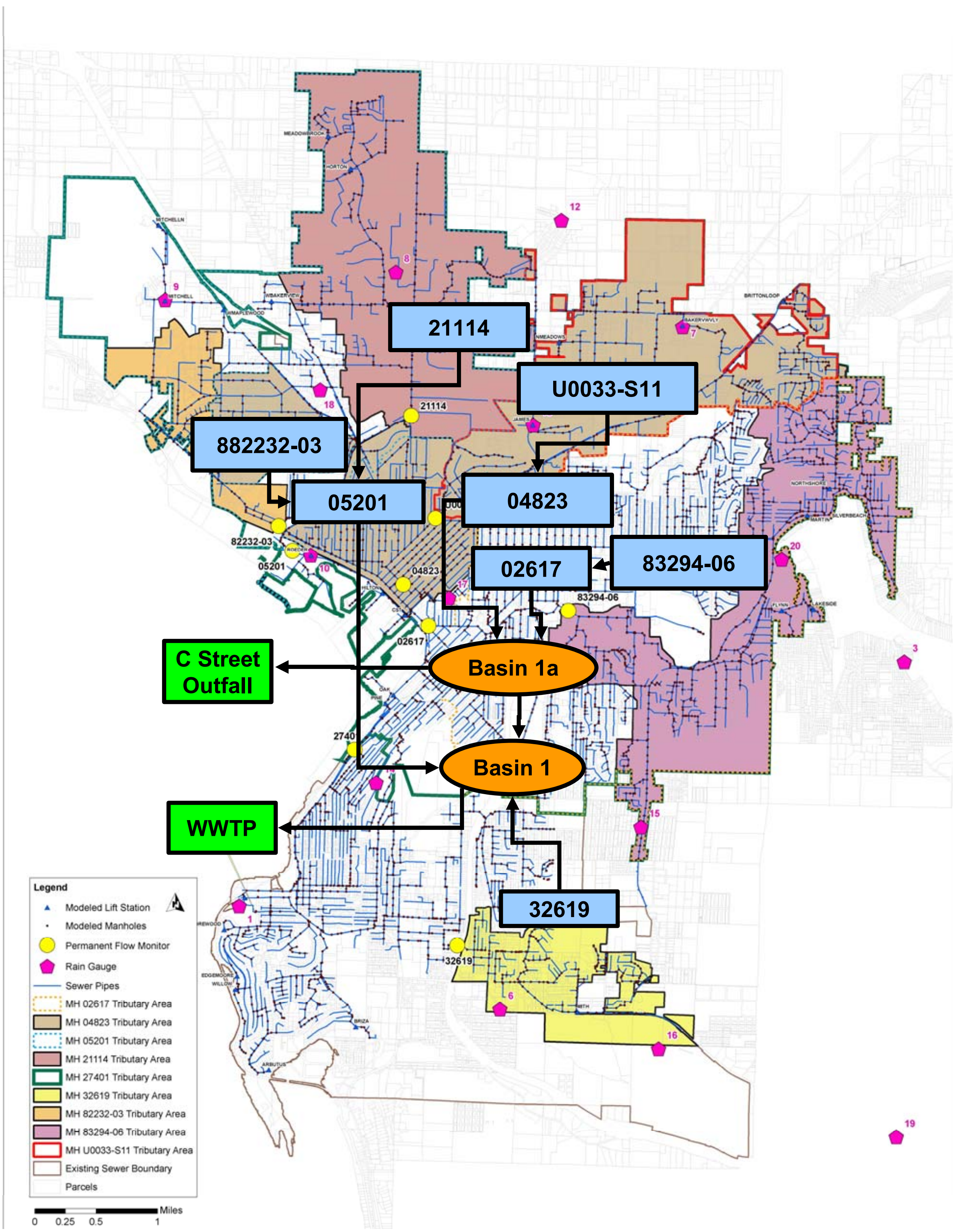
The City measures flow within the collection system by a series of eight permanent ADS meters. These meters measure depth and average velocity to calculate flow at hourly intervals. The ADS meter locations within the collection system are shown in Figure 1. Three primary meters, 5201, 02617, and 0482, cover large sections of the northern part of the system. Four of the meters, 82232-03, 21114, U0033-S11, and 83294-06 are located upstream from the primary meters as shown in the figure. Meter 32619 covers a southeastern portion of the system.

Up to four of the non-primary meters were not operational during all of the calibration periods. The meter at manhole 27401 was moved during the winter to manhole 32619. No data were collected at meter 27401 during the calibration periods. Data from 32619 were only available for the month of April 2005. Based on the collection system network, the areas tributary to each of the eight meters defined eight metered tributary basins.

Additionally, another basin was defined by the flow meter at the Post Point Wastewater Treatment Plant (WWTP). This basin is divided into two parts, Basin 1a and Basin 1, as a portion of this basin is connected to the C-street overflow. The measurements taken at the WWTP were from the meters at the outfall and the alternate outfall. The flow from the C Street combined sewer overflow (CSO) was calculated based on the depth of the water surface above the overflow weir when discharge occurred. The statistics of the metered basins are described in Table 2. Figure 3 illustrates a schematic representation of the sewer basins defined by the meter locations and overflows.

Table 2 Metered Basin Statistics
Comprehensive Sewer Plan
City of Bellingham

Basin	Tributary Basin Area, acres	Tributary Basin Sewer Length, thousands of feet
U0033_S11	1,998	154
83294-06	2,165	216
82232-03	459	28
32619	759	53
21114	2,383	120
05201	4,476	229
04823	3,368	345
02617	5,291	614
WWTP	19,211	1,682



SCHEMATIC OF BASINS BY FLOW METER

FIGURE 3

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COMPREHENSIVE SEWER PLAN

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4.0 MODEL CALIBRATION

Calibration is the process of adjusting parameters in a model to accurately and precisely represent measured variables (e.g., flow, depths, velocity, volume, etc.). Calibration is necessary because collection system models are mathematical representations of a physical system that incorporate some level of simplification. These necessary simplifications introduce error and uncertainty into the analysis. Adjustments of model parameters are necessary to reduce error and better meet the expectations of model application.

The H2OMAP Sewer model was calibrated in several steps. First, the model was calibrated to dry season DWFs to accurately represent only flows generated by residential, commercial, and industrial sources. Second, the model was calibrated to wet season DWFs to represent the groundwater infiltration that occurs during the wet season, also referred to as Base Infiltration (BI). Third, the model was calibrated to WWFs also referred to as I/I. The next section further describes these flows components and how they are modeled in H2OMAP Sewer.

4.1 Sewer Flow Components

Sewer flows can generally be categorized into two major components: sanitary flow, and wet weather flow (or I/I). Sanitary flow is the wastewater flow generated by residential, commercial and industrial customers that are tributary to the collection system. These flows generally exhibit a diurnal pattern, although industrial facilities can have varying patterns based on process wastewater generation.

Inflow is typically described as flow that enters the collection system through directly connected impervious areas (DCIA). These DCIAs, such as connected storm drains, will have a direct and immediate response to rainfall. Infiltration is less responsive than inflow because it enters the collection system through cracks after the rainfall infiltrates through the soil matrix. Infiltration can be further divided into near surface infiltration and BI.

Near surface infiltration (typically just referred to as infiltration) enters the sewers after rainfall works it way through soil and backfill and enters sewers through cracks in joints, manhole walls, etc. Near surface infiltration can enter the sewers and be seen in flow measurements for several days after a storm subsides.

BI enters the sewer through the same pathways as near surface infiltration, but has a much more indirect response to rainfall. For example, during the wet season, groundwater level can increase as many storms come through the area, and may not be apparent in the sewers until the ground around the sewers become fully saturated. The groundwater may stay high through the wet season and therefore, this type of infiltration will remain a constant source of infiltration until rains stop in the spring, the groundwater depth subsides, and the soils start drying out. GWI can therefore last for a month or more after a rainfall event in certain locations. Figure 4 illustrates an example of what these components may look like if it was possible to monitor each component separately.

4.2 Model Accuracy and Precision

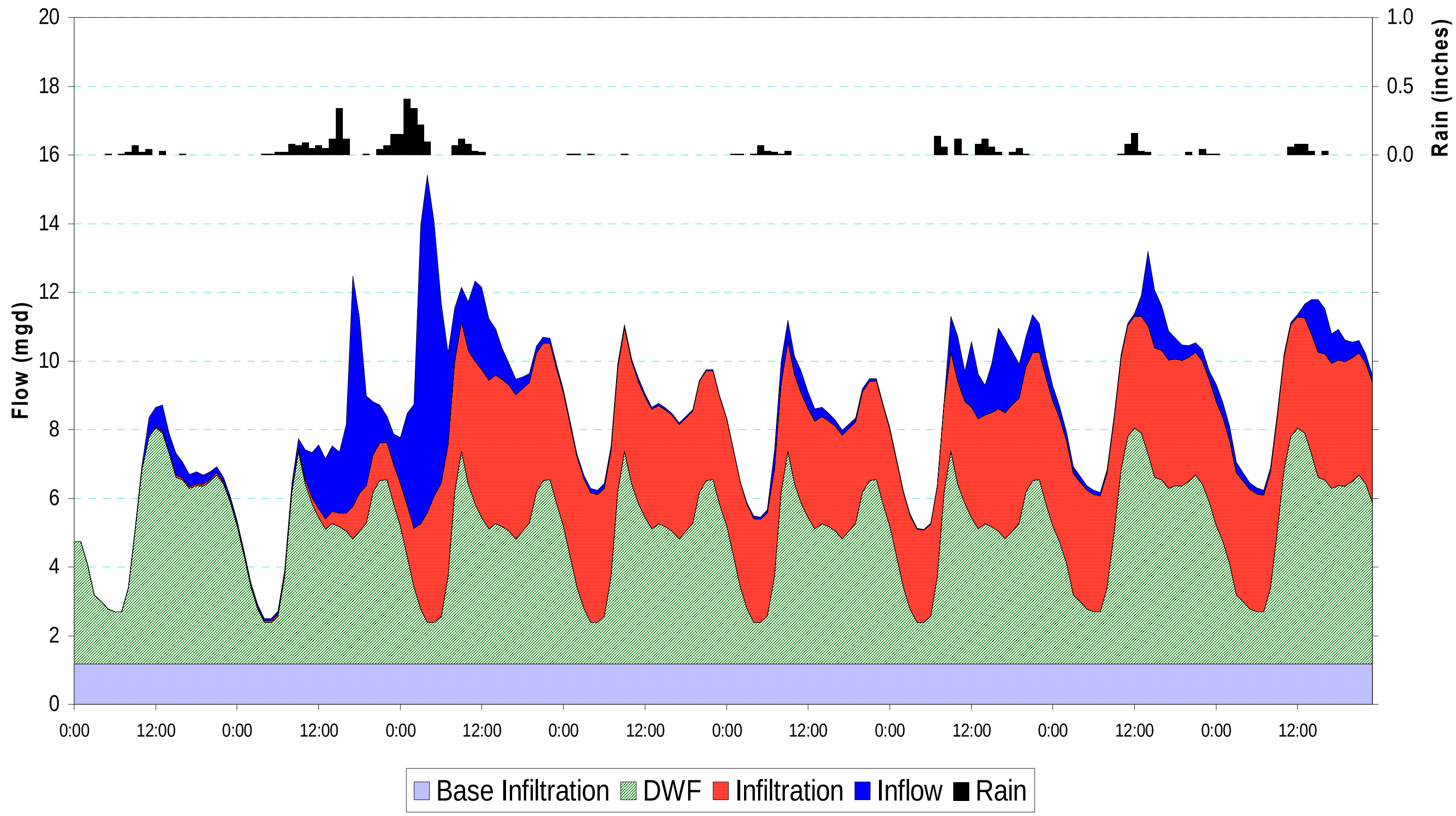
Model calibration should include an assessment of the precision and accuracy of modeled variables compared to measured variables. In this case, flows are the primary variable used for calibration. When modeling collection system flows, DWF during the dry and wet seasons as well as total flow during the wet season (both DWF and I/I) should be compared to make sure modeled flows represent measured flows to within a reasonable goal. The goal depends on the specific use of the model to make projections.

Plotting a time series of measured and modeled flows for a calibration period gives a good qualitative illustration of model accuracy and precision. However, scatter plots provide a better quantitative examination of model accuracy and precision. The precision of the model can be examined by generating a best-fit line through a scatter plot of measured and modeled flow data. A perfect fit would put all points on the 1-to-1 line and produce an R^2 equal to 1.0. No model will be perfect, but the R^2 should generally be above 0.70.

Although precision is important, more important is the accuracy of the model. Accuracy of the model can be examined by plotting an envelope around the 1-to-1 line. For example, two lines can be plotted that represent boundaries of plus 15 percent and minus 15 percent around the perfect fit line. If the points fall in this envelope, the model is considered to be plus/minus 15 percent accurate. Both precision and accuracy will be reported for the DWF and I/I calibrations. An accuracy goal of plus or minus15 percent for measured to modeled dry and wet weather flows is used for this study.

4.3 Modeling Dry Weather Flow (During Dry Season)

Modeling of DWFs can be performed in several different ways and is usually a function of the model that is being used. H2OMAP Sewer allows estimation of ADWFs either based on population and employment data or land use data. Population and employment data based on TAZ data were used for this study, as documented in the Comprehensive Plan. The TAZ polygons provided in the dataset were not at a fine enough resolution to provide accurate flow input points to individual junctions within the model. Therefore, a process was applied to further subdivide the TAZ polygons by overlaying the model network, and using detailed land use polygons to further subdivide the TAZ polygons to provide flow injection points for 2,591 junctions out of a total of 3,744 junctions in the model.



SEWER FLOW COMPONENTS

FIGURE 4

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PATH AND FILE NAME

4.3.1 Diurnal Patterns

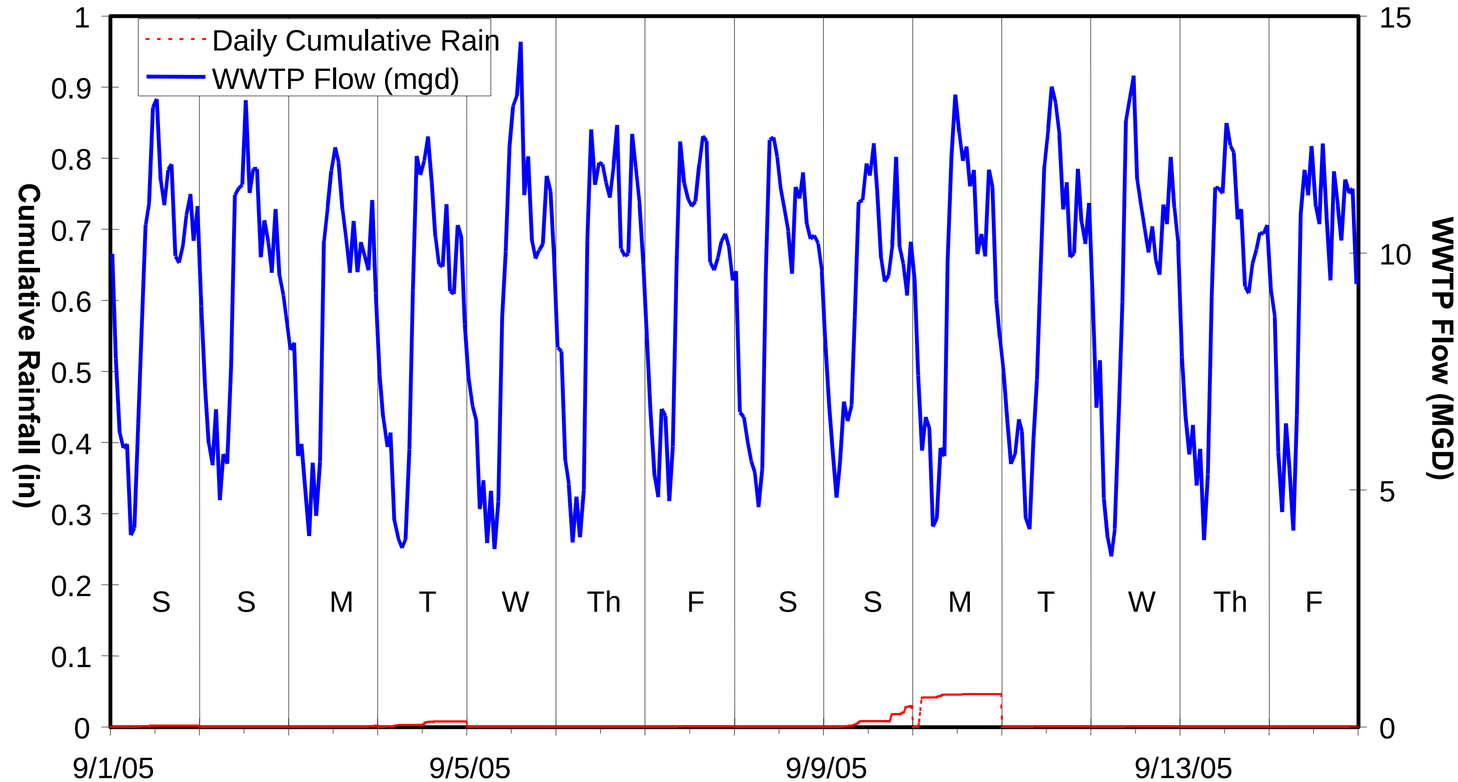
Diurnal patterns were then developed for the 2,591 flow loading points defined above. The flow metered period from September 1, 2005 through September 15, 2005, was used because it contained negligible rainfall and best represented the DWF patterns throughout the system. The data did not show significant variation between weekdays and weekends as shown in Figure 5, so a single diurnal pattern was developed for each basin representative of any day (both weekdays and weekends). The hourly measured flow data were averaged for the two-week period to create a daily average pattern. The measured flow at the WWTP was used from the same period to develop the diurnal pattern for the portions of the system not monitored by a local flow meter. The diurnal curves for each basin are illustrated in Figure 6. These diurnal curves were applied to flow loading points that were upstream of each respective meter location.

DWF calibration is then completed by estimating unit flow factors for both population and employment to calculate ADWFs for each sewer basin (at each metering point) in the collection system model. Unit flow factors of 78 gallons/capita/day (gpcd) for population and 82 gpcd for employment were estimated in total for the system based on WWTP flows and population. These two variables were used as the initial estimate for each flow loading point and then adjusted according to best match the monitored ADWFs at each meter location. The diurnal patterns could also be slightly adjusted to best match the overall pattern in each basin.

Table 3 summarizes the unit flow factors applied to each sewer basin to best represent the DWFs throughout the system. This method produces an accurate estimate of diurnal flow patterns during the calibration period and also allows for easy updating of ADWFs for future flow scenarios (e.g., a new ADWF can be entered, the diurnal patterns remain the same, and the new diurnal flows are calculated).

Table 3 Unit Flow Factors by Sewer Basin
Comprehensive Sewer Plan
City of Bellingham

Basin	Unit Flow for Population (gpcd)	Unit Flow for Employment (gpcd)
U0033_S11	90	95
83294-06	113	119
82232-03	78	82
32619	63	67
21114	78	82
05201	78	82
04823	90	95
02617	78	82
Basin 1	63	67
Average	78	82



WEEKEND AND WEEKDAY DIURNAL PATTERN

FIGURE 5

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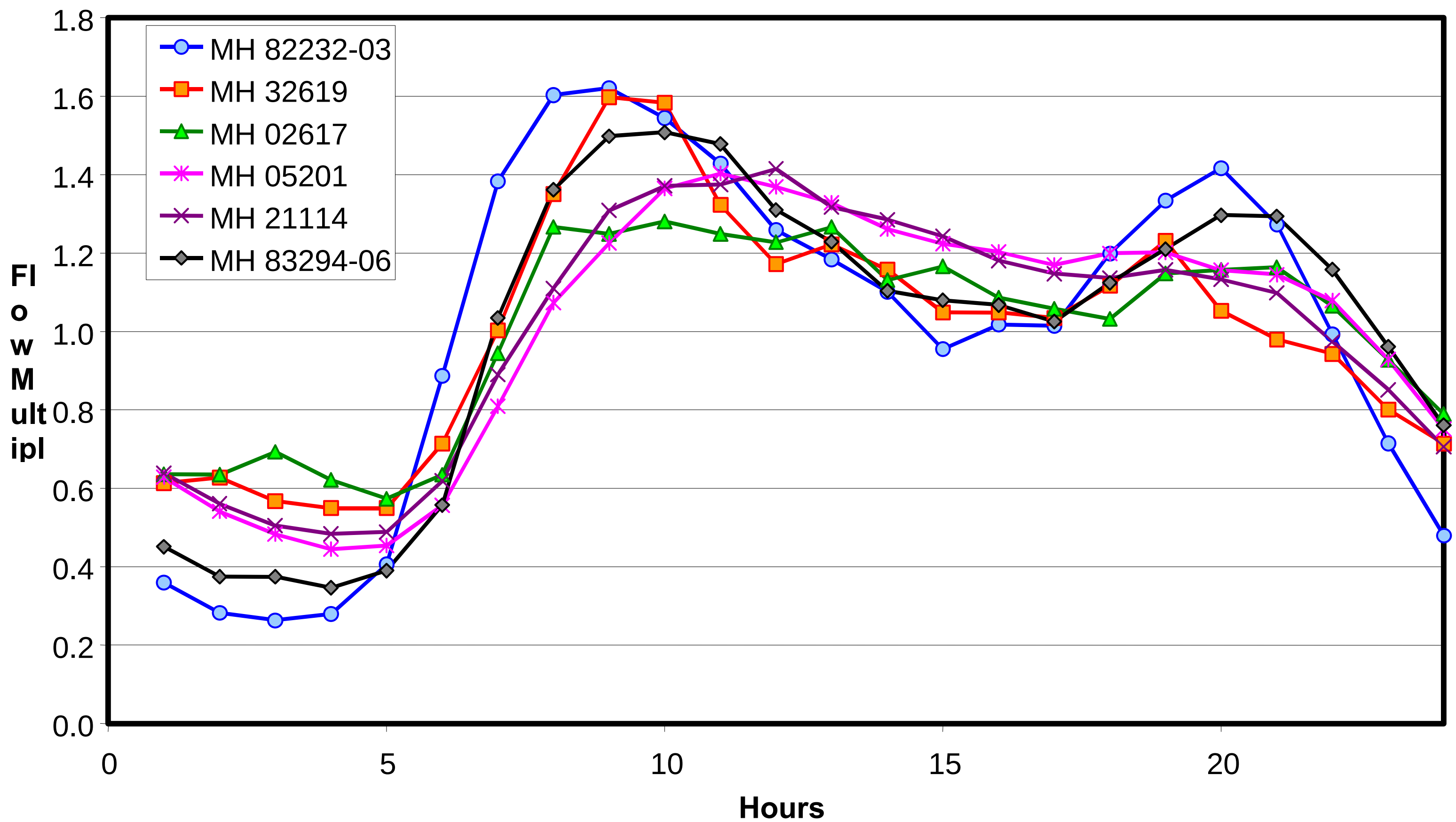

BASIN DIURNAL PATTERNS

FIGURE 6

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Dry season DWF calibration graphs (both time series and scatter plots) for each of the basins are included in Attachment B. The precision measured by R^2 for all modeled DWFs exceeded 0.90. The full data set of hourly modeled DWFs were generally within plus or minus 15 percent of measured flows. Peak, average and minimum DWFs were even more accurate as shown in Table 4. These statistics indicate that the model was well-calibrated for DWFs.

Table 4 Dry Weather Flow Calibration Statistics (Dry Season)
Comprehensive Sewer Plan
City of Bellingham

	Maximum DWF			**Average DWF**			**Minimum DWF**		
Basin	Meas. (mgd)	Model (mgd)	Diff.(1) (%)	Meas. (mgd)	Model (mgd)	Diff.(1) (%)	Meas. (mgd)	Model (mgd)	Diff.(1) (%)
U0033_S11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
83294-06	1.91	1.93	-1	1.28	1.34	-5	0.44	0.52	-18
82232-03	0.22	0.22	0	0.14	0.14	0	0.04	0.03	25
32619	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21114	1.07	1.19	-11	0.77	0.86	-12	0.37	0.42	-14
05201	1.83	1.80	2	1.30	1.30	0	0.58	0.59	-2
04823	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
02617	5.88	5.77	2	4.59	4.42	4	2.63	2.40	9
WWTP	12.05	11.87	2	9.17	9.16	0	4.76	4.90	-3

Note:
1. Diff. = (Measured - Modeled)/Measured * 100.

4.4 Modeling Dry Weather Flow (During Wet Season)

H2OMAP Sewer cannot explicitly model long drawn out BI that occurs during the wet season as described Section 4.1. Therefore, BI was accounted for as a constant amount of flow. The BI was estimated using DWF measured during the wet season (early January 2005) and compared to the DWF from September 2005.

After the model was run, base infiltration factors were determined by comparing the flow measurements during the January calibration period at each meter to the flows measured at the same meter during DWF. The metered flow data indicated that BI was not constant throughout the system, which is expected given the age range of the component sewers in each basin. The total BI was 1.54 mgd in the system, which was divided between the four primary areas for application in the model.

The total BI had to be distributed throughout the collection system model. It was assumed that the amount of BI was proportional to the pipe length and diameter. H2OMAP Sewer allows for the application of an infiltration rate per unit of pipe diameter times pipe length. Table 5 summarizes the flow, and factors applied to each basin.

Table 5 Basin Infiltration Flows and Factors
Comprehensive Sewer Plan
City of Bellingham

Basin	Base Infiltration (mgd)	Factor
04824	0.19	0.00008
05202	0.18	0.00020
02167	1.15	0.00025
Basin 1	0.02	0.00001(1)
Total	1.54	

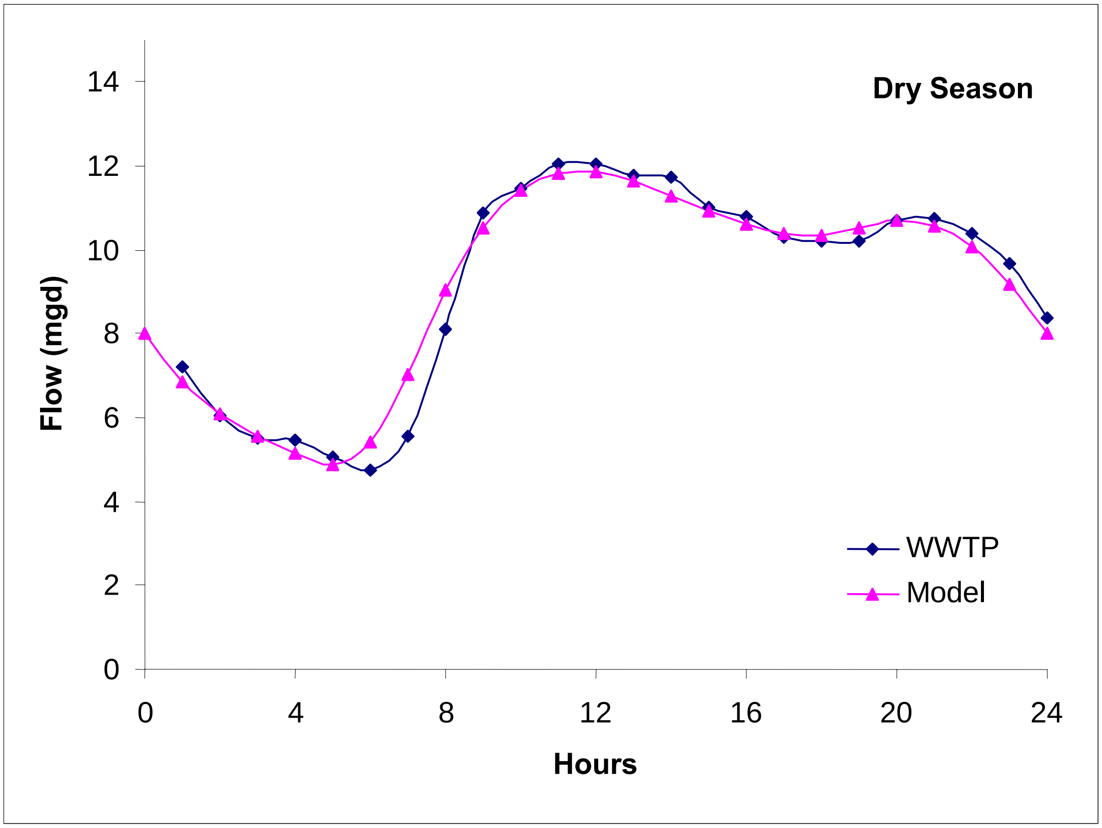
Notes:
1. Factor was applied to every other pipe for numerical reasons

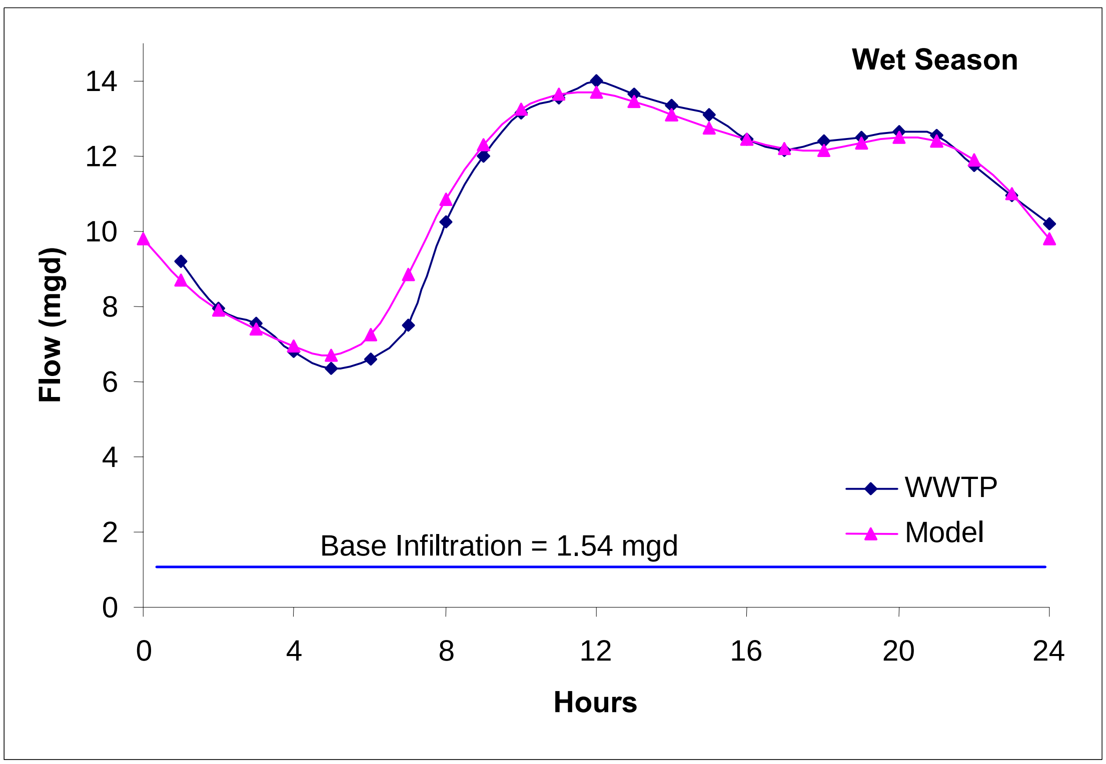
Figure 7 illustrates the DWF calibration plots at the WWTP for both the dry season and wet season (with BI added). Attachment C illustrates graphs (both time series and scatter plots) for the wet season DWF calibrations. The statistics again indicate that modeled DWFs for the wet seasons were accurate and precise as compared to metered flows for all basins.

4.5 Modeling Infiltration and Inflow

Model calibration should include an assessment of the accuracy and precision of the modeled variables compared to the measured variables. In the case of modeling collection system flows, total flows during the wet season (both DWFs and I/I) should be compared to make sure modeled flows represent measured flows to within a reasonable goal. The goal of the wet weather calibration was to bring the model flows within 15 percent, plus or minus of the measured flows.

I/I can be modeled in H2OMAP Sewer using several different techniques. The RTK method was chosen (also referred to as the Tri-Triangular method in the users guide) because it represents the best method in this software package to accurately model collection systems with excessive I/I.





CUMULATIVE RAINFALL FOR THE WET WEATHER CALIBRATION EVENT

FIGURE 7

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

The RTK hydrograph is comprised of three overlapping triangular hydrographs, each defined by the fraction of rainfall volume, R, time to peak, T, and a recession constant, K. The first triangle represents the initial system response to the rain, such as direct inflow with a short response time. The second triangle represents the intermediate response due to infiltration. The third triangle can represent long-term infiltration, and has a longer time to peak. Figure 8 illustrates the components of a RTK hydrograph.

To begin the calibration process to I/I, each rain gauge was assigned an area via the Thiessen polygon method. Initially a default RTK hydrograph was assigned each rain gauge area.

Calibration to I/I involved adjusting the RTK parameters in H2OMAP Sewer until the modeled total flows adequately represented the measured flows. This calibration process was first applied to the January 2005 period. When the peaks, volumes, and shapes were well fit, then the other two calibration periods (November 2004 and April 2005) were projected to verify the calibration parameters best represent all three periods. This process of utilizing several independent events is known as verification. Table 6 summarizes the RTK parameters for each rain gauge basin.

Figure 9 shows the rain gauge basins in the system, colored by R. Ideally R is less than 5 for a collection system. When R ranges from 5 to 10 a fair amount of rain is getting into the system. Values of R greater than 10 indicate that the system is probably combined with many direct connections. The highest R values are located in the central downtown area and the vicinity of the WWTP.

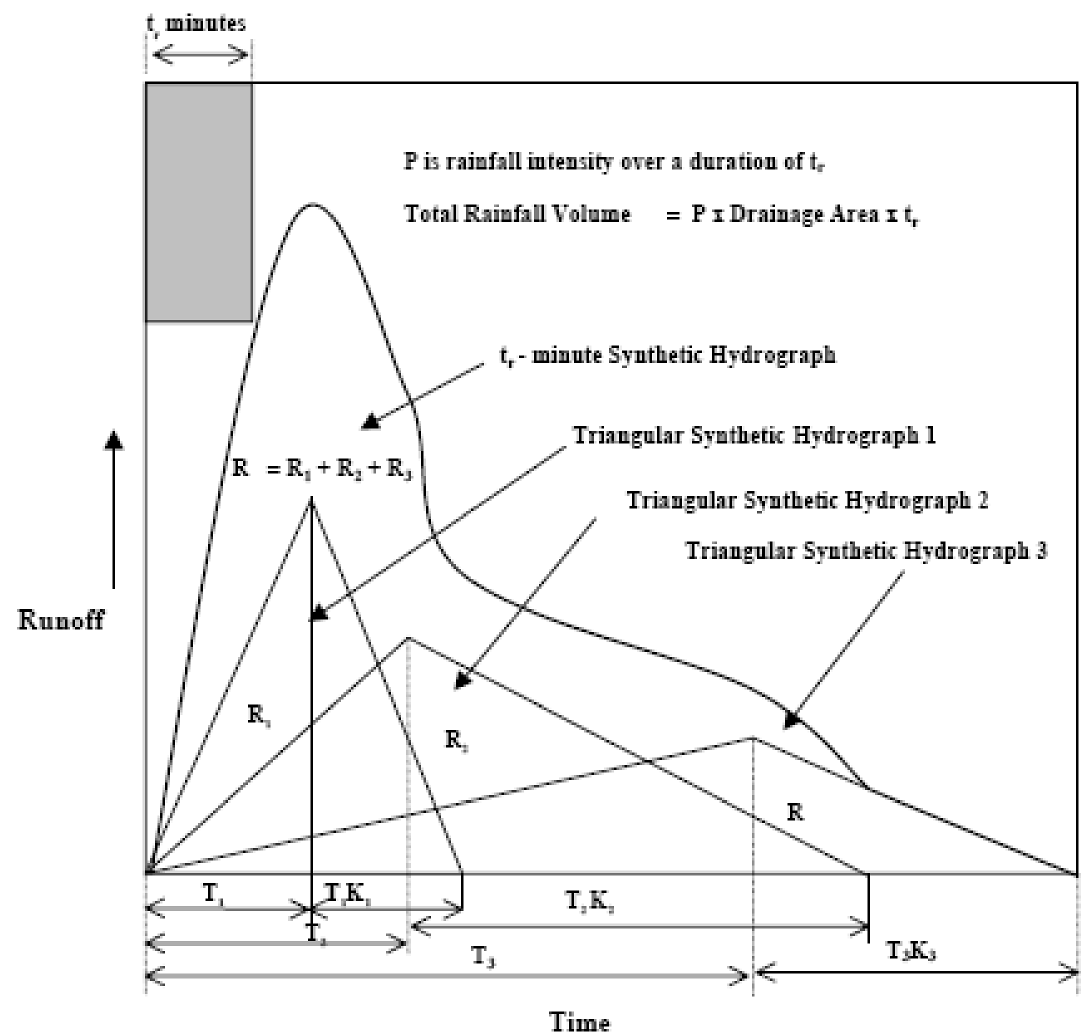
Figure 10 illustrates times series plots for total flows at the WWTP for the three calibration periods. Attachments D, E, and F contain the time series and scatter plots for the November 2004, January 2005, and April 2005 calibration periods respectively. Tables 7, 8, and 9 summarize the measured versus modeled peak hourly flows (PHF), peak daily flows (PDF), and peak weekly flows (PWF) for each calibration period. These statistics illustrate an excellent calibration over all three periods for each basin.

Table 6 Basin RTK Parameters
Comprehensive Sewer Plan
City of Bellingham

Basin[1]	R	R1	R2	R3	T1	T2	T3	K1	K2	K3
Short Street	2	15	40	45	2	8	36	2	3	5
Mitchell Way	0.5	7	40	53	2	8	36	2	3	5
Roeder PS	11.5	32	40	28	2	8	24	2	3	3
James St. LS	5	15	45	40	1	10	48	2	3	2
Sunset Res.	7	8	55	37	2	8	48	2	3	5
WWTP	10	18	40	42	2	8	24	2	3	2
Revielle Res.	4	5	80	15	2	8	24	2	3	4
Lake Padden	0.75	1	20	79	2	8	36	2	3	3
City Hall	22	75	23	2	2	8	52	2	3	4
Shuksan M.S.	4.5	25	50	25	2	8	36	2	3	2
Blodel Park	2.5	1	65	34	2	12	52	2	3	3.5
Central Shops	13	25	65	10	2	12	60	2	3	6
38th St.	1.5	2.5	20	77.5	2	8	36	2	3	3
Bakerview Valley	6.5	15	44	41	2	10	48	2	3	5

Note:

1. Basins represent rain gauge basins.



COMPONENTS OF A RTK HYDROGRAPH

FIGURE 8

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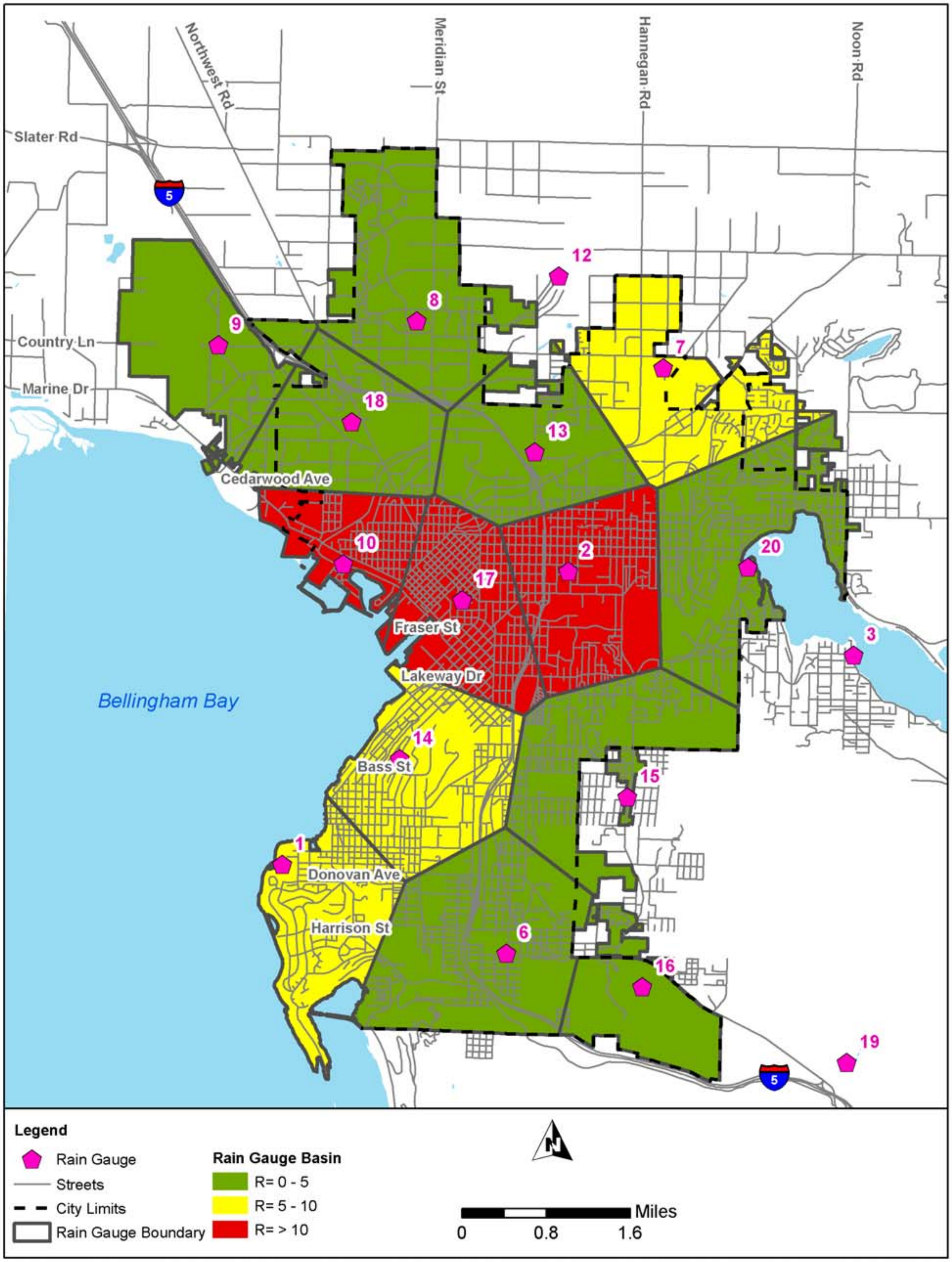
COMPREHENSIVE SEWER PLAN



RAIN GAUGE BASIN

FIGURE 9

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COMPREHENSIVE SEWER PLAN

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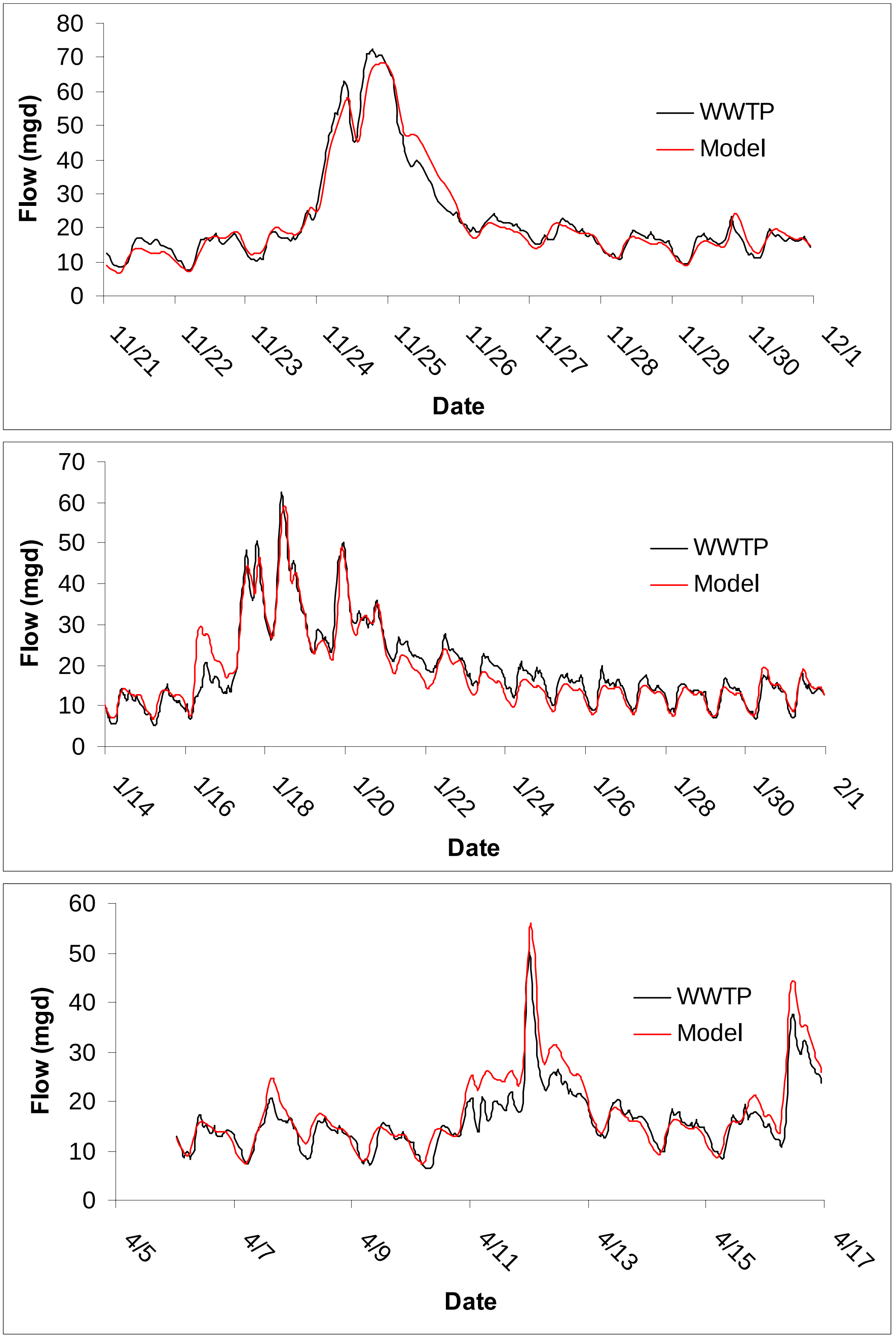

WWTP TIME SERIES PLOTS FOR THE THREE CALIBRATION PERIODS

FIGURE 10

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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Table 7 November 2004 Calibration Period Statistics[1]
Comprehensive Sewer Plan
City of Bellingham

Basin	Peak Hourly Flows			Peak Daily Flows[3]			Peak Weekly Flows[4]		
	Meas. (mgd)	Model (mgd)	Diff.[2] %	Meas. (mgd)	Model (mgd)	Diff.[2] %	Meas. (mgd)	Model (mgd)	Diff.[2] %
U0033-S11	6.7	7.1	-7	112.7	118.1	-5	333.3	425.9	-28
83294-06	7.3	7.6	-4	121.6	136.9	-13	534.8	579.6	-8
82232-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
32619	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21114	2.9	2.8	4	49.0	47.8	3	228.1	234.5	-3
05201	6.2	6.9	-11	110.8	118.0	-7	427.2	466.7	-9
04823	16.7	16.2	3	242.1	271.0	-12	731.9	825.1	-13
02617	46.7	34.4	26	660.7	583.7	12	2090.3	1961.1	6
WWTP	72.2	68.4	5	1369.9	1282.6	6	4330.2	4342.3	-0

Notes:
1. The calibration period extends from 11/21/2004 - 11/30/2004.
2. Diff = (Measured – Modeled) / Measured * 100.
3. Peak Daily Flow from 11/24/2004.
4. Peak Weekly Flow from 11/23/2004 - 11/29/2004.

Table 8 January 2005 Calibration Period Statistics[1]
Comprehensive Sewer Plan
City of Bellingham

Basin	Peak Hourly Flows Meas. (mgd)	Peak Hourly Flows Model (mgd)	Peak Hourly Flows Diff.[2] %	Peak Daily Flows[3] Meas. (mgd)	Peak Daily Flows[3] Model (mgd)	Peak Daily Flows[3] Diff.[2] %	Peak Weekly Flows[4] Meas. (mgd)	Peak Weekly Flows[4] Model (mgd)	Peak Weekly Flows[4] Diff.[2] %
U0033-S11	5.0	5.1	-2	72.6	84.2	-16	359.2	422.4	-17
83294-06	5.4	6.0	-11	108.1	115.2	-6	588.7	608.6	-3
82232-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
32619	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21114	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
05201	5.8	6.0	-3	91.4	98.7	-8	470.7	510.1	-8
04823	12.0	12.0	0	167.9	175.6	-5	820.0	849.3	-4
02617	27.0	26.4	2	387.4	406.8	-5	2052.8	2051.7	0
WWTP	62.7	58.8	6	972.2	957.4	2	4832.6	4650.2	4

Notes:
1. The calibration period extends from 1/13/2005 - 1/31/2005.
2. Diff = (Measured – Modeled) / Measured * 100.
3. Peak Daily Flow from 1/18/2005.
4. Peak Weekly Flow from 1/17/2005 - 1/23/2005.

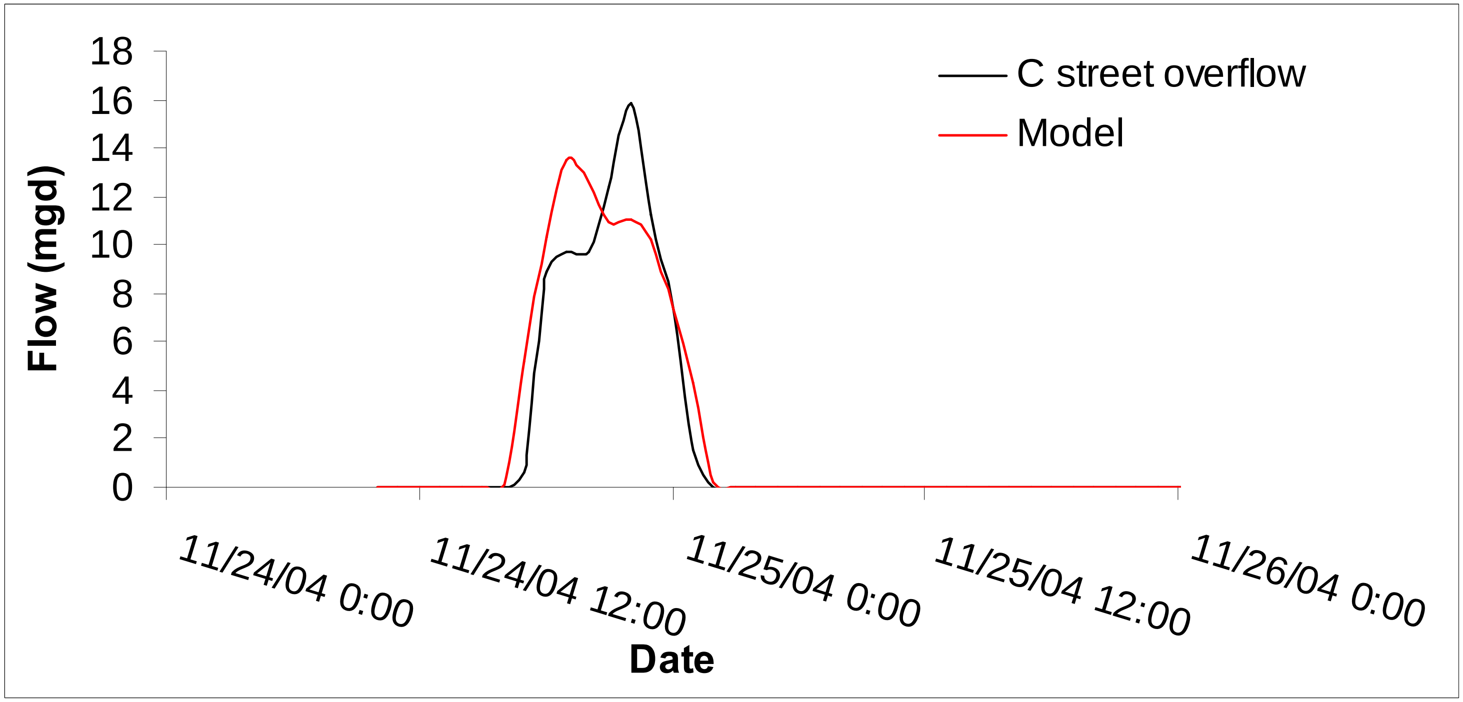
Table 9	April 2005 Calibration Period Statistics[1] Comprehensive Sewer Plan City of Bellingham								
	Peak Hourly Flows			**Peak Daily Flows[3]**			**Peak Weekly Flows[4]**		
Basin	Meas. (mgd)	Model (mgd)	Diff.[2] %	Meas. (mgd)	Model (mgd)	Diff.[2] %	Meas. (mgd)	Model (mgd)	Diff[2] %
U0033-S11	4.2	4.5	-7	44.9	61.2	-36	232.9	291.4	-25
83294-06	4.4	5.4	-24	77.4	100.7	-30	442.5	515.9	-17
82232-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
32619	8.8	10.6	-21	8.8	10.6	-21	48.9	52.7	-8
21114	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
05201	3.3	4.6	-38	53.6	74.5	-39	310.7	377.5	-22
04823	8.9	11.2	-25	98.4	122.2	-24	471.9	581.3	-23
02617	20.8	25.7	-23	266.2	320.9	-21	1503.8	1640.0	-9
WWTP	50.2	55.7	-11	601.7	729.4	-21	3053.1	3449.0	-13

Notes:
1. The calibration period extends from 4/6/2005 - 4/16/2005.
2. Diff = (Measured – Modeled) / Measured * 100.
3. Peak Daily Flow from 4/11/2005.
4. Peak Weekly Flow from 4/10/2005 - 4/16/2005.

The CSO that occurred during the November 2004 calibration period was also examined. Insignificant CSOs were measured during the other two calibration periods. Figure 11 illustrates the measured compared to the modeled flows at CSO Discharge # 3. The CSO flow was calculated by measuring depth over the overflow weir. The measured peak flow was 15.8 mgd, while the modeled peak flow was 14.2 mgd, representing a difference of plus 11 percent. The measured volume of CSO was 3.22 MG and the modeled volume of CSO was 4.01 MG, representing a difference of minus 25 percent. This CSO comparison also illustrates the calibration of the model.

4.6 Verifying Model Hydraulics

Another verification of model accuracy is to examine how the modeled flows influence the hydraulic grade line (HGL) throughout the system. The HGL is the elevation at which flows will rise within any system of pipes based on the hydraulics of the sewers. Again, the model was examined during DWFs (both dry and wet season) and during the three wet season calibration periods.



FLOWS FOR NOVEMBER CSO AT DISCHARGE NO. 3

FIGURE 11

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

Initial queries of the results showed that the water depth approached the rim elevation at some manholes. Closer examination of the data revealed that these manholes had rim elevations that were very close to the crown of the pipes, and in some cases the crown of the pipe was located above the rim. If the rim elevation is raised by a few feet, the water depth does not approach the rim elevation for any of the calibration events.

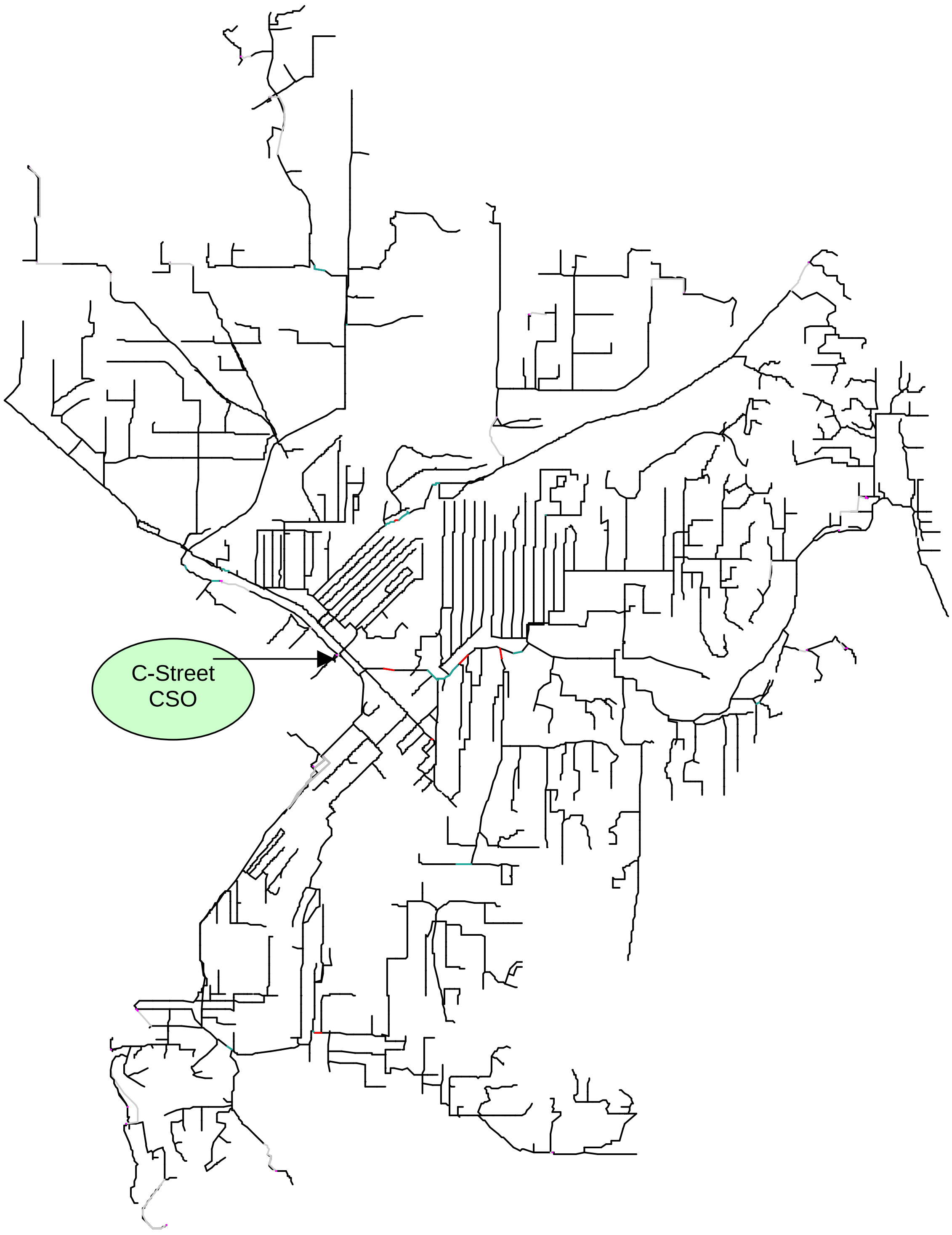
The peak flow depth to pipe diameter ratio (d/D) was evaluated for the dry season DWFs and for the three storm events. Figure 12 shows the pipes colored by the d/D ratio for DWF. Force mains are colored grey. Sewers with d/D less than 0.5 are colored black. Pipes where d/D exceeds 0.5, but is less than 1 are colored blue. Pipes where d/D exceeds 1 are colored red. There are very few sewer pipes where d/D exceeds 0.5 at any point during the day during DWF. During DWF 9 lines reach a d/D ratio of 1, and are summarized in Attachment H.

Figures 13, 14, and 15 show the sewer lines colored using the same color coding for the November, January, and April storm events, respectively. The majority of the sewers with d/D greater than 0.5 are concentrated in the downtown area, and the northwestern part of basin U0033-S11 for the storm events. There are additional lines where d/D exceeds 0.5 scattered throughout the system. The lines that reach d/D of 1 during the storms are summarized in Attachment H. The November storm has the highest number, with 196 pipes becoming full at a point during the storm. This is not surprising given the large amount of I/I in the system.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The model has been calibrated within the calibration goal of plus or minus 15 percent from data during 2004 and 2005. The model reproduces these events given the challenges and variability in rainfall and modeling long-term infiltration, including the model prediction of one significant CSO event.

The model will be used to evaluate the system response to the design storms for the current conditions and used to estimate the future conditions with the projected population. The results of these runs will be used to develop a new capital improvement program by identifying, potential problem areas in the system, undersized components, and used to aid in the design of new sewers to currently unsewered portions of the UGA.



DWF CALIBRATION PIPE DEPTH RANGES

FIGURE 12

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COMPREHENSIVE SEWER PLAN

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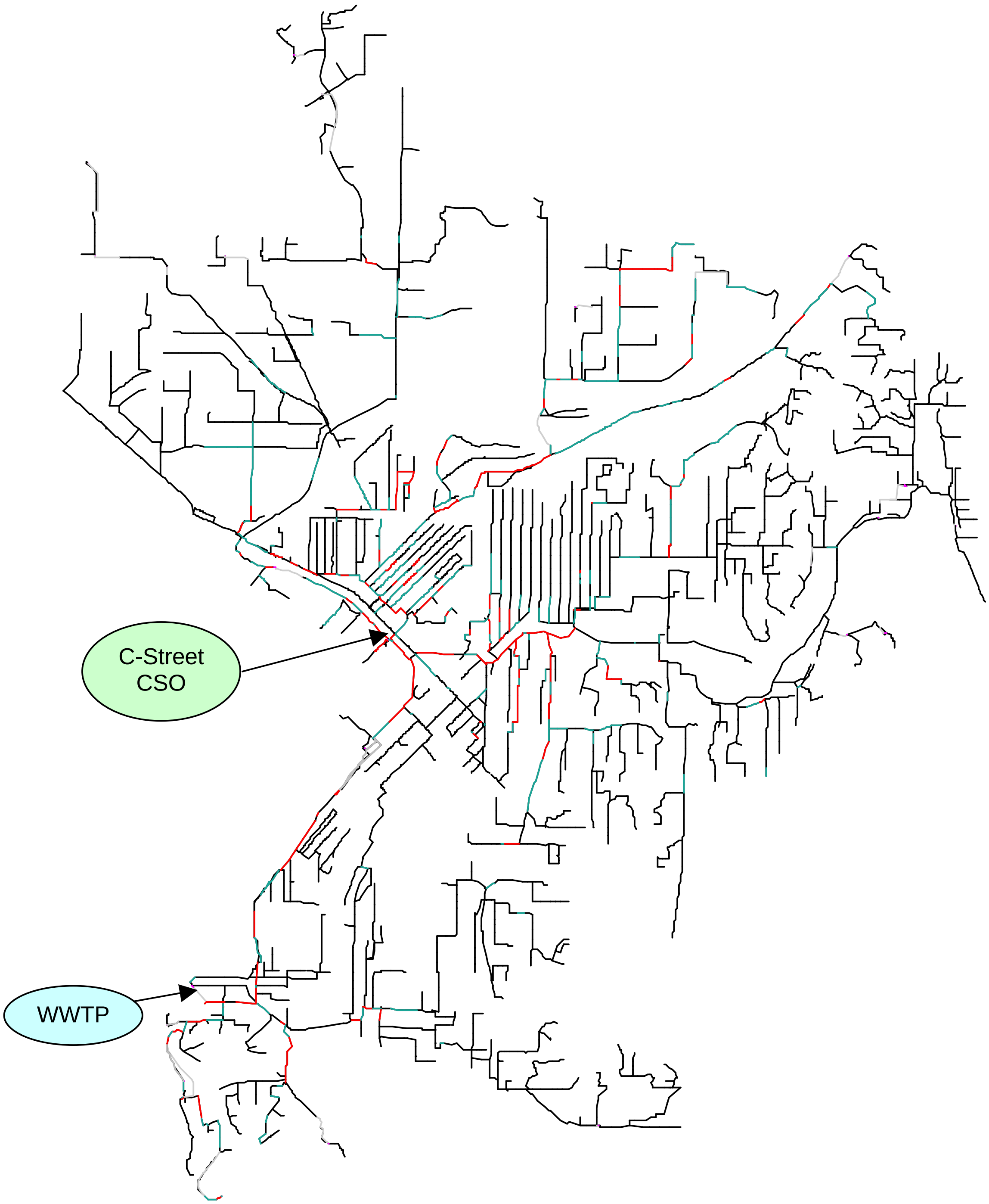

- Forcemains = gray
- Pipes with d/D < 0.5 = black
- Pipes with d/D > 0.5 and < 1 = teal

NOVEMBER 2004 CALIBRATION PIPE DEPTH RANGES

FIGURE 13

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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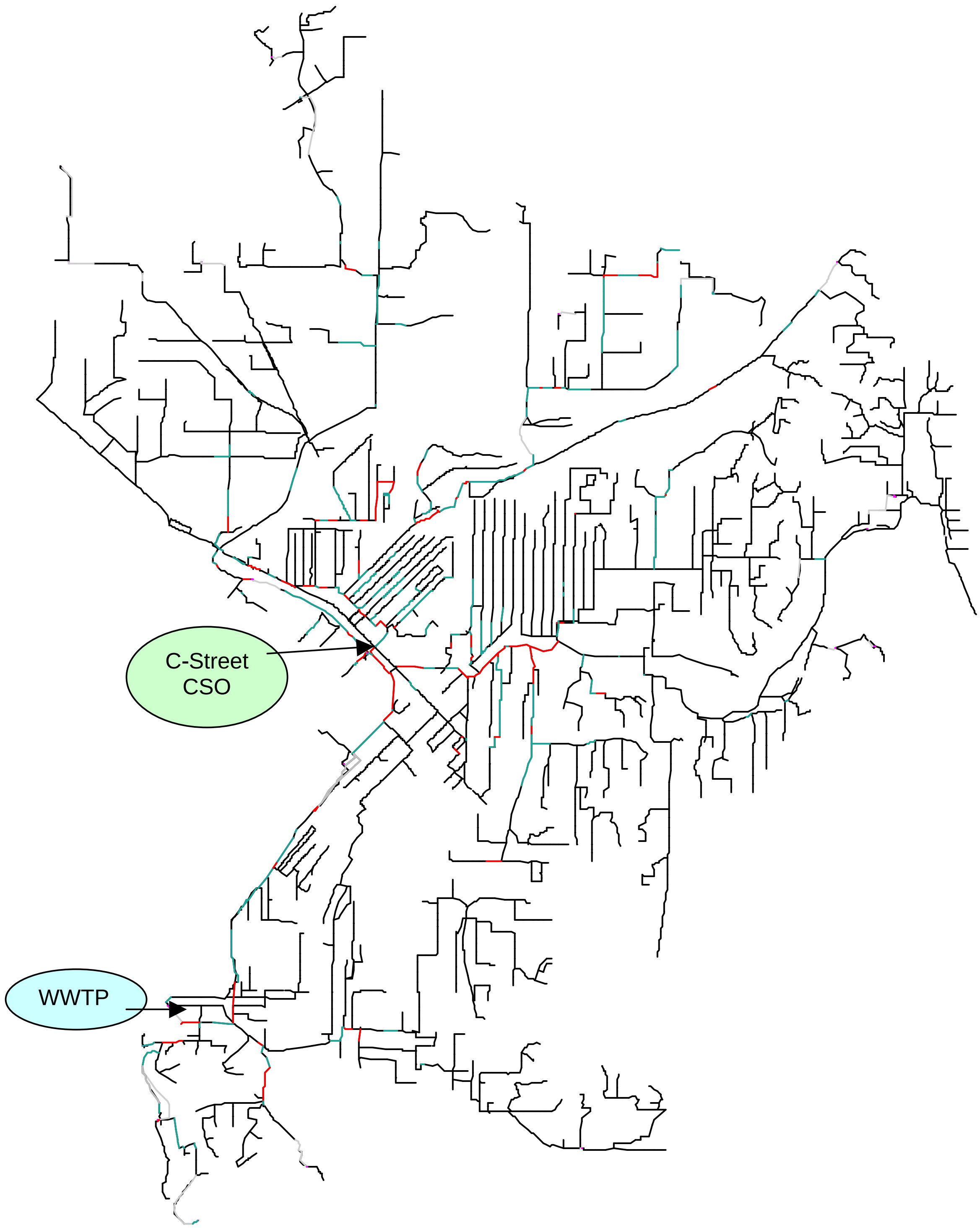

- Forcemains = gray
- Pipes with d/D < 0.5 = black
- Pipes with d/D > 0.5 and < 1 = teal
- Pipes full, Manhole HGL greater than 2 feet from rim = red.

JANUARY 2005 CALIBRATION PIPE DEPTH RANGES

FIGURE 14

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COMPREHENSIVE SEWER PLAN

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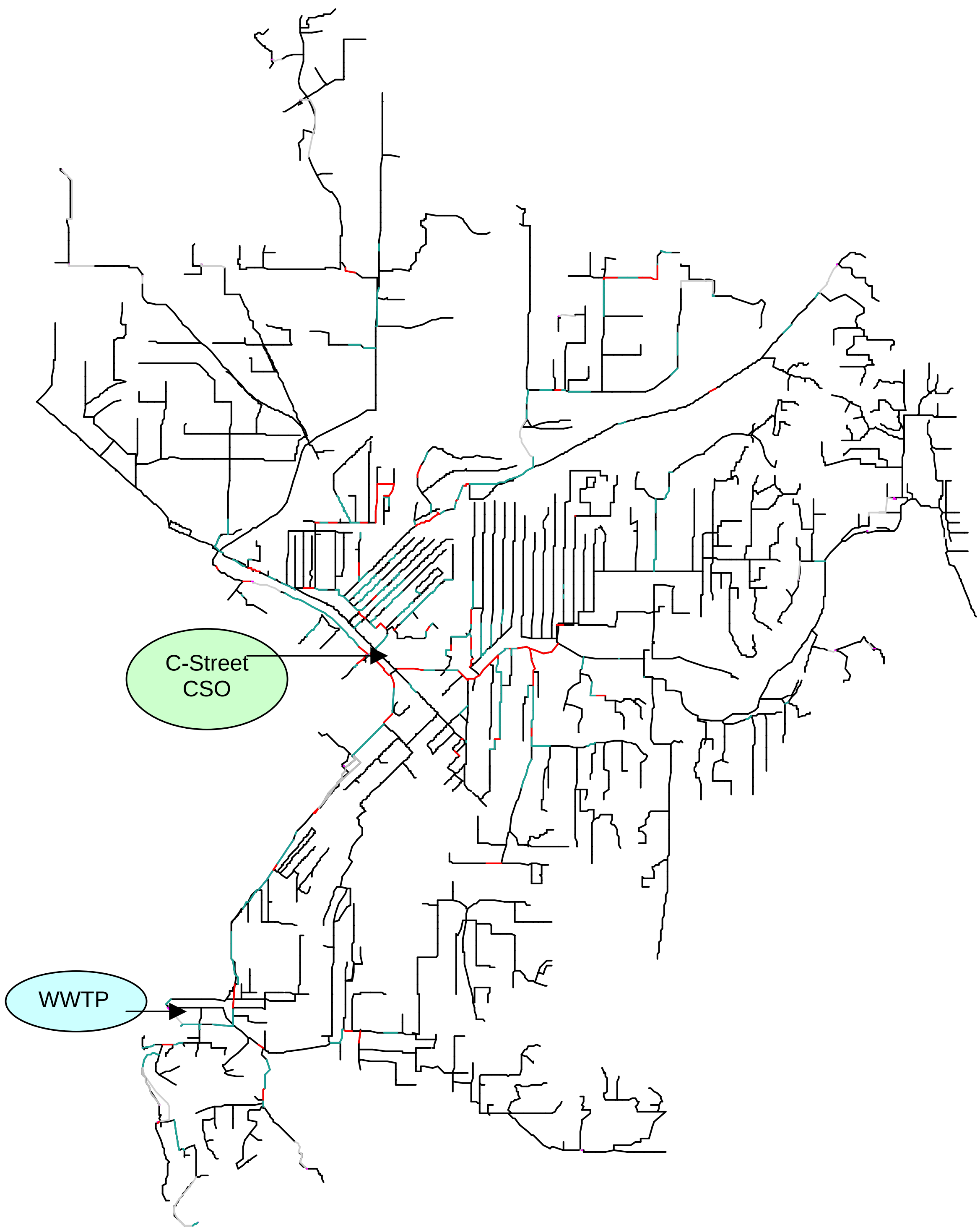

- Forcemains = gray
- Pipes with d/D < 0.5 = black
- Pipes with d/D > 0.5 and < 1 = teal
- Pipes full, Manhole HGL greater than 2 feet from rim = red.

APRIL 2005 CALIBRATION PIPE DEPTH RANGES

FIGURE 15

CITY OF BELLINGHAM
COMPREHENSIVE SEWER PLAN

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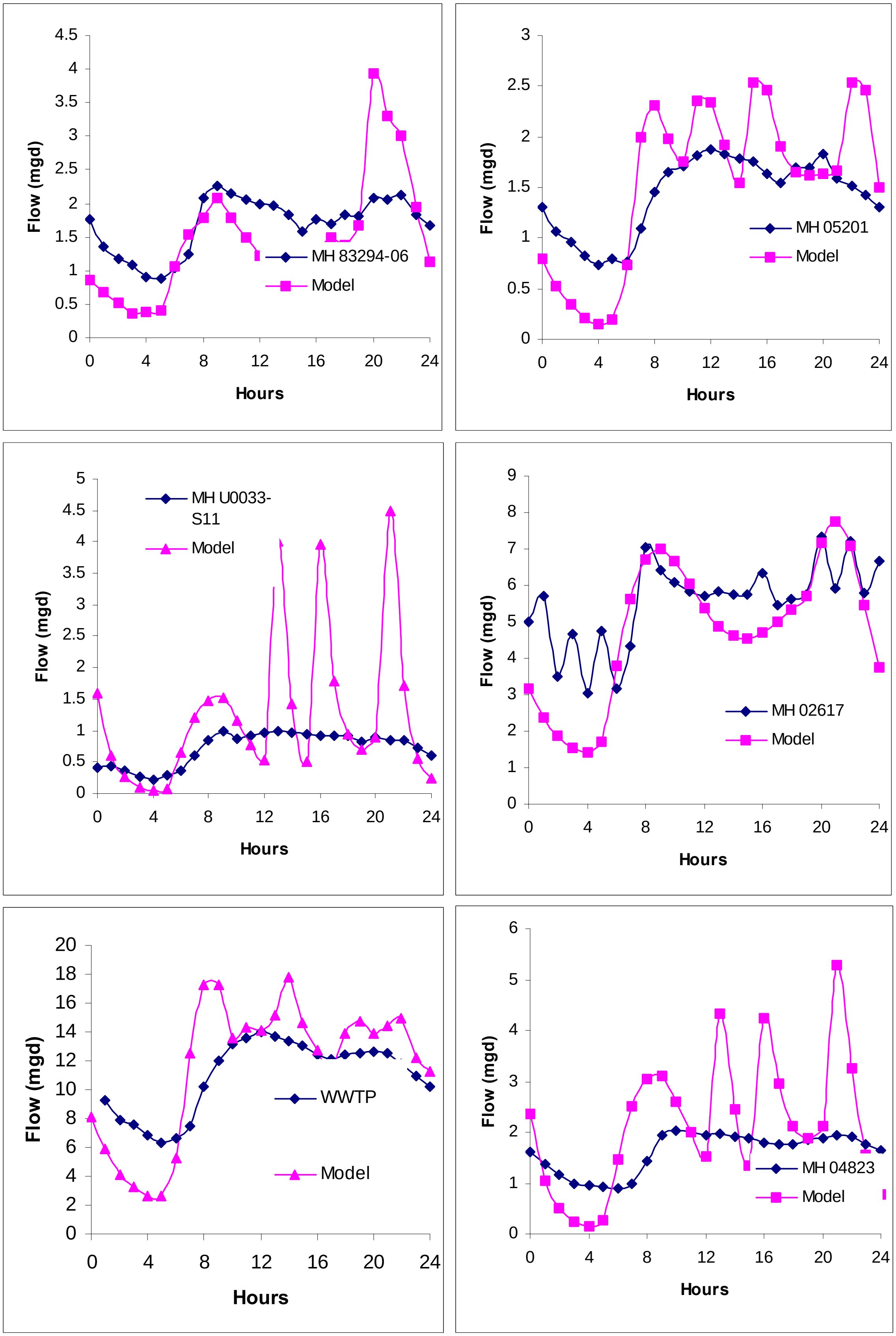
Attachment A

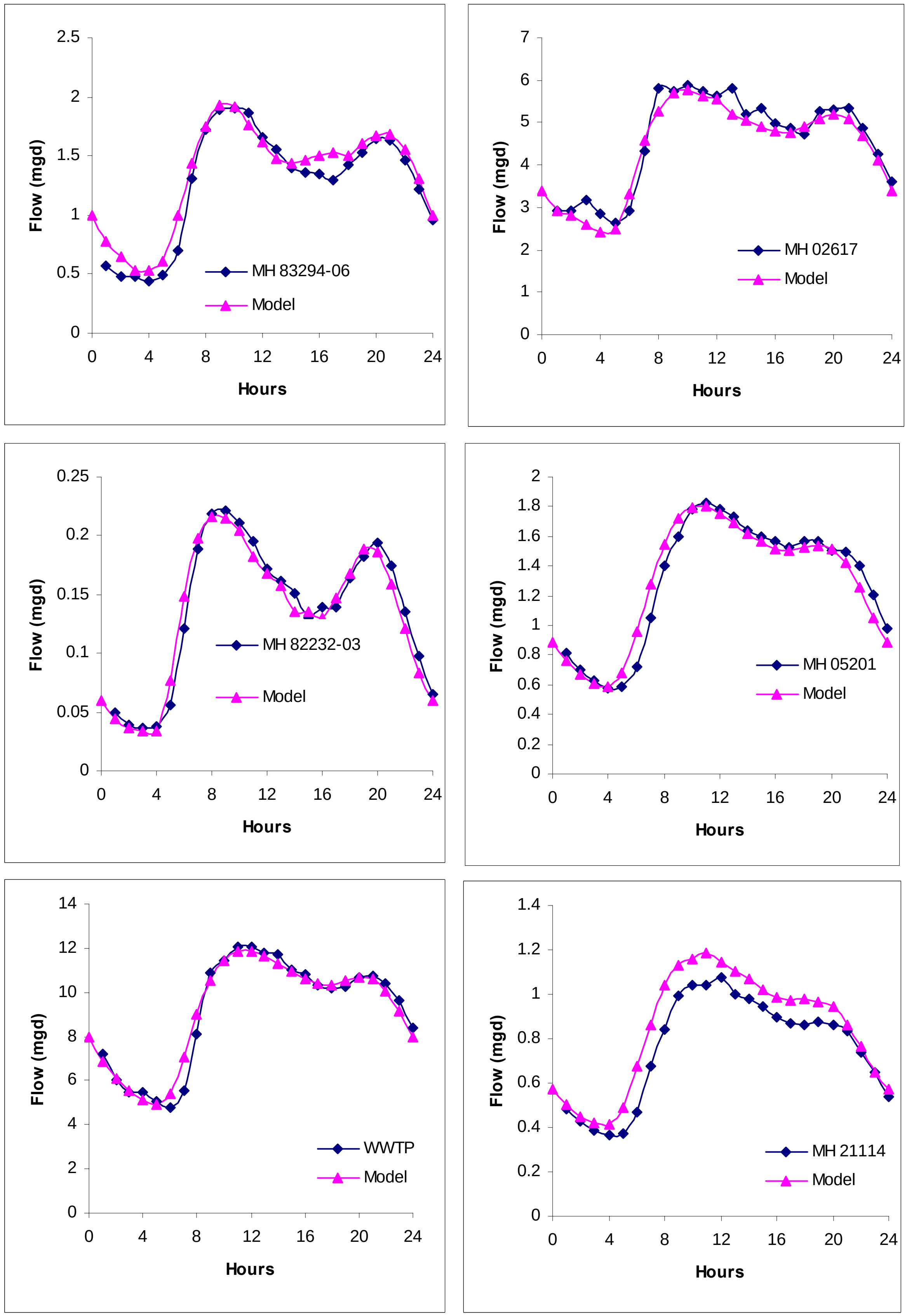
IDMODELING EXAMPLE DRY WEATHER PLOTS



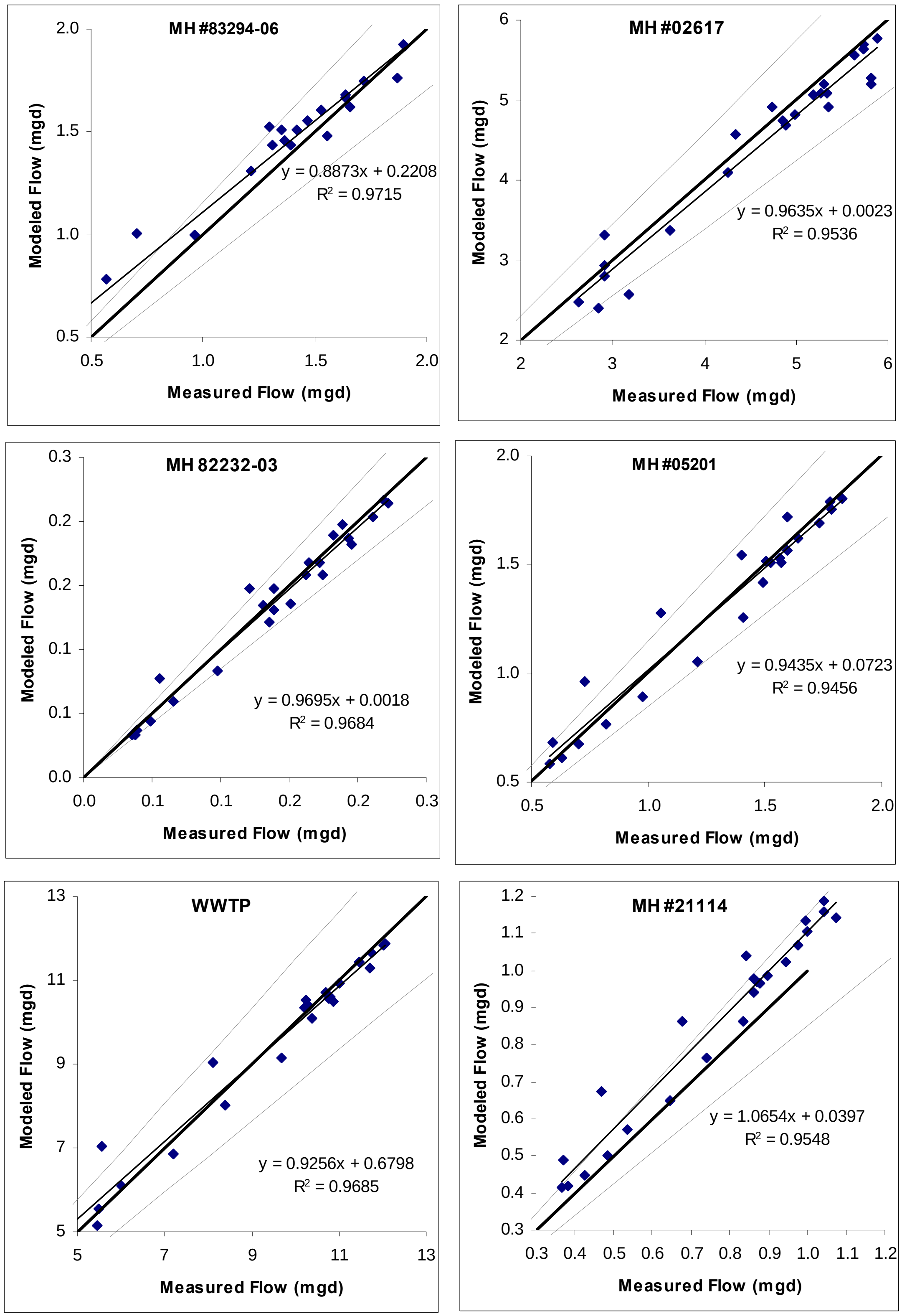
IDModeling Initial Dry Weather Calibration

Attachment B

DRY WEATHER DRY SEASON CALIBRATION PLOTS



DWF Time series Calibration Results (dry season)

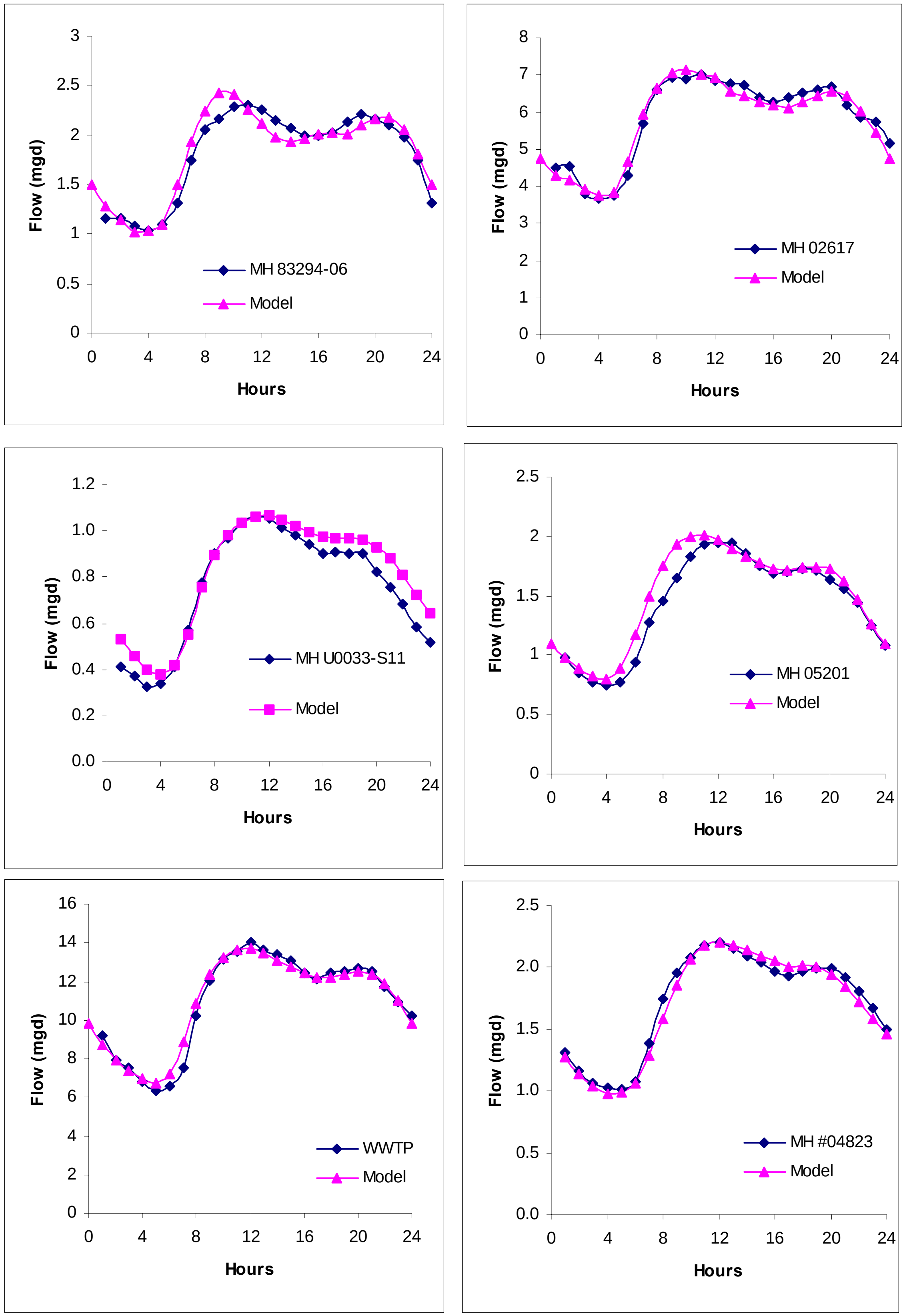


ADWF Scatter Plot Calibration Results (dry season)

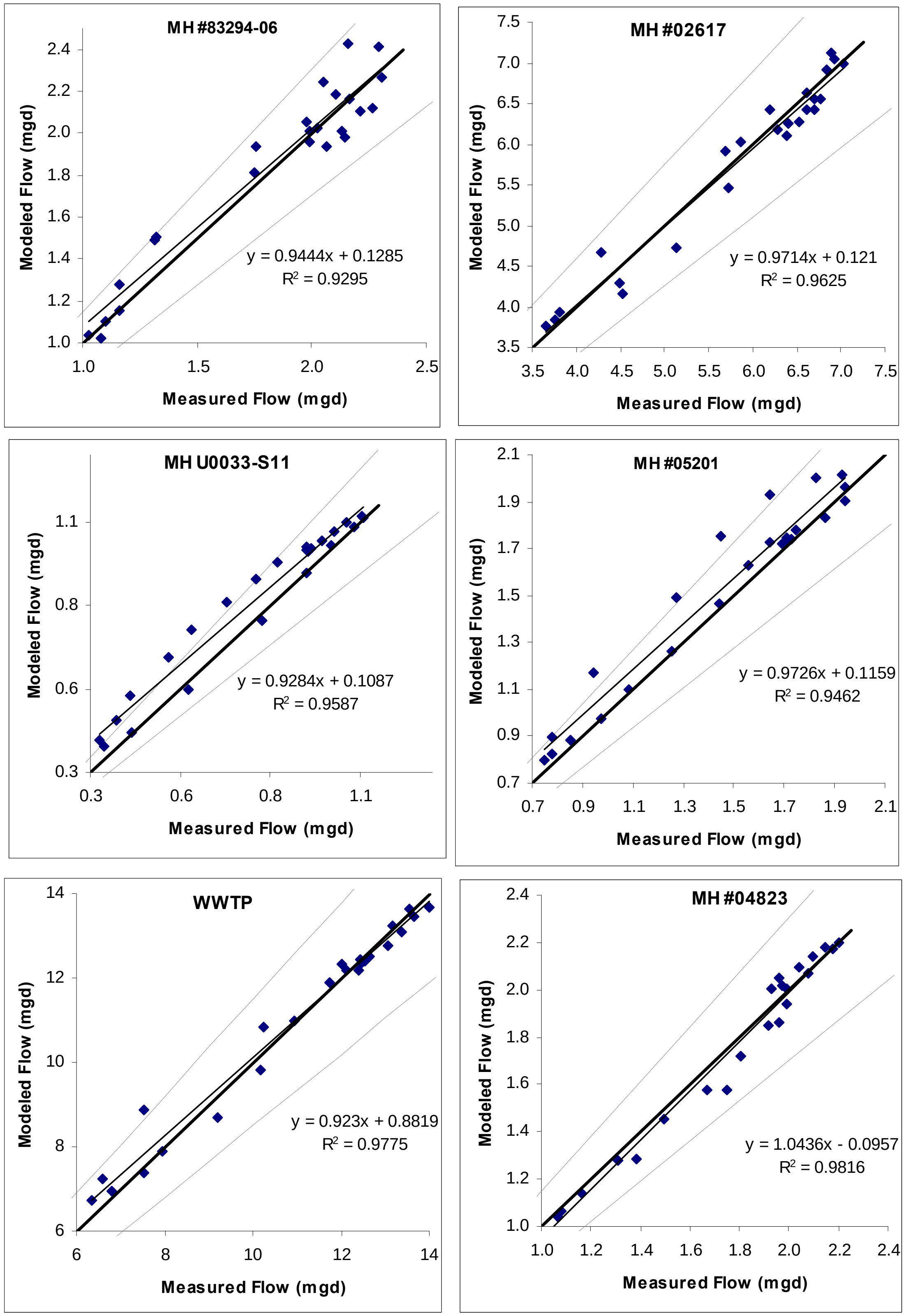
Grey lines represent the 15 percent envelope, bold black line represents the 1:1 line and the black line represents the linear regression of the data points.

Attachment C

DRY WEATHER WET SEASON CALIBRATION PLOTS



ADWF Time Series Calibration Results (wet season)

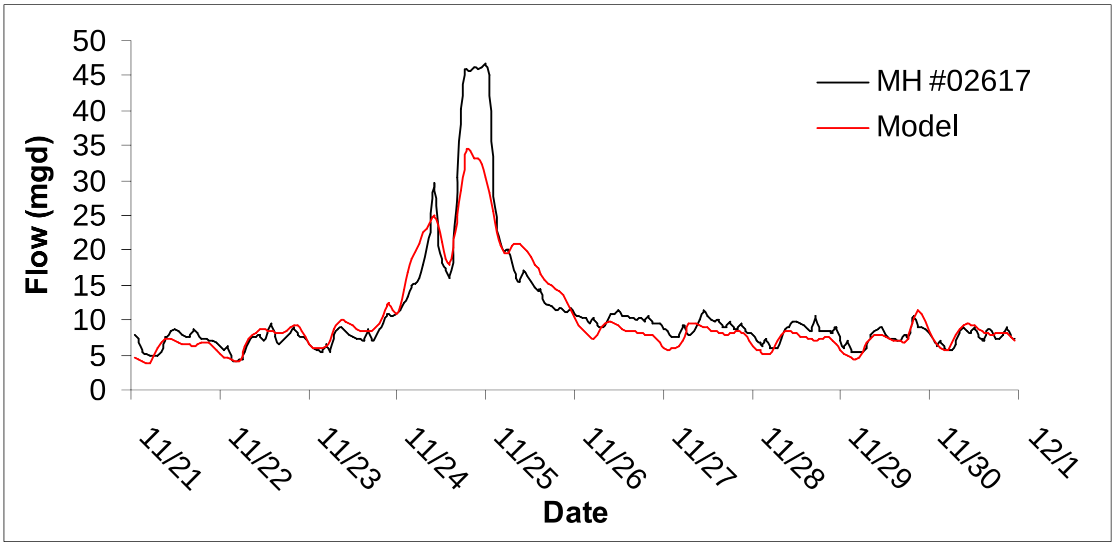


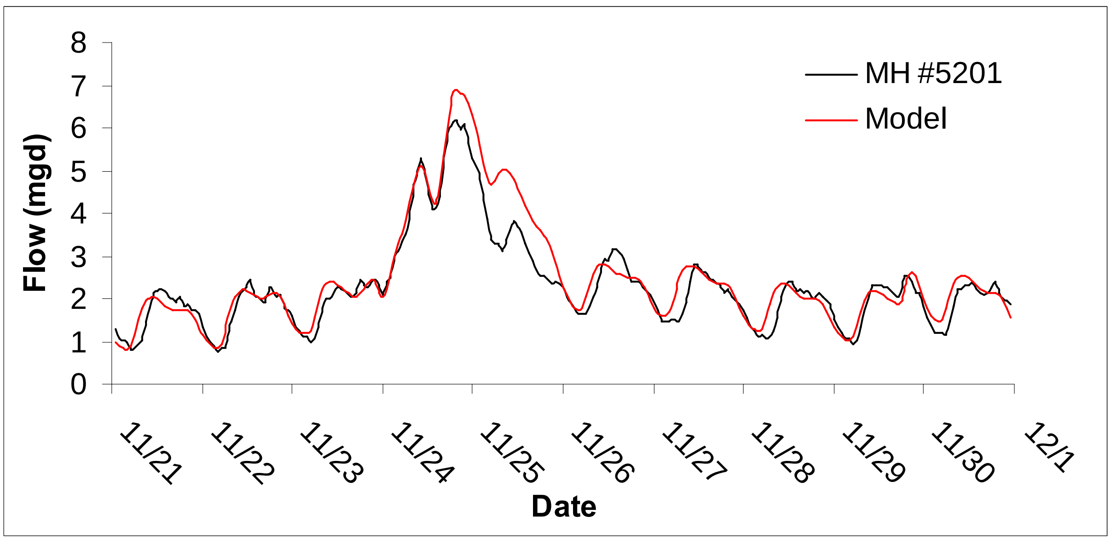
DWF Scatter Plot Calibration Results

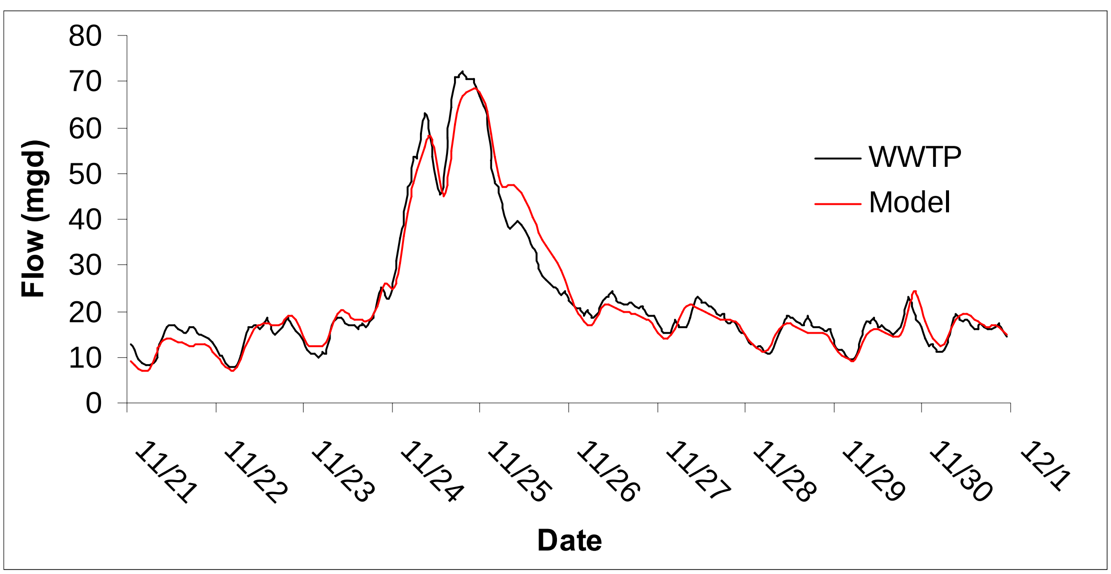
Grey lines represent the 15 percent envelope, bold black line represents the 1:1 line and the black line represents the linear regression of the data points.

Attachment D

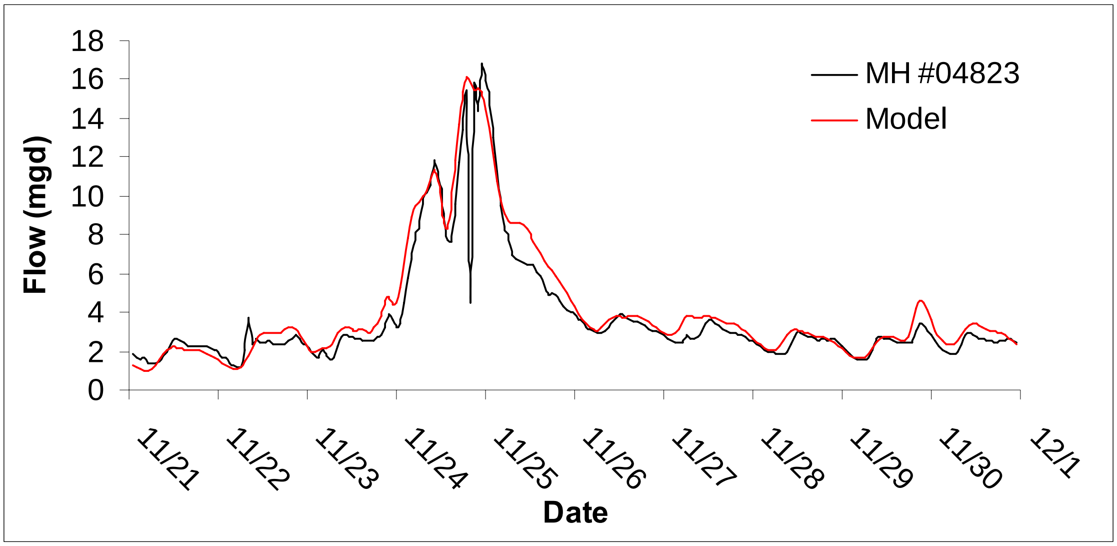
NOVEMBER 2004 CALIBRATION PLOTS

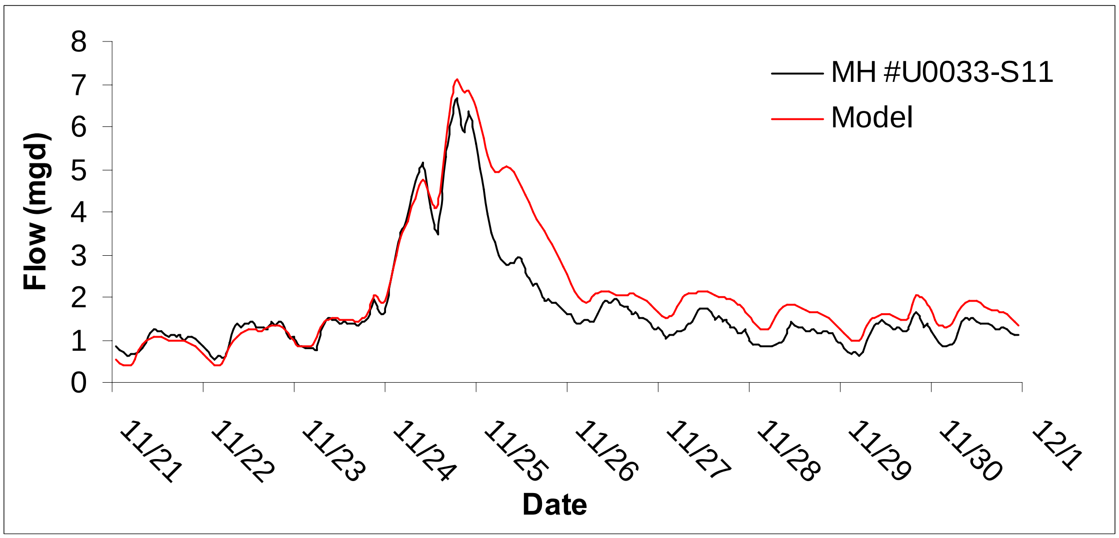


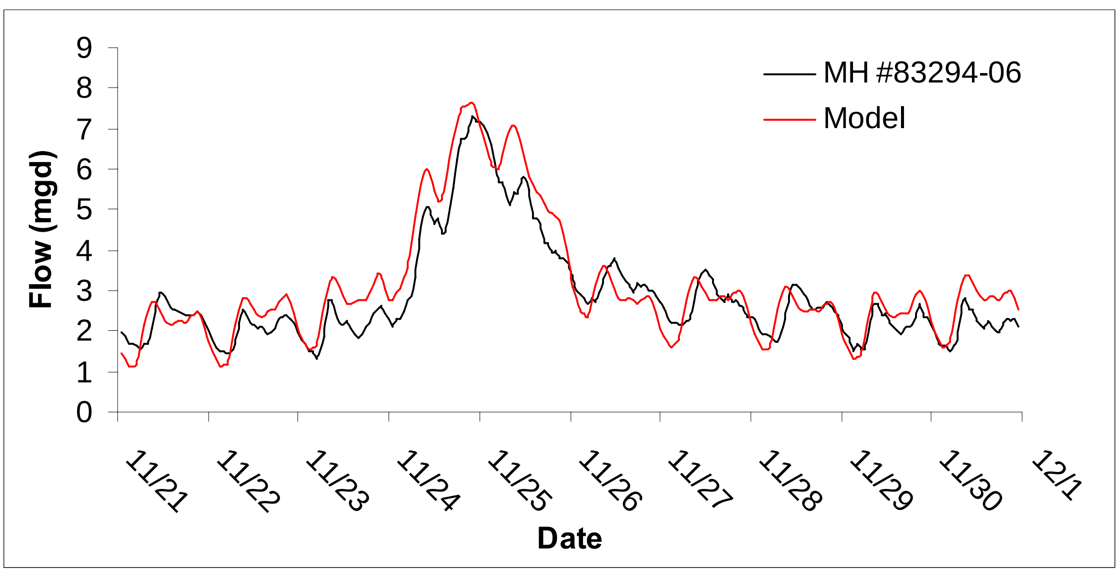




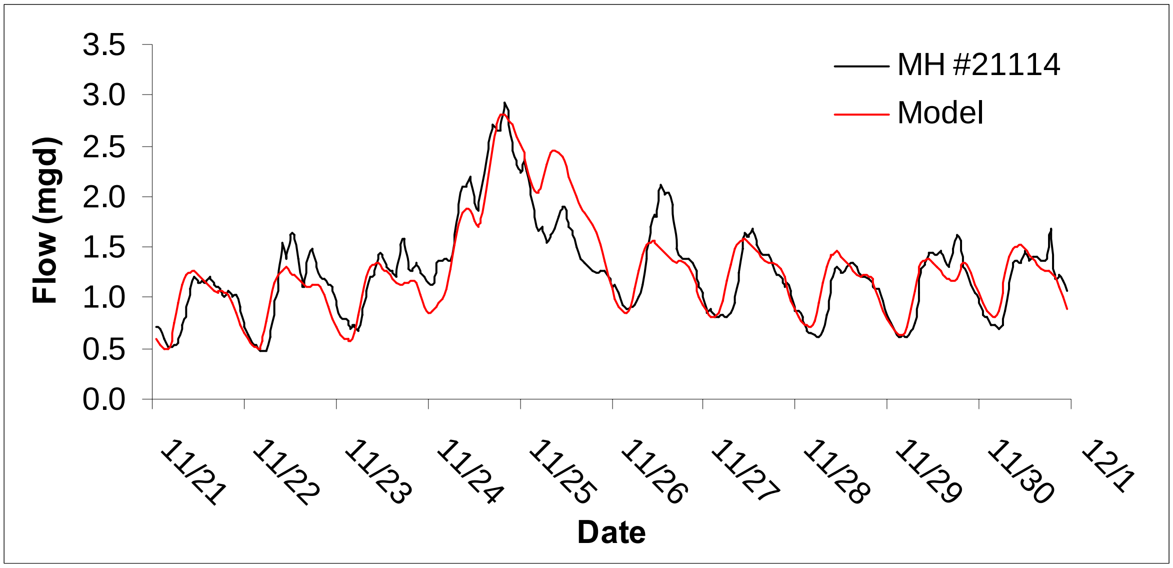
November 2004 Storm Model Calibration Results

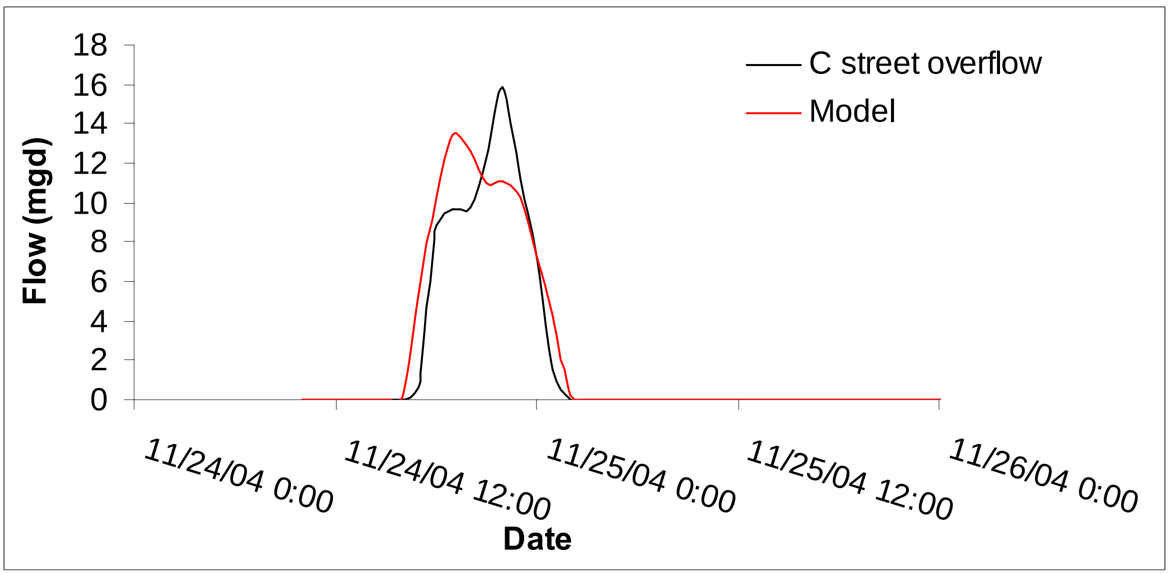




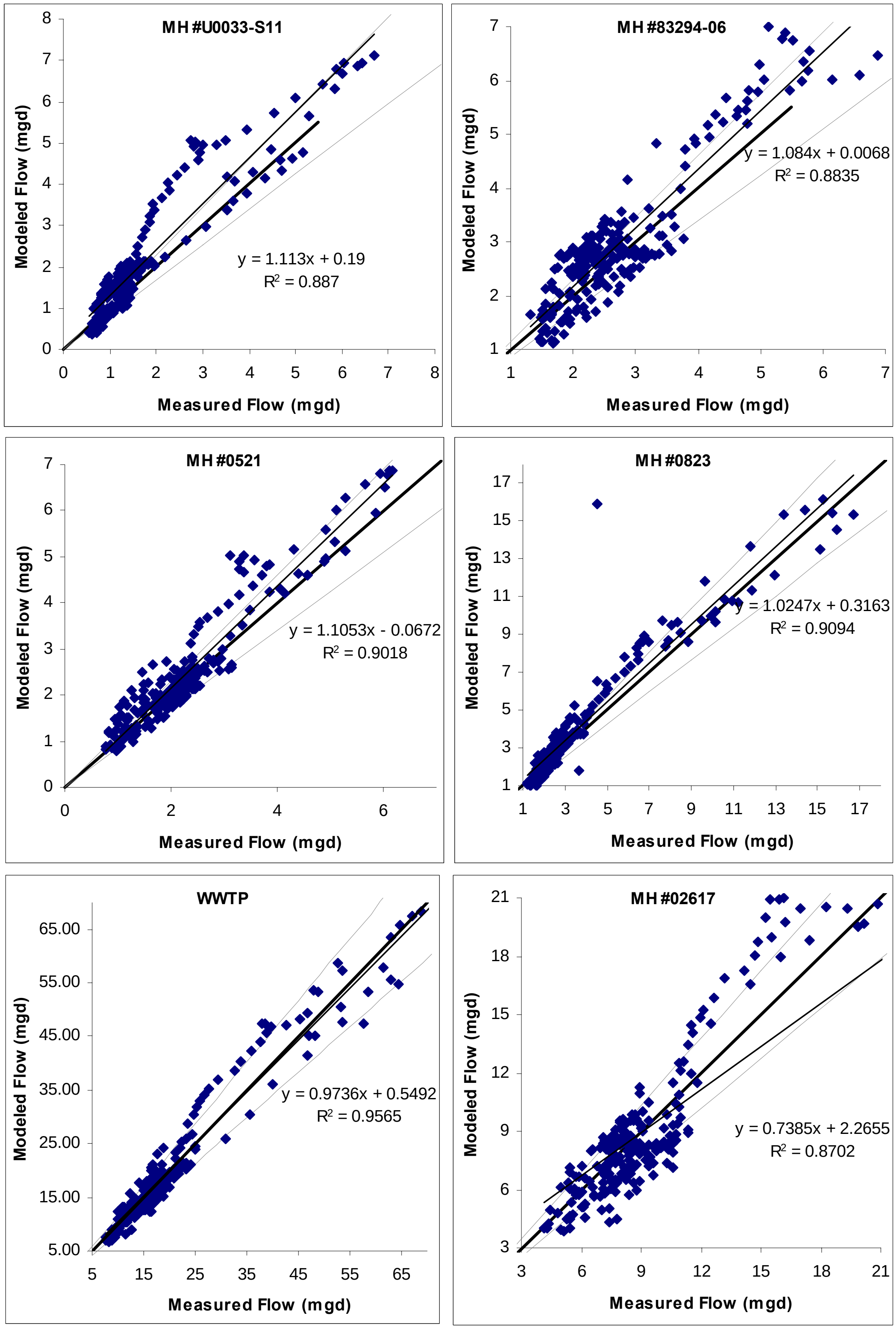


November 2004 Storm Model Calibration Results





November 2004 Storm Model Calibration Results

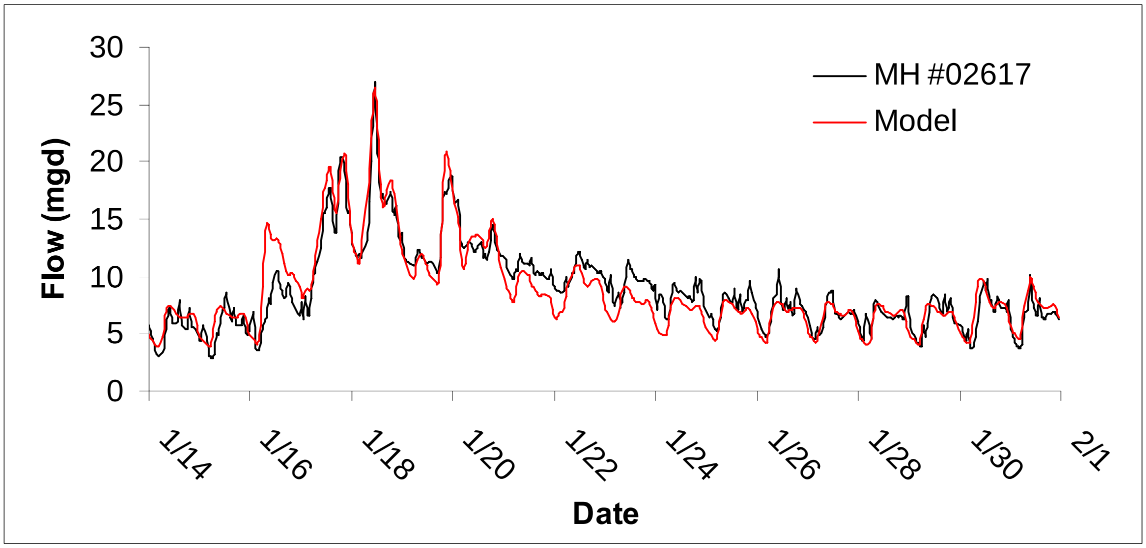


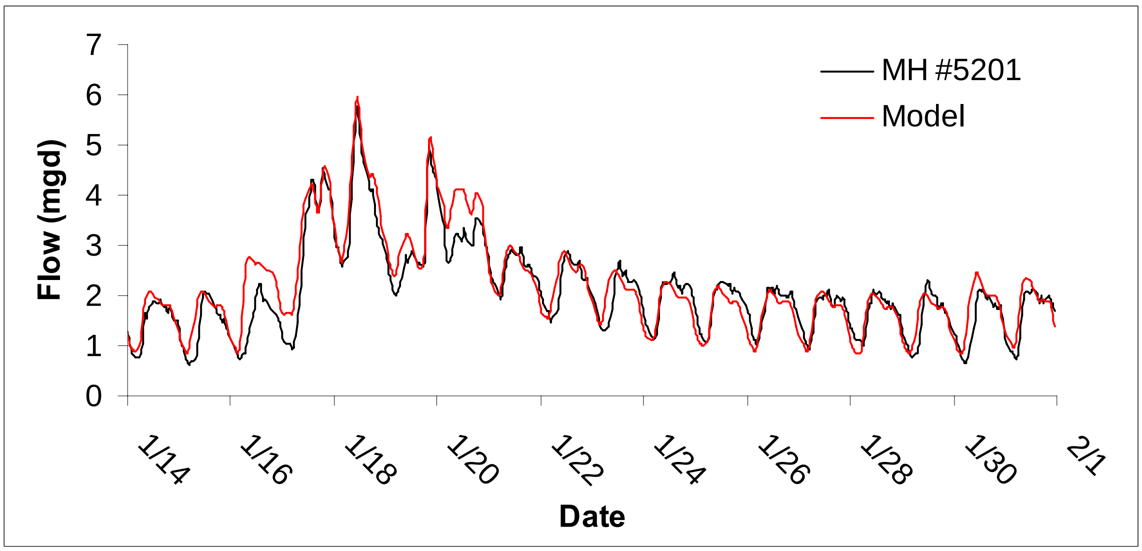
November 2004 Storm Model Calibration Scatter Plots

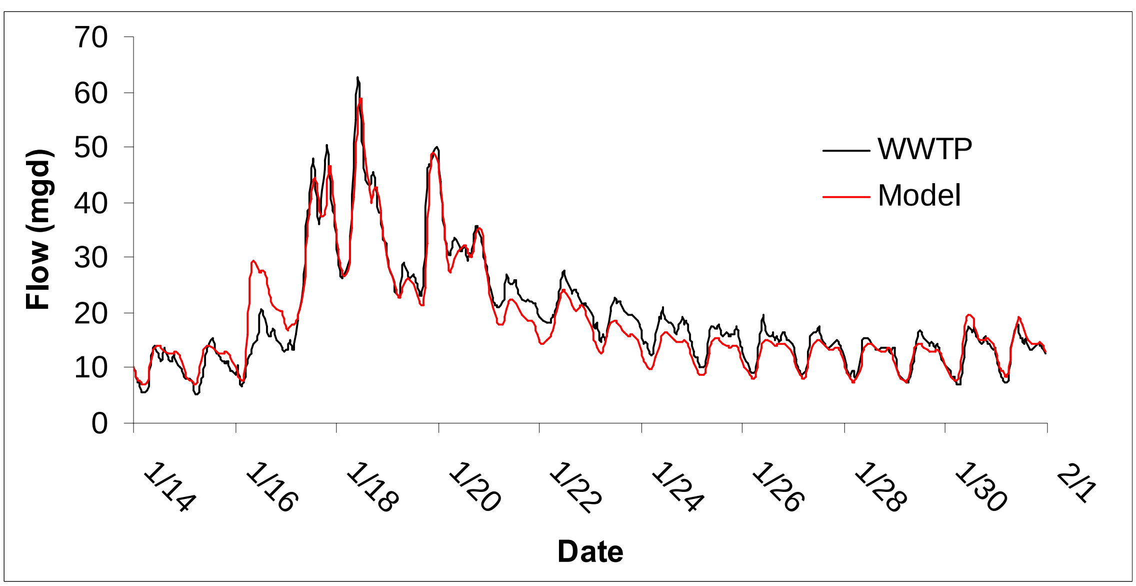
Grey lines represent the 15 percent envelope, bold black line represents the 1:1 line and the black line represents the linear regression of the data points.

Attachment E

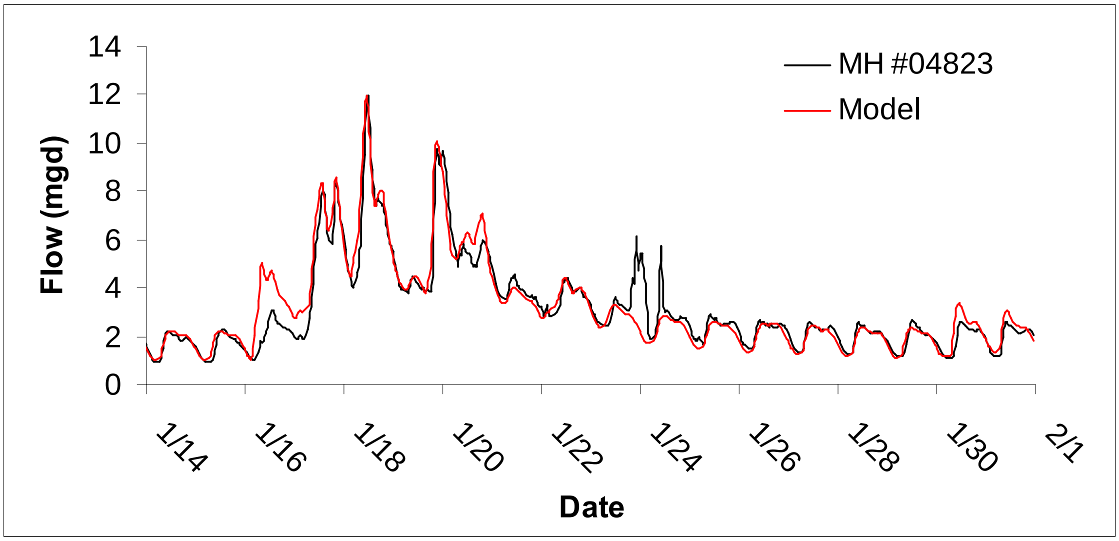
JANUARY 2005 CALIBRATION PLOTS

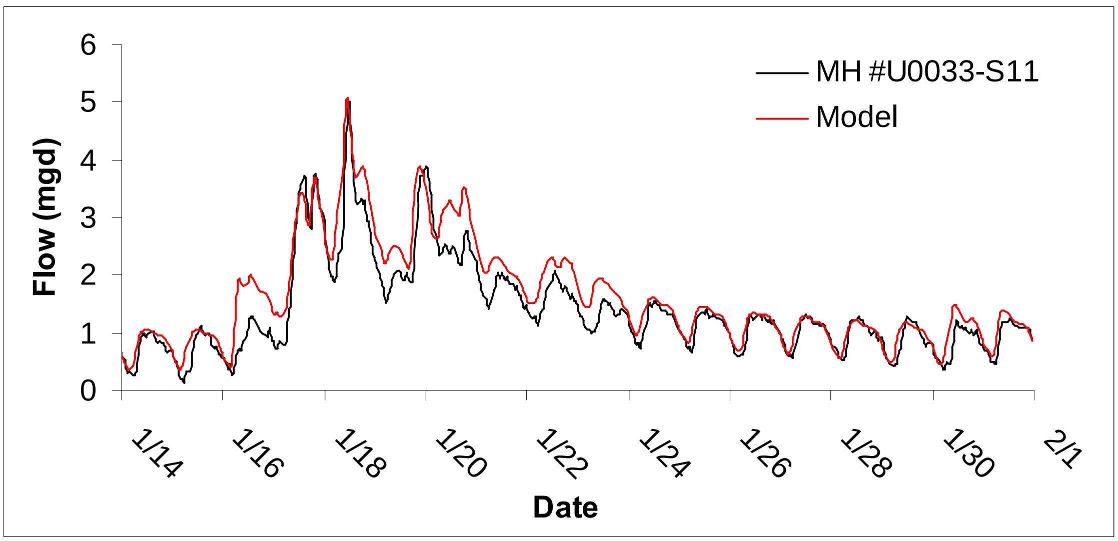


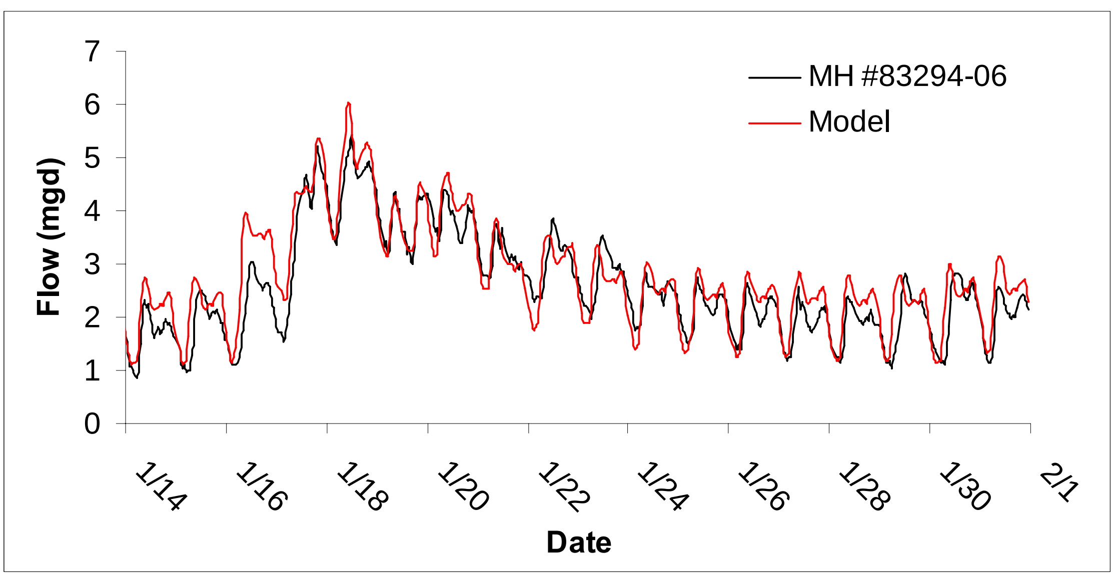




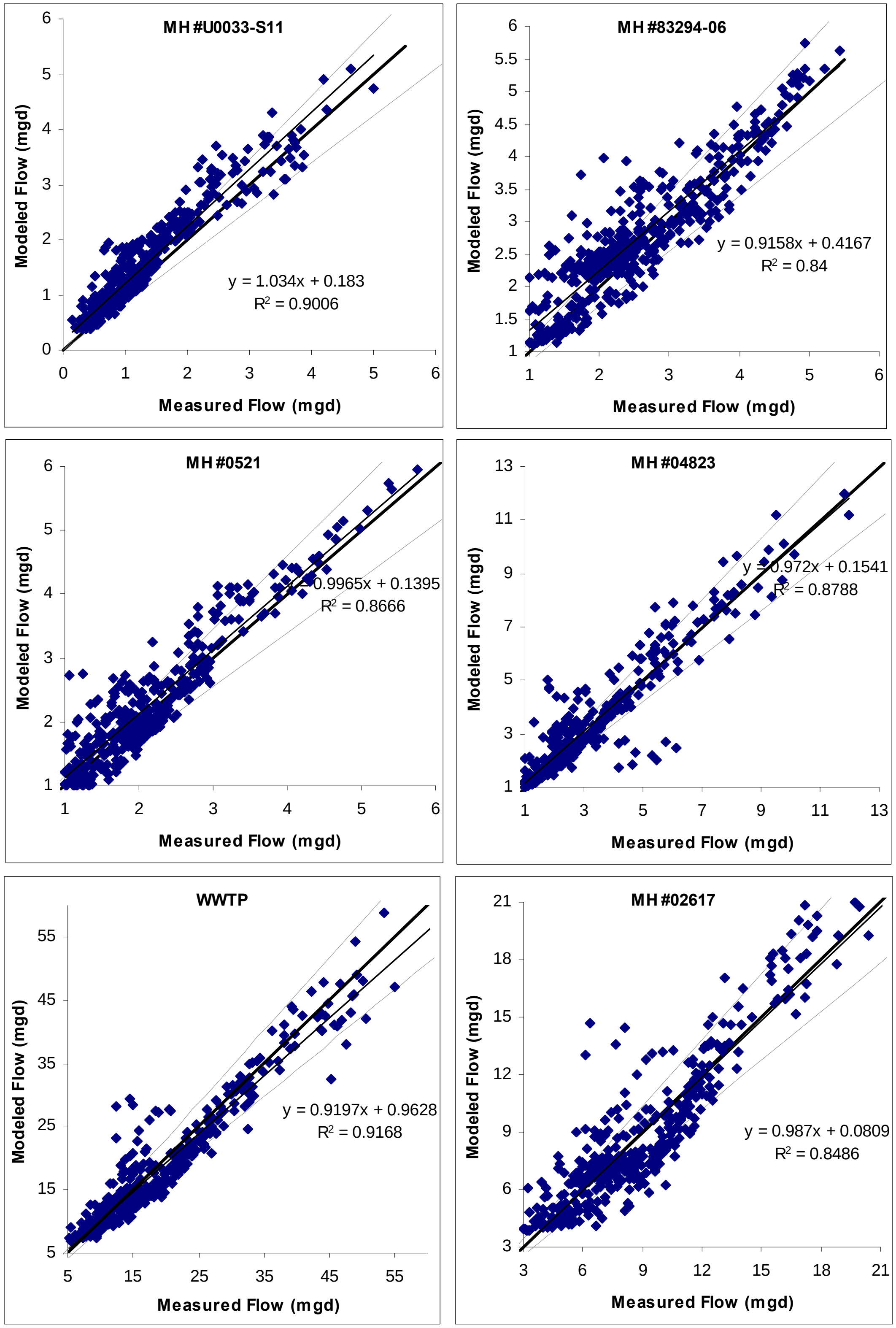
January 2005 Storm Model Calibration Results







January 2005 Storm Model Calibration Results

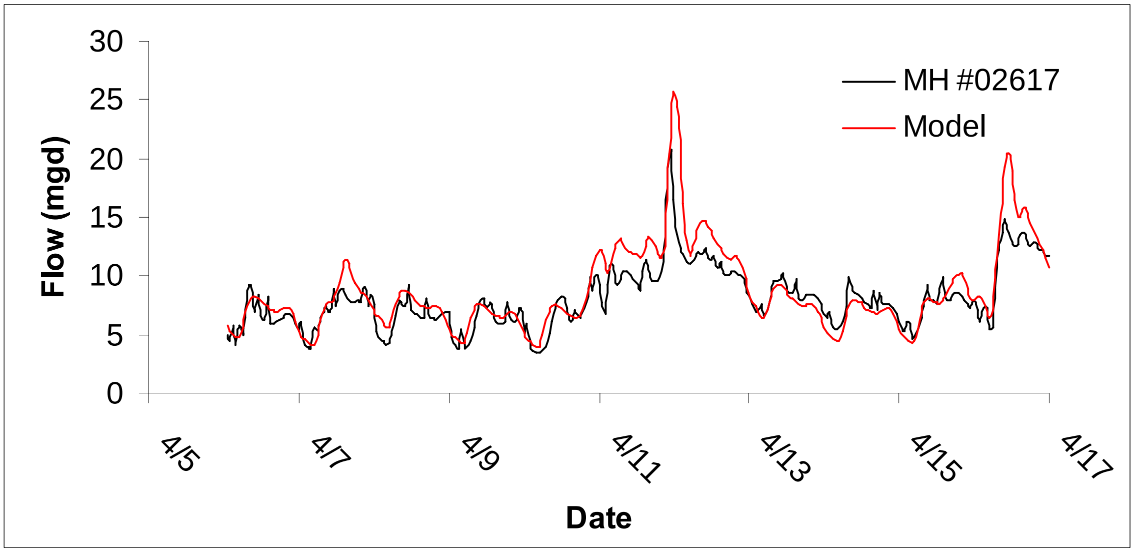


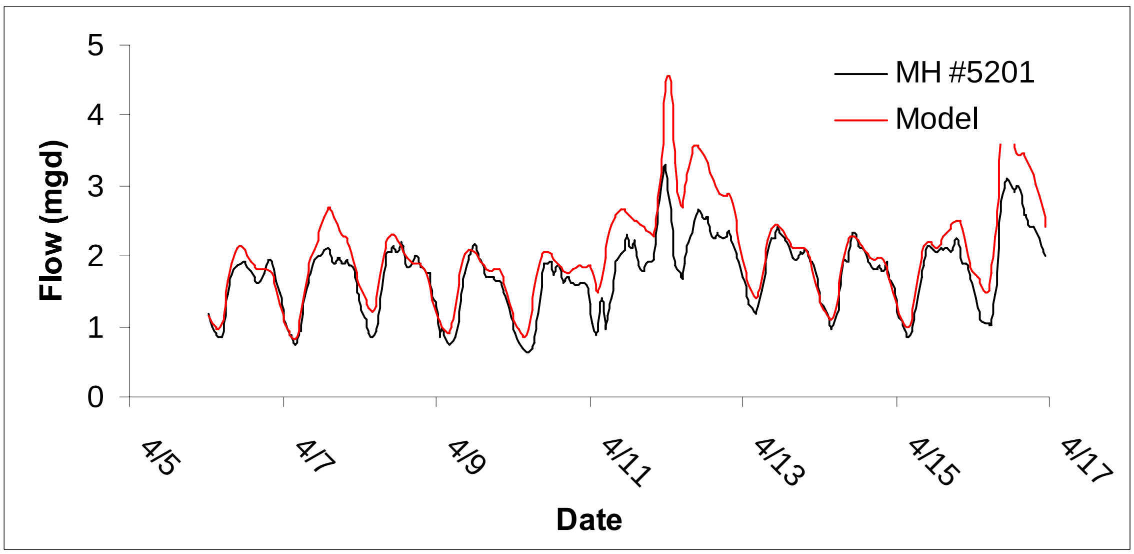
January 2005 Storm Model Calibration Scatter Plots

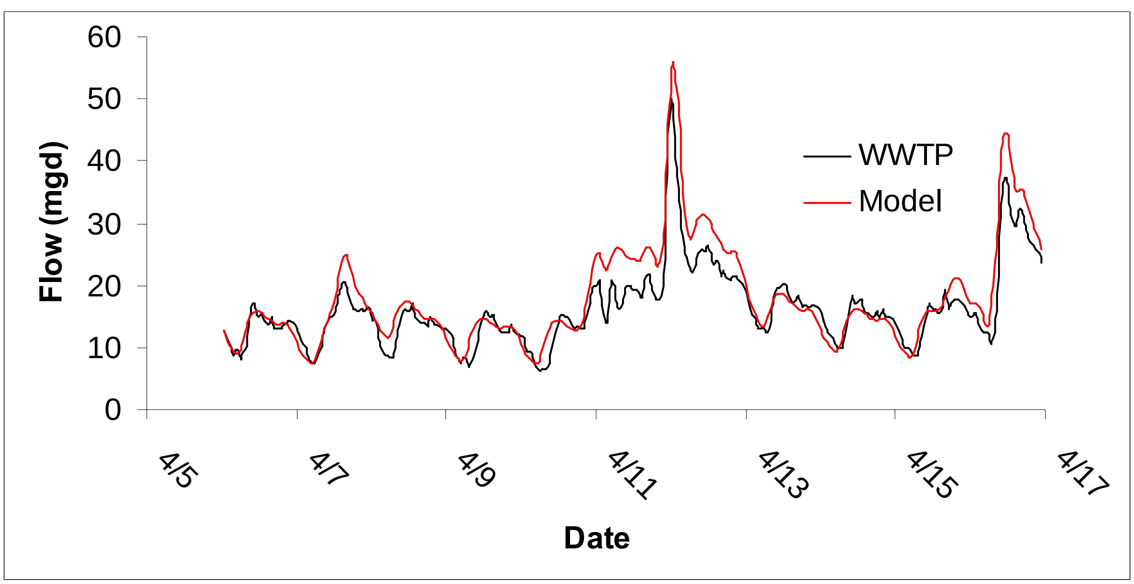
Grey lines represent the 15 percent envelope, bold black line represents the 1:1 line and the black line represents the linear regression of the data points.

Attachment F

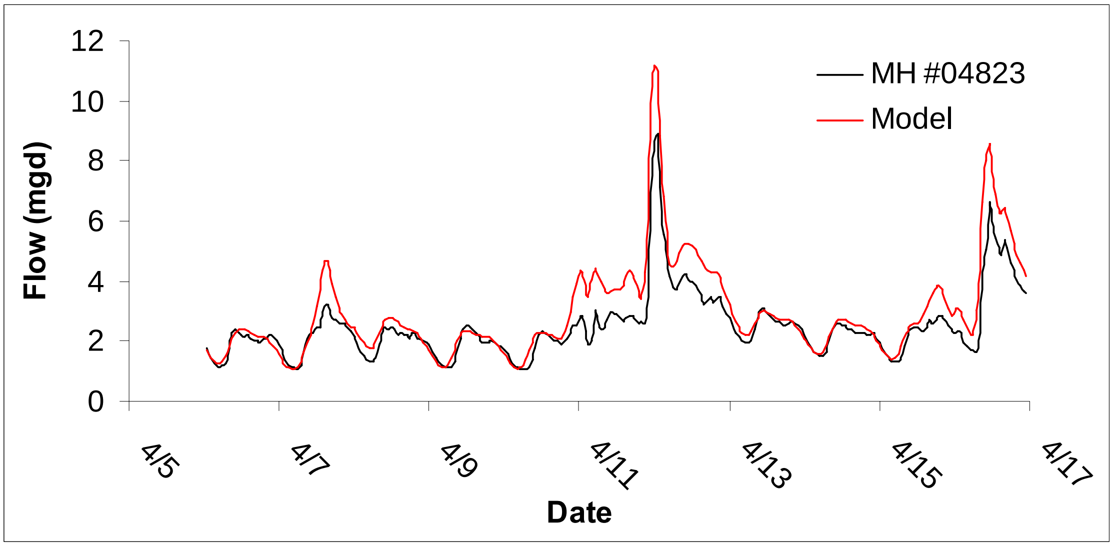
APRIL 2005 CALIBRATION PLOTS

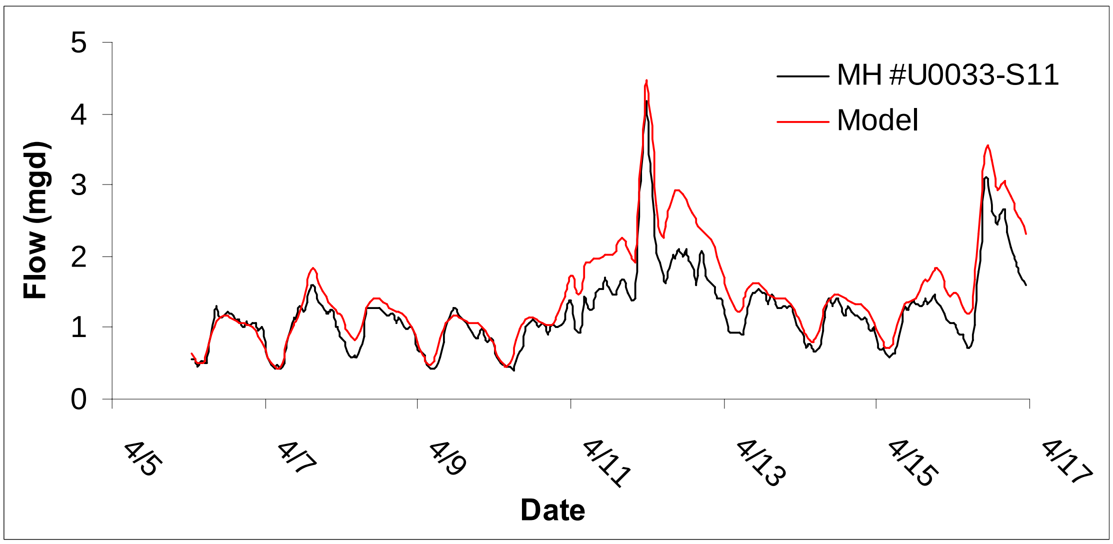


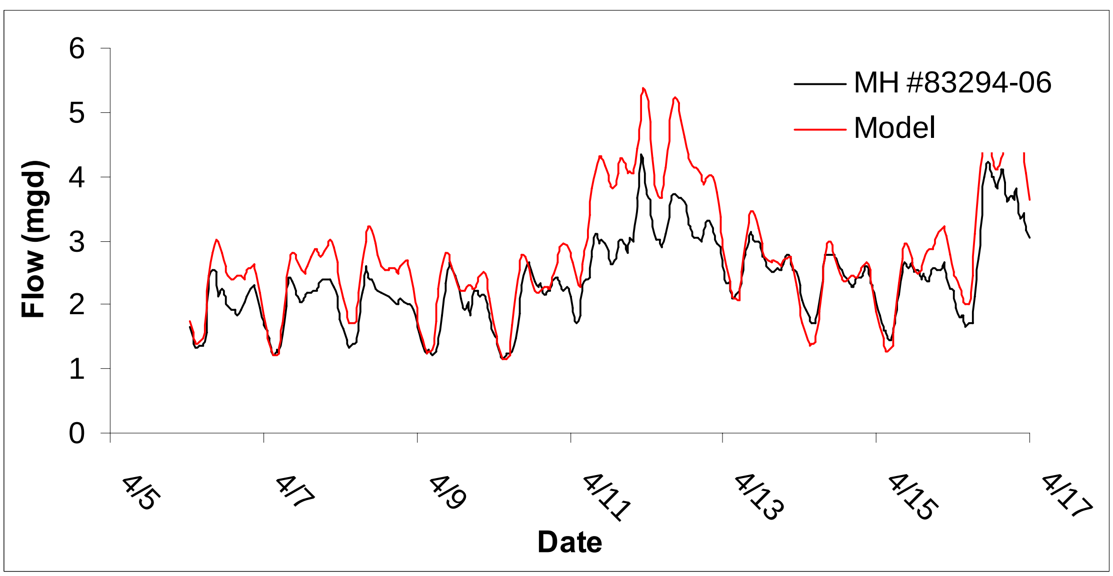




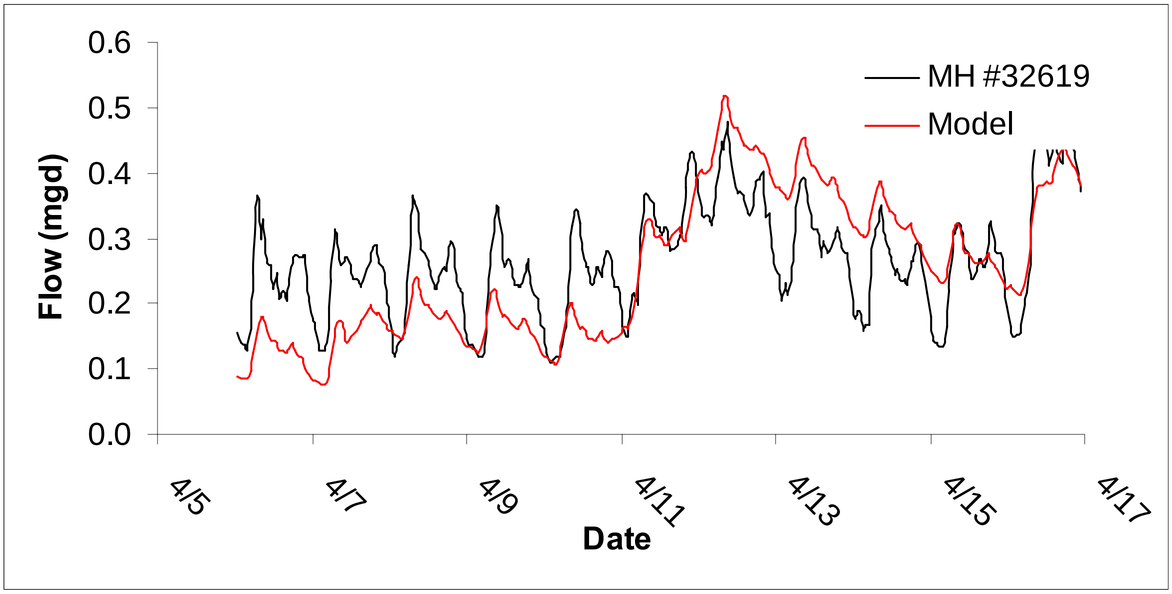
April 2005 Storm Model Calibration Results



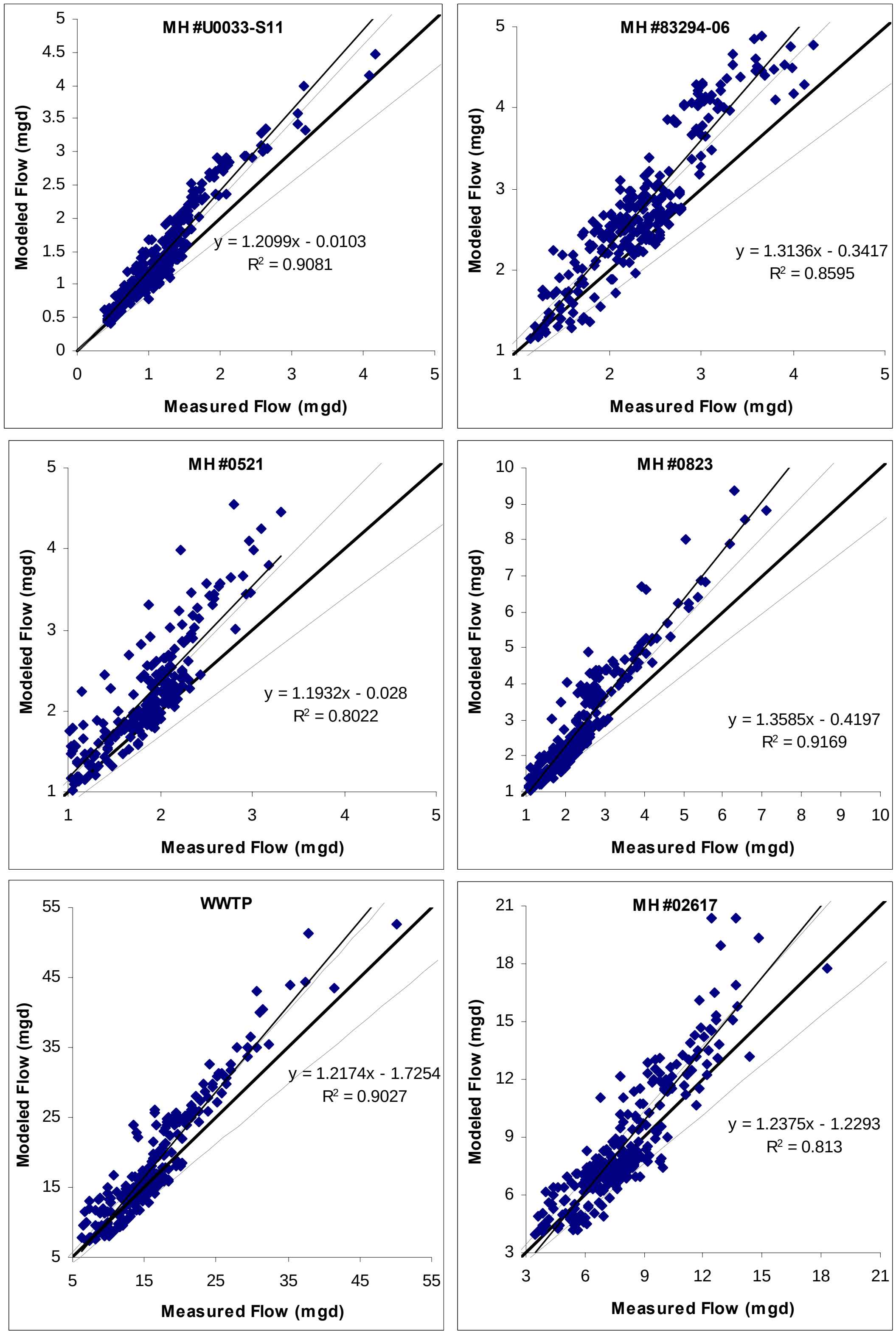




April 2005 Storm Model Calibration Results



April 2005 Storm Model Calibration Results



April 2005 Storm Model Calibration Scatter Plots

Grey lines represent the 15 percent envelope, bold black line represents the 1:1 line and the black line represents the linear regression of the data points.

Attachment G

LOG OF FULL PIPES DURING CALIBRATION EVENTS

Log of Full Pipes During Calibration Events
Comprehensive Sewer Plan
City of Bellingham

Pipe ID	DWF	November 2004	January 2005	April 2005
10002_9910		X		
10702_10701		X		
10906_10002		X		
10912_10906		X		
10913_10912		X		
12904_12811		X		
14202_14203		X		
14203_14204		X		
14204_14205		X		
14508_14513		X	X	
16803_17014		X		
16907_16908		X		
17007_17016	X	X	X	X
1801_T83311-01	X	X	X	X
1909_1911		X	X	
1912_1913		X	X	
1913_1914		X		
1914_1915		X		
1915_2207		X		
2015_2016		X	X	
2016_2018		X		
2018_2020		X		
2120_2121		X	X	
2121_3501		X	X	
2122_2120		X		
2204_3306		X		
2208_2209		X		
2210_2205		X		
22403_22402		X	X	
2305_T83302-51		X	X	X
2319_T83302-55		X	X	
2407_2522		X		
24206_2806		X		
24207_24206		X		
2507_2618		X	X	
2522_2507	X	X	X	X

Log of Full Pipes During Calibration Events
Comprehensive Sewer Plan
City of Bellingham

Pipe ID	DWF	November 2004	January 2005	April 2005
2601_2602		X	X	
2602_2604		X	X	
2605_2606		X	X	
2606_T83303-11		X		
26910_26901		X		
26924_T72013-01		X	X	X
2702_2801		X		
27118_27009		X		
27302_T82363-02		X	X	
2801_2802		X	X	
2802_2813		X	X	
2804_2812		X	X	
2805_2804		X		
2813_82252-04		X		
2820_2601		X	X	
2821_2820		X	X	
2825_2821		X	X	
28303_28212		X	X	X
2913_2912		X	X	X
29305_29213		X		
29310_29308		X		
29311_29310		X	X	
29312_29311	X	X	X	X
29320_29319		X	X	
30112_T72022-01		X		
30114_30113		X		
30137_T72022-01		X		
30204_30205		X	X	
30205_30105		X		
30307_30323		X		
30309_30308		X		
30323_30203		X		
30902_30911		X		
30903_30904		X	X	
30904_30905		X		
30905_30906		X		
30906_28301		X		
30911_30903		X	X	

Log of Full Pipes During Calibration Events
Comprehensive Sewer Plan
City of Bellingham

Pipe ID	DWF	November 2004	January 2005	April 2005
3116_3114		X	X	
31701_31703		X		
31912_30902		X		
32020_31701		X		
3208_3209		X		
3209_3210		X	X	
3301_T83302-03	X	X	X	X
3302_3303		X		
3306_3307		X	X	
3307_T83302-52	X	X	X	X
3312_3307		X		
3405_T83301-01		X		
3409_3405		X	X	
3501_83293-11		X	X	
3502_T83294-01		X	X	
3504_3502		X	X	
3505_3504		X	X	
3506_3505		X	X	
37402_23209		X		
37403_37402		X	X	X
4001_4107		X	X	
42801_W0073-S03		X	X	
4301_3302		X	X	
43303_S0147-S01		X	X	
4405_4407		X	X	
4408_3214		X	X	
4604_4715		X	X	
4610_4608		X	X	
4710_83304-11		X	X	
4711_4710		X	X	
4805_4823		X	X	
4824_83304-08		X	X	
4901_4923		X	X	
49502_49504		X	X	
5004_5006		X	X	X
5006_5019		X	X	
5012_5016		X	X	
5102_5105		X	X	

Log of Full Pipes During Calibration Events
Comprehensive Sewer Plan
City of Bellingham

Pipe ID	DWF	November 2004	January 2005	April 2005
5212_5215		X	X	X
5217_5309		X	X	X
5218_5217		X	X	
53101_53005		X	X	
53105_53102		X	X	
53402_53401		X	X	
53403_53402		X	X	
53801_53903		X	X	
53802_53801		X	X	
53803_S0271-S03		X	X	
53902_53901		X	X	
53903_53902		X	X	
5703_5701		X	X	
5712_4813		X	X	
5815_5810		X	X	
6408_83294-10		X	X	
6806_6807		X	X	
72112-04_72112-05		X	X	
7809_7804		X	X	X
804_U0071-S02		X	X	
82254-01_5327		X	X	
83082-01_83082-07		X	X	
83082-07_53803		X	X	
83161-04_83161-03		X	X	
83161-08_83161-07		X	X	
83191-04_9804		X	X	
83201-15_83201-16		X	X	
83201-16_7504		X	X	
83201-28_83201-06		X	X	
83201-42_83201-13		X	X	
83201-43_83201-44		X	X	
83292-01_83292-62		X	X	
83292-22_83292-66		X	X	
83292-62_83293-10		X	X	
83293-10_83293-09		X	X	
83301-01_3212		X	X	
83302-02_3211		X	X	
83302-12_83302-03		X	X	

Log of Full Pipes During Calibration Events
Comprehensive Sewer Plan
City of Bellingham

Pipe ID	DWF	November 2004	January 2005	April 2005
83302-13_83302-12		X	X	X
83302-22_2319	X	X	X	X
83303-01_49701		X	X	
83303-03_83303-02		X	X	
83303-05_2605		X	X	
83304-08_83304-10		X	X	
83304-10_2905		X	X	
83304-12_4815		X	X	
83304-14_3010		X	X	
928_72111-02		X	X	
9609_9610		X	X	
9713_9712		X	X	
9714_9713		X	X	
9804_9716		X	X	
9904_83191-04		X	X	
9906_9904		X	X	
9910_9906		X	X	
S0253-S01_83163-06		X	X	
S0271-S03_53802		X	X	
STB22-S01_43301		X	X	
T72013-02_26910		X	X	
T72014-01_T72014-35		X	X	
T72022-01_928		X	X	
T82362-01_27707		X	X	
T82362-47_27302		X	X	
T82363-02_T72014-01		X	X	
T83293-01_T83294-01	X	X	X	X
T83294-01_3409		X	X	
T83301-01_3313		X	X	
T83302-03_83302-22		X	X	X
T83302-51_2304		X	X	X
T83302-52_3301		X	X	
T83302-54_2305		X	X	
T83302-55_T83302-54	X	X	X	X
T83303-11_83303-03		X	X	
U0023-S05_U0023-S04		X	X	
U0023-S06_U0023-S05		X	X	

Log of Full Pipes During Calibration Events
Comprehensive Sewer Plan
City of Bellingham

Pipe ID	DWF	November 2004	January 2005	April 2005
U0023-S07_U0023-S06		X	X	
U0023-S12_U0023-S11		X	X	
U0023-S17_U0023-S14		X	X	X
U0033-S01_4919		X	X	
U0081-S08_U0081-S05		X	X	
U0093-S01_U0093-Y01		X	X	X
U0099-S03_83082-01		X	X	
U0100-S01_U0023-S17		X	X	
U0100-S02_U0100-S01		X	X	

Note:
X = pipes full during some point in the calibration period.

Appendix J

RECOMMENDED COLLECTION SYSTEM PIPING IMPROVEMENTS

Table J.1	Manholes in which the Water Level Reaches within 2 feet of the Rim in 2026 During the November 2004 Storm Comprehensive Sewer Plan City of Bellingham				
27707	5216	9716	3114	53607	14203
27118	5203	9611	2806	83082-07	22605
31921	17014	53803	5009	9712	20819
30911	17009	53902	2820	83191-04	U0005-S11
30204	U0077-S01	4208	2306	29719	20902
5208	83292-01	3508	4406	2305	20803
83303-05	U0005-S13	7507	3209	2319	20804
2602	9714	20801	3207	2812	5218
31912	9904	3507	83301-14	2822	23911
30902	14202	4011	83302-03	4405	2210
U0099-S03	13709	4106	2814	4901	2209
2826	2120	4005	83302-02	3210	2121
2604	13607	4008	3208	5001	10913
2601	2015	3505	3313	83301-15	9910
2828	2208	4009	16506	3405	83082-01
S0271-S03	14305	3504	3413	83302-22	53106
5220	2016	4007	2819	20904	53801
5206	20802	4006	2805	U0005-S10	83304-05
2821	83293-07	4107	3301	20903	83293-11
2831	83293-24	83292-02	4923	83293-19	3501
2810	7506	12502	2804	83292-17	2204
8918	4002	U0077-S02	83302-14	20901	1912
83304-06	4108	22709	2603	29312	2122

Table J.1 Manholes in which the Water Level Reaches within 2 feet of the Rim in 2026 During the November 2004 Storm
Comprehensive Sewer Plan
City of Bellingham

29319	4001	11003	3116	16504	14304
U0005-S12	3502	83161-08	24206	10912	14206
22606	3506	3418	83302-21	53102	2606
2823	2018	3409	5104	83082-02	2205
2825	13606	5101	16405	37403	1915
5217	2014	9805	9804	12503	14201
5211	2605	9803	83301-19	12504	3306
5202	2829	9713	83301-16	9906	1913
5207	9610	9802	2207	10910	30309
5219	83161-09	24207	1914	10914	Pine_FM_OUT
5210	10002	83302-13	53105	5307	

Table J.2 Sewer Segments Recommended for Replacement
Comprehensive Sewer Plan
City of Bellingham

Basin	Project No.	Old Link	Old Dia. (in)	US MH	DS MH	Length (ft)	New Dia. (in)
South Basin	1	31912_30902	12	31912	30902	77	20
		30902_30911	12	30902	30911	140	20
		30911_30903	12	30911	30903	355	30
		30903_30904	12	30903	30904	42	20
		30904_30905	12	30904	30905	487	20
South Basin	2	29320_29319	15	29319	29320	430	18
		29320_29312	15	29320	29312	274	18
		29312_29311	8	29312	29311	235	18
		29311_29310	8	29311	29310	46	18
2617	3	3306_3307	8	3306	3307	97	18
		2204_3306	8	2204	3306	407	18
		2210_2205	8	2210	2205	158	18
		2209_2210	8	2209	2210	441	18
		2208_2209	8	2208	2209	316	18
		2207_2208	12	2207	2208	274	18
		1915_2207	8	1915	2207	394	18
		1914_1915	8	1914	1915	436	18
		1913_1914	8	1913	1914	482	18
		1912_1913	8	1912	1913	161	18
		1911_1912	12	1911	1912	319	18

Table J.2 **Sewer Segments Recommended for Replacement**
Comprehensive Sewer Plan
City of Bellingham

Basin	Project No.	Old Link	Old Dia. (in)	US MH	DS MH	Length (ft)	New Dia. (in)
2617	4	T83293-01_T83294-01	15	T83293-01	T83294-01	355	20
		3413_T83293-01	12	3413	T83293-01	50	20
		83293-11_3413	15	83293-11	3413	31	20
		3501_83293-11	12	3501	83293-11	288	18
		2121_3501	12	2121	3501	154	18
		2120_2121	12	2120	2121	457	18
		2122_2120	15	2122	2120	450	18
		2020_2122	8	2020	2122	398	18
		2018_2020	10	2018	2020	293	18
		2016_2018	10	2016	2018	299	18
		2015_2016	10	2015	2016	301	18
		2014_2015	12	2014	2015	334	18
2617	5	83293-10_83293-09	8	83293-10	83293-09	457	12
		83292-62_83293-10	8	83292-62	83293-10	166	12
		83292-01_83292-62	8	83292-01	83292-62	325	12
2617	6	12503_12502	10	12503	12502	385	16
		12502_12402	10	12502	12402	270	16

Table J.2 Sewer Segments Recommended for Replacement
Comprehensive Sewer Plan
City of Bellingham

Basin	Project No.	Old Link	Old Dia. (in)	US MH	DS MH	Length (ft)	New Dia. (in)
2617	7	20804_20805	8	20804	20805	353	12
		20803_20804	8	20803	20804	224	12
		20904_20903	8	20903	20904	314	12
		20904_20801	8	20904	20801	314	12
		20801_20802	8	20801	20802	268	12
		20802_20803	8	20802	20803	426	12
		20902_20903	8	20902	20903	340	12
		20901_20902	8	20901	20902	354	12
2617	8	83082-07_53803	8	83082-07	53803	201	20
2617	9	7507_6806	8	7507	6806	479	12
		7506_7507	8	7506	7507	465	12
		7505_7506	8	7505	7506	459	12
		7504_7505	8	7504	7505	200	12
		83201-16_7504	8	83201-16	7504	289	12
		83201-15_83201-16	8	83201-15	83201-16	157	12
2617	10	3114_3111	12	3114	3111	147	16
		3116_3114	8	3116	3114	198	16
2617	11	82133-02_15703	8	82133-02	15703	325	18

Table J.2 Sewer Segments Recommended for Replacement
Comprehensive Sewer Plan
City of Bellingham

Basin	Project No.	Old Link	Old Dia. (in)	US MH	DS MH	Length (ft)	New Dia. (in)
		83302-12_83302-03	8	83302-12	83302-03	86	12
		83302-13_83302-12	6	83302-13	83302-12	110	12
		83302-14_83302-13	10	83302-14	83302-13	114	12
		3210_83302-14	8	3210	83302-14	177	12
		3209_3210	8	3209	3210	479	12
2617	12	13214_13212	8	13214	13212	129	24
2617	13	U0005-S13_U0005-S12	8	U0005-S13	U0005-S12	304	12
4823	14	53101_53005	10	53101	53005	356	12
		53102_53101	10	53102	53101	418	12
		53105_53102	10	53105	53102	415	12
		53106_53105	10	53106	53105	353	12
							Total =
4823	15	53803_S0271-S03	8	53803	S0271-S03	302	18
		83082-07_53803	8	83082-07	53803	201	20
		83082-01_83082-07	8	83082-01	83082-07	131	24
		U0099-S03_83082-01	8	U0099-S03	83082-01	294	24

Table J.2 Sewer Segments Recommended for Replacement
Comprehensive Sewer Plan
City of Bellingham

Basin	Project No.	Old Link	Old Dia. (in)	US MH	DS MH	Length (ft)	New Dia. (in)
4823	16	9712_8310	15	9712	8310	339	18
4823	17	9804_9716	12	9804	9716	230	24
4823	18	10002_9910	18	10002	9910	358	20
		10906_10002	18	10906	10002	290	20
		11003_10910	15	11003	10910	420	20
		10910_10909	15	10910	10909	150	20
		10909_10908	15	10909	10908	40	20
		10908_10907	15	10908	10907	186	20
		10907_10913	18	10907	10913	51	20
		10913_10912	18	10913	10912	267	20
		10912_10906	18	10912	10906	129	20
4823	19	5105_5107	24	5105	5107	12	42
4823	20	53902_53901	8	53902	53901	49	12
5201	21	23207_23210	15	23207	23210	178	18
		23208_23207	15	23208	23207	369	18
		23209_23208	12	23209	23208	289	18
		37402_23209	12	37402	23209	334	18
		37403_37402	12	37403	37402	115	18

Table J.2	Sewer Segments Recommended for Replacement Comprehensive Sewer Plan City of Bellingham						
Basin	**Project No.**	**Old Link**	**Old Dia. (in)**	**US MH**	**DS MH**	**Length (ft)**	**New Dia. (in)**
		37404_37403	12	37404	37403	181	18
		37405_37404	12	37405	37404	82	18
5201	22	22406_83184-28	10	22406	83184-28	45	12

Notes:

(1) Manholes numbers starting with T indicate Tee connection.

Table J.3 Recommended Parallel Sewer Segments
Comprehensive Sewer Plan
City of Bellingham

Basin	Project No.	US MH	DS MH	Length (ft)	New Dia. (in)
2617	1	T83302-54	2305	23	42
		T83302-55	T83302-54	206	48
		2319	T83302-55	77	48
		83302-22	2319	135	48
		83302-21	83302-22	115	36
2617	2	3506	3505	360	36
		3505	3504	310	36
		3504	3502	332	36
		3502	T83294-01	179	36
		3409	3405	388	36
		3405	T83301-01	168	36
		T83301-01	3313	140	36
		3313	3312	88	36
		3312	3307	344	30
		3307	T83302-52	375	36
		T83302-52	3301	87	36
		3301	T83302-03	253	42
4823	3	9805	9804	34	24
		83191-04	9805	391	24
		9904	83191-04	353	24
		9906	9904	306	24
		9910	9906	245	24
					total =
4823	4	5107	5002	288	24
		5102	5105	522	30
		5327	5102	223	30
		82254-01	5327	309	36
		5320	82254-01	17	36
		5310	5320	300	36
		5309	5310	37	36

Table J.3	Recommended Parallel Sewer Segments Comprehensive Sewer Plan City of Bellingham				
Basin	**Project No.**	**US MH**	**DS MH**	**Length (ft)**	**New Dia. (in)**
		5217	5309	245	36
		5218	5217	190	30
					total =
5201	5	17016	5201	424	36
		17007	17016	102	36
		17008	17007	145	36
		17009	17008	86	36
		5225	5224	415	24
		9007	9008	378	24
		8920	9007	368	24
		8918	8919	260	24
		9108	9109	398	24

Notes:

(1) Manholes numbers starting with T indicate Tee connection.

Table J.4 Estimated Now Sewer Components to Serve UGA
Comprehensive Sewer Plan
City of Bellingham

Basin	Project(1)	Area	Tie in Manhole	Length (ft)	Slope (ft/ft)	Dia. (in)	Capacity (gpm)	Manholes (No.)
5201	1	Northwest	U0047-S11	14,560	0.0034	8	351	42
5201	2	Northwest		11,230	0.0046	8	408	53
	Force main	Northwest	X0047-S05	10,500		6		0
	Pump Station	Northwest						
4823	3	North	W0088-S07	2,500	0.0033	8	346	7
4823	4	North	83082-05	2,700	0.0037	8	366	8
4823	5	North	83093-01	3,175	0.032	8	1,077	9
South	6	Central	73094-12	5,375	0.006	8	466	15

Notes:
(1) Project 2 will likely require a force main and pump station due to local topography.

Appendix K

ESTIMATED COST OF COLLECTION SYSTEM IMPROVEMENT

Table K.1 Collection System Improvement Segments
Comprehensive Sewer Plan
City of Bellingham

Priority	Location	Project Cost
1	Manhole 31912 to 30905	$350,000
1	Manhole 29319 to 29310	$259,000
1	Manhole 30204 to 30205	$92,000
1	Manhole 83082-02 to S0271-S03	$232,000
1	Manhole 10914 to 10913	$90,000
1	Manhole 9804 to 8310	$296,000
1	Manhole 2014 to T83294-01	$870,000
1	Manhole 3506 to T83302-03	$1,352,000
1	Manhole 9910 to 9804	$415,000
1	Rhoder Forcemain Improvements	$8,700,000
2	Manhole 1912 to 3307	$884,000
2	Manhole 53801 to 53903 and 53902 to 53901	$94,000
3	Manhole 83292-01 to 83293-09	$200,000
3	Manhole 12504 to 12402	$293,000
3	Manhole 22605 to 12609	$683,000
3	Manhole 83201-15 to 6806	$436,000
3	Manhole 3114 to 3111	$34,000
3	Manhole 13214 to 13212	$37,000
3	Manhole U0005-S13 to U0005-S09	$196,000
3	Manhole 53106 to 53005	$332,000
3	Manhole 11003 to 9910	$513,000
3	Manhole 37405 to 23210	$387,000
3	Manhole 22406 to 83184-28	$9,000
3	Manhole 17009 to 5201	$428,000
3	Manhole 5218 to 5002	$906,000
3	Expansion of collection system into unsewered areas	$11,086,000
Total Estimated Project Cost		**$29,174,000**