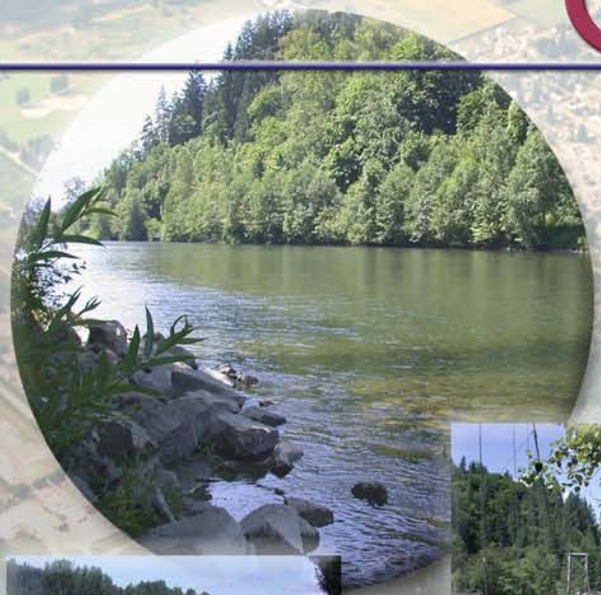
King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

FINAL Wastewater Facilities Plan for the Carnation Wastewater Treatment Facility



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Prepared for King County By:
Carollo Engineers

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JAMES PHILLIP HAGSTROM
STATE OF WASHINGTON
37252
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES 10/01/07

BRAD J. EINFELD
STATE OF WASHINGTON
16698
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES: 6/3/2006

King County Department of
Natural Resources and Parks

FINAL FACILITIES PLAN

CARNATION WASTEWATER TREATMENT FACILITY

October 2005

carollo engineers

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

King County Department of Natural Resources and Parks

CARNATION WASTEWATER TREATMENT FACILITY

FINAL FACILITIES PLAN

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ACRONYMS AND ABBREVIATIONS

7Q10	7-day low flow with a 10-year recurrence interval
A^2O	Anaerobic/anoxic/oxic process
AAL	average annual load
ACH	air changes per hour
alum	aluminum sulfate
AKART	All Known Available and Reasonable methods of prevention, control, and Treatment
American	American Engineering Corporation
BA	biological assessment
BAT	best available technology
BNR	biological nutrient removal
BOD	biochemical oxygen demand
BOD_5	5-day biochemical oxygen demand
Bridge	Carnation Farm Road Bridge
C	Celsius
CAC	Citizen's Advisory Committee
$CaCO_3$	calcium carbonate
Carollo	Carollo Engineers
CIP	capital improvement program
CFR	Code of Federal Regulations
cfs	cubic feet per second
CFU	colony forming unit
City Council	Carnation City Council
City	City of Carnation
Cl_2	chlorine
cm/day	centimeters per day
CMU	concrete masonry unit
COD	chemical oxygen demand
Comprehensive Plan	King County general land use and development comprehensive plan
Cosmopolitan	Cosmopolitan Engineering
County	King County
County Council	Metropolitan King County Council
CWA	Clean Water Act
CWWTF	Carnation Wastewater Treatment Facility
CY	cubic yard
D	dependent on likelihood of exposure to humans and habitats

DBO	design/build/operate
DI	ductile iron
DO	dissolved oxygen
DOH	Washington Department of Health
DWS	Drinking Water Standards
EA	environmental assessment
EBMUD	East Bay Municipal Utility District
Ecology	Washington Department of Ecology
EDC	endocrine disrupting compound
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
Executive	King County Executive
FEMA	Federal Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FONSI	Findings of No Significant Impact
fps	feet per second
ft	feet
ft^3/day	cubic feet per day
FTE	full-time equivalent
gal	gallons
gfd	gallons of permeate produced per square foot of membrane per day
GIS	Geographic Information System
GLO	Government Land Office
GMA	Growth Management Act
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
GW	groundwater
HPA	Hydraulic Project Approval
HDPE	high-density polyethylene
HDR	HDR Engineering
hp	horsepower
HRT	hydraulic retention time
HVAC	heating, ventilation, and air conditioning
Hz	hertz
I/I	inflow and infiltration
JARPA	Joint Aquatic Resources Permit Application
kg/ha/d	kilograms per hectare per day

kVA	kilovolt-amperes
kW	kilowatt
lb/day	pounds per day
LEED	Leadership in Energy & Environmental Design
LF	linear feet
LS	lump sum
MBR	membrane bioreactor
MCC	motor control center
MDF	maximum daily flow
MDL	method detection limit
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
MJ/sq CM	millijoules per square centimeter
MLSS	mixed liquor suspended solids
mL	milliliter
mm	millimeter
MMF	maximum monthly flow
MML	maximum monthly load
mph	miles per hour
MPN	most probable number
µg/L	microgram per liter
N	nitrogen
NA	not applicable
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
NH_3-N	ammonia-nitrogen
NO_3-N	nitrate-nitrogen
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NR	not regulated
NRHP	National Register of Historic Places
ntu	nephelometric turbidity unit
NWRI	National Water Research Institute
O&M	operations and maintenance
Orange Book	Criteria for Sewage Works Design Manual
P	phosphorus
PAA	potential annexation area
Park	Tolt MacDonald Park
PHF	peak hourly flow
PSE	Puget Sound Energy

Public Health	Public Health – Seattle & King County
Qal	recent alluvium geological unit
R	reserved by Ecology (depends on fate of water)
RAS	return activated sludge
R.W. Beck	R.W. Beck and Associates
RCW	Revised Code of Washington
RDL	reporting detection limit
RM	river mile
Roth Hill	Roth Hill Engineering Partners, LCC
SBR	sequencing batch reactor
SCADA	supervisory control and data acquisition
scfm	standard cubic feet per minute
SEPA	State Environmental Policy Act
sf	square feet
SFHA	special floor hazard area
SIP	State Implementation Plan
SKCDPH	Seattle – King County Department of Public Health
SOTE	standard oxygen transfer efficiency
SRP	soluble reactive phosphorus
SWA	Stillwater Wildlife Area
SWQ	Surface Water Quality Standards
TDR	Tolt Delta Reach
TKN	total Kjeldahl nitrogen
TM	technical memorandum
TMDL	total maximum daily load
TOC	total organic carbon
trail	Snoqualmie Valley Trail
TSS	total suspended solids
UCT	University of Cape Town process
UGA	urban growth area
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	ultraviolet
VIP	Virginia Initiative Plant process
VOC	volatile organic compound
VFD	variable-frequency drive
WAC	Washington Administrative Code
WAS	waste activated sludge
WDFW	Washington Department of Fish and Wildlife

WDOT	Washington Department of Transportation
WRIA	Water Resource Inventory Area
WQGW	Water Quality for Groundwater Standards
WTD	Wastewater Treatment Division

Name

Carnation Wastewater Treatment Facility

Proponent/Lead Agency

King County Department of Natural Resources and Parks

Wastewater Treatment Division
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98014

Project Representative

Brenda Osterhaug, Project Manager
Major Capital Improvement Program
Wastewater Treatment Division

Phone: (206) 263-3794
Fax: (206) 684-1741
E-mail: Brenda.Osterhaug@METROKC.GOV

Prepared By

Carollo Engineers
1218 Third Avenue, Suite 1600
Seattle, Washington, 98101
Phone: (206) 684-6532
Fax: (206) 903-0419

1.0 EXECUTIVE SUMMARY

This Facilities Plan for the Carnation Wastewater Treatment Facility (CWWTF) has been prepared in accordance with the Submission of Plans and Reports for Construction of Wastewater Facilities (2000) Washington Administrative Code (WAC) 173-240 for submittal to the Washington Department of Ecology (Ecology). This plan is designed to demonstrate that the proposed project will meet the applicable guidelines, regulations, and approval requirements for issuance of a discharge permit. In addition, the Facilities Plan serves as a comprehensive guide to the project.

The City of Carnation (City) is located on the Snoqualmie River within the Snoqualmie Valley (see Figure 1.1) and is an incorporated city within King County (County). At the request of the City, the County proposes to build and operate a new local wastewater treatment facility and associated river outfall to meet the needs of the City's designated Urban Growth Area (UGA) for a 2030 facility design year. The City will construct and operate a vacuum sewer collection system for the conveyance of sewage from residences and businesses within the City to the treatment facility. An agreement between the County and the City, attached as Appendix C of this plan, requires the facility to be operational by December 2007.

Historically, the City has relied on a system of individual septic tanks and drain fields. In 1987, Public Health – Seattle & King County (Public Health) declared the City a public health hazard area based on the number of inadequate septic systems and the likely contamination of the unprotected aquifer from which drinking water is derived.[1] Public Health made this declaration based on the soil conditions within the City, documented illegal sewage disposal repairs, and informal surveys confirming inadequate systems. Due to the costs associated with a lot-to-lot survey and comprehensive ground water studies, Public Health has been unable to determine the full extent of the health threat. Since then, Public Health has taken the step of restricting property use or prohibiting remodeling projects in cases where the long-term protection of public health is at risk. Legal repairs to existing septic systems on inadequately sized lots may require a notice of nonconforming repair on the property deed of records.[2] Attached as Appendix D, Public Health issued a letter on September 28, 2005 that indicates that due to continued public exposure to surfacing sewage and untreated sewage entering the groundwater aquifer, current on-site sewage disposal practices in the City are clearly inadequate and present a Severe Public Health Hazard to the community.[3] As a result, Public Health supports the development of a sewer system for the City. Public Health views the system remains the "most viable solution for the long-term protection of the public's health." Replacing on-site septic systems with a wastewater treatment facility is important to address public health concerns, achieve the City's comprehensive plan goals, and enhance community livability.

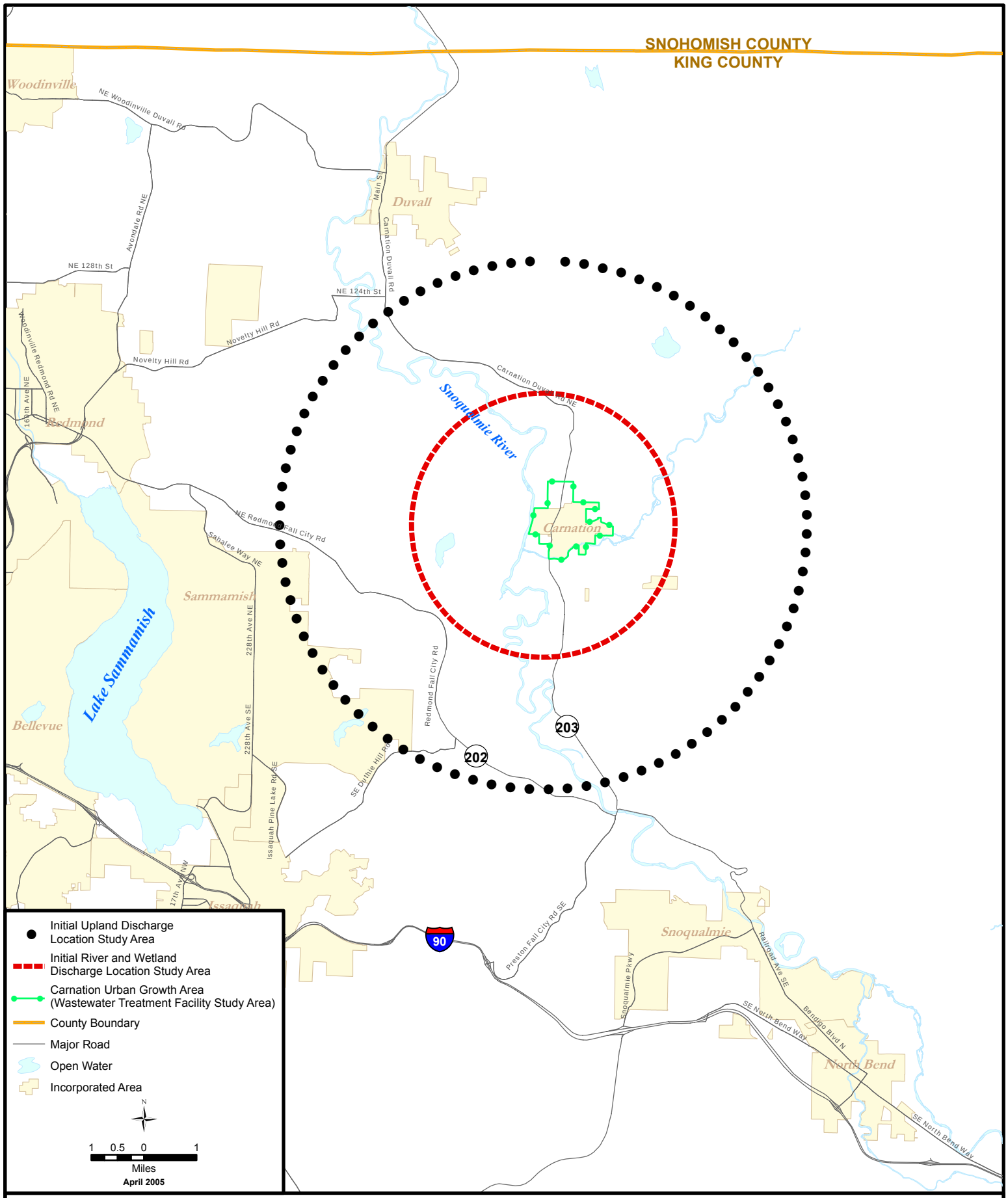

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Figure 1.1

Project Study Areas in Carnation and Vicinity

CARNATION WASTEWATER TREATMENT FACILITY

1.1 Future Flows and Loads

From the spring of 2003 through the summer of 2004, the City and County developed an approach to estimate populations and wastewater flows, as well as specific loads to a proposed treatment facility, for future years. Population development is documented in the City of Carnation 2004 Sewer Comprehensive Plan.[4] Table 1.1 summarizes the design flows and load projections for the CWWTF. The City's population is expected to increase from 1,893 residents in 2000 to residential saturation (3,871 residents) by the year 2017.

Table 1.1 Population, Flow, and Load Projections
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Projections by Major Milestone and Year			
	Startup 2007	**Full Sewer[a] 2012**	**Residential Saturation[b] 2017**	**Design Year 2030**
Planning forecasts[c]				
Population	2,185	3,816	3,871	3,871
Households	733	1,281	1,300	1,300
Employees	634	809	1,254	2,175
Flow (mgd)				
Average annual	0.21	0.32	0.34	0.37
Maximum monthly	0.27	0.42	0.44	0.48
Maximum daily	0.43	0.67	0.71	0.77
Peak hourly	0.63	0.72	1.29	1.4[d]
BOD (lb/day)				
Average annual	538	923	954	991
Maximum monthly	700	1,200	1,240	1,288
Maximum daily	915	1,570	1,622	1,684
TSS (lb/day)				
Average annual	538	923	954	991
Maximum monthly	700	1,200	1,240	1,288
Maximum daily	915	1,570	1,622	1,684

Notes:

mgd = million gallons per day
lb/day = pounds per day

a. End of the anticipated rapid increase in population (5% annual growth rate until the buildout density is reached) after the vacuum sewers are available.
b. The residential saturation was determined based on the buildout density of the residentially zoned land within the UGA.
c. Source: Roth Hill Engineering Partners, LLC, *City of Carnation 2004 Sewer Facilities Plan*, *City Review Draft,* September 2004.
d. Allows for wet well equalization.

In accordance with the countywide planning policies presented in the King County Comprehensive Plan[5] and to satisfy the requirements of the Revised Code of Washington (90.48 RCW),[6] the County commissioned a study in 2004 to review and determine the cost implications of initiating a water demand management program (to promote conservation through retrofitting equipment and/or establishing new plumbing codes) in conjunction with the design of the CWWTF. The study determined that conservation practices will have little to no effect on the design of the CWWTF or the collection system but may impact associated operations and maintenance (O&M) costs.

1.2 Water Quality and Regulatory Approvals

In 2003, the County made a commitment to the citizens of the City that the CWWTF design would provide highly treated effluent, herein referred to as highly treated water, to meet the stringent water quality requirements for the selected discharge alternative. For the river outfall discharge alternative, the anticipated National Pollutant Discharge Elimination System (NPDES) requirements would be set based on technology, water quality, and the 1994 total maximum daily load (TMDL) study for the Snoqualmie River.[7] This commitment will allow the facility to be capable of meeting the Class A reclaimed water standards, as regulated by the Washington Departments of Health and Ecology, should either the County or the City desire to use the water in the future. Class A reclaimed water would allow for unrestricted non-potable contact applications as well as use for the restoration or enhancement of wetlands. Class A standards require the highly treated water from the CWWTF to meet additional water quality criteria for parameters such as total coliform and turbidity. Ecology also reserves the right to regulate nutrients such as nitrate and total phosphorus for specific reuse applications.

The County will treat and discharge wastewater from the City in accordance with the applicable permit standards. Permits related to the construction of the facility and discharge from the CWWTF to the river are expected to include NPDES construction and municipal discharge permits, Washington Department of Natural Resources Aquatic Lands Lease permit, and local clearing and grading, right-of-way, and building/construction permits. The CWWTF will be designed to meet all permit requirements and water quality standards in effect at the time of permit issuance. Table 1.2 summarizes the anticipated requirements for the discharge of treated wastewater from the CWWTF to the Snoqualmie River. Table 4.2 of this document lists the minute quantities of other constituents such as metals, which are also regulated by the Surface Water Standards.[8]

Table 1.2 Anticipated Discharge Requirements to the Snoqualmie River
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Allowable Limit
Year-Round or Non-TMDL Permit Limitations	
Average monthly	
BOD_5[a]	30 mg/L, 155 lb/day
TSS[a]	30 mg/L, 155 lb/day
NH_3-N[b]	38.3 mg/L
Fecal coliform[c]	50 CFU per 100 mL
Residual Cl_2[b]	0.063 mg/L
Average weekly	
BOD_5[a]	45 mg/L, 233 lb/day
TSS[a]	45 mg/L, 233 lb/day
NH_3-N[b]	91.3 mg/L
Fecal coliform	400 CFU per 100 mL
Residual Cl_2[b]	0.165 mg/L
Maximum daily	
Temperature (7-day average)[d]	16 ^oC
pH[e]	6.5 - 8.5
Turbidity[f]	5 ntu + river background
Total dissolved gas[g]	110 percent
Minimum daily	
DO[h]	9.5 mg/L
TMDL Permit Limitations (Aug - Oct)[i]	
Maximum daily	
BOD_5	25 lb/day
NH_3-N	8.4 lb/day
SRP	3 lb/day

BOD_5 = biochemical oxygen demand	NH_3-N = ammonia-nitrogen
^oC = degrees Celsius	ntu = nephelometric turbidity unit
CFU = colony forming units	mg/L = milligrams per liter
Cl_2 = chlorine	mL = milliliter
DO = dissolved oxygen	TSS = total suspended solids

Notes:

a. Average monthly concentration cannot exceed 30 mg/L or 15 percent of the respective monthly average influent concentrations, whichever is more stringent.
b. As reported by Cosmopolitan in Technical Memorandum (TM) No. 12 for these toxic substances and assuming limiting acute and chronic dilution factors of 8.7 and 116, respectively. The Surface Water Standards also list other regulated constituents such as heavy metals not listed in this table. Using updated potential dilution allowances; the allowable concentration would likely be greater than that reported in this table.
c. Based on a geometric mean value, with not more than ten percent of all samples exceeding 100 colonies / 100 mL.
d. No temperature increase can raise the receiving water temperature by greater than 0.3^oC if natural temperature exceeds criteria.
e. Human-caused variation within acceptable range, less than 0.2 unit.
f. Results in less than a 10 percent increase when the background turbidity is more than 50 ntu.
g. Criteria does not apply when the stream flow exceeds the 7-day, 10-year flood frequency.
h. No DO decrease greater than 0.2 mg/L when the receiving water body is lower than the criteria due to natural conditions.
i. Based on the 1994 TMDL study for mass discharge loading. For the months of August, September, and October, the water quality must meet both the NPDES and the year-round limitations.

Sources: Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.; *Water quality standards for surface waters of the state of Washington*, *WAC 173-201A* (2003).; Joy, J., *Snoqualmie River Total Maximum Daily Load Study*, Ecology Report #94-71, 1994.

In addition, the County is continuing to prepare documentation to meet the other major regulatory approval processes.

- The final Environmental Impact Statement (EIS) analyzed the characteristics, probable impacts, and mitigation measures for the CWWTF alternatives. The final EIS was issued October 15, 2004, and addressed all comments submitted (eight government agencies and 20 individuals or groups) after a 30-day public comment period and public hearing.[9]
- A biological assessment (BA) has been prepared for the CWWTF in order to comply with Section 7 of the Endangered Species Act (ESA) and is required for the City to apply for federal funding. The BA has submitted to the Environmental Protection Agency (EPA) for review in September 2005 and forwarded to the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) for their concurrence shortly thereafter.
- A Joint Aquatic Resources Permit Application (JARPA) was submitted to the appropriate permitting agencies in April 2005. It is anticipated that the project will require a Hydraulic Project Approval (HPA) and a Shoreline Substantial Development permit.

1.3 Treatment Process

Treatment processes that would effectively provide the level of treatment to meet the anticipated discharge requirements for all of the discharge alternatives evaluated during preliminary design were evaluated. The evaluation examined a range of suspended, fixed-film, and hybrid processes for the following criteria: 1) risk, 2) capital and O&M costs, 3) facility space requirements, 4) process reliability, 5) operations familiarity, 6) maintenance requirements, and 7) odor control and enclosure costs. Based on the evaluation, activated sludge coupled with membrane bioreactor (MBR) technology was recommended for the CWWTF. This technology provides the highest water quality while requiring the smallest environmental footprint. In addition, the City would have state-of-the-art treatment at a cost similar to a more conventional treatment system.

Given the environmental sensitivity of the Snoqualmie River and surrounding areas, the CWWTF will include state-of-the art biological treatment and separation facilities that include:

- Fine-screening, solids storage, and odor control facilities
- Liquid treatment facilities
  - Activated sludge with anoxic, anaerobic, and aerobic zones
  - MBR tanks
  - Ultraviolet (UV) disinfection facilities

- Aerated solids holding/thickening basin
- Odor control equipment
- Chemical feed and storage tanks and appurtenances
- Laboratory and staff office and support facilities

In general, the facility will be designed to provide constant, reliable treatment; have on-line automated alarms; and possess redundancy or standby equipment for each unit treatment process. Mechanical treatment devices such as screens, pumps, and blowers will be provided with one standby unit. The facility processes will be designed to continue to fully treat the flow while any single process unit is removed from service for maintenance or repair. For the river outfall discharge alternative, the CWWTF is required by Ecology to meet a minimum Class II level of reliability and redundancy. Reliability Class II pertains to "works whose discharge, or potential discharge, as a result of its volume and/or character, would not permanently or unacceptably damage or affect the receiving waters or public health during periods of short-term operations interruptions, but could be damaging if continued interruption of normal operations were to occur."[10] In the event that the County or the City would be interested in beneficial reuse in the future (wetlands restoration or urban use), the CWWTF design has the flexibility to meet the Class A reclaimed water standards and the reclaimed water standards for discharging to wetlands.[11]

1.4 Wastewater Treatment Facility Siting

Alternative sites for the CWWTF were investigated by a systematic process of screening for favorable site characteristics. Figure 1.1 illustrates the different study areas investigated in this project. The study area for the CWWTF was restricted to the City's UGA boundary lines, consistent with the City of Carnation 1996 General Comprehensive Plan.[12] A coarse-screening of sites within the study area narrowed the search to 15 land parcels that met the minimal critical land use, geographic, technical, and environmental criteria. Using the geographic information system (GIS), visual observation, and other County data, the County further screened the identified land parcels based on land use compatibility and acquisition requirements, geographic location, technical feasibility, and regulatory environmental impacts.

As a result of the screening process, two sites were selected for further evaluation, as shown in Figure 1.2. The City-owned site is zoned for light industrial and manufacturing use and is the planned location of the City's Vacuum Station No. 1. The site is generally flat and undeveloped with the exception of a single-family residence located on the northeast corner of the property. The Weckwerth site is also located in a light industrial/manufacturing area, adjacent to a middle school and the City fire station. The King County Executive (Executive), in consultation with the City, used environmental, cost, engineering, community impact, and County policy considerations to select the City-owned site as the preferred location for the proposed CWWTF.

1.5 Discharge Alternatives

Five discharge alternatives were initially evaluated: 1) direct discharge to the Snoqualmie River, 2) wetlands discharge, 3) upland discharge, 4) conveyance to existing facilities, and 5) non-potable water reuse for irrigational and commercial purposes. Conveyance to existing facilities was eliminated from further study based on excessive cost and environmental impact.[13] Reclaimed water use for irrigational and commercial purposes was determined to have a greater cost than other discharge alternatives, due in part to the limited number of users, and thus was deferred for consideration in the future. [14] The three remaining discharge alternatives were evaluated further prior to preparation of the EIS.[15] These were the:

- Conventional river outfall at the Carnation Farm Road Bridge (Bridge), near the Tolt MacDonald Park (Park), or at Chinook Bend[16,17]
- Upland discharge through high-rate infiltration to groundwater[18,19]
- Wetlands restoration in the Stillwater Wildlife Area (SWA) [20,21]

Based on these reports, the EIS[22] evaluated the following three alternatives:

- Conventional river outfall at the Bridge
- Upland discharge through high-rate infiltration to groundwater
- Wetlands restoration in the SWA

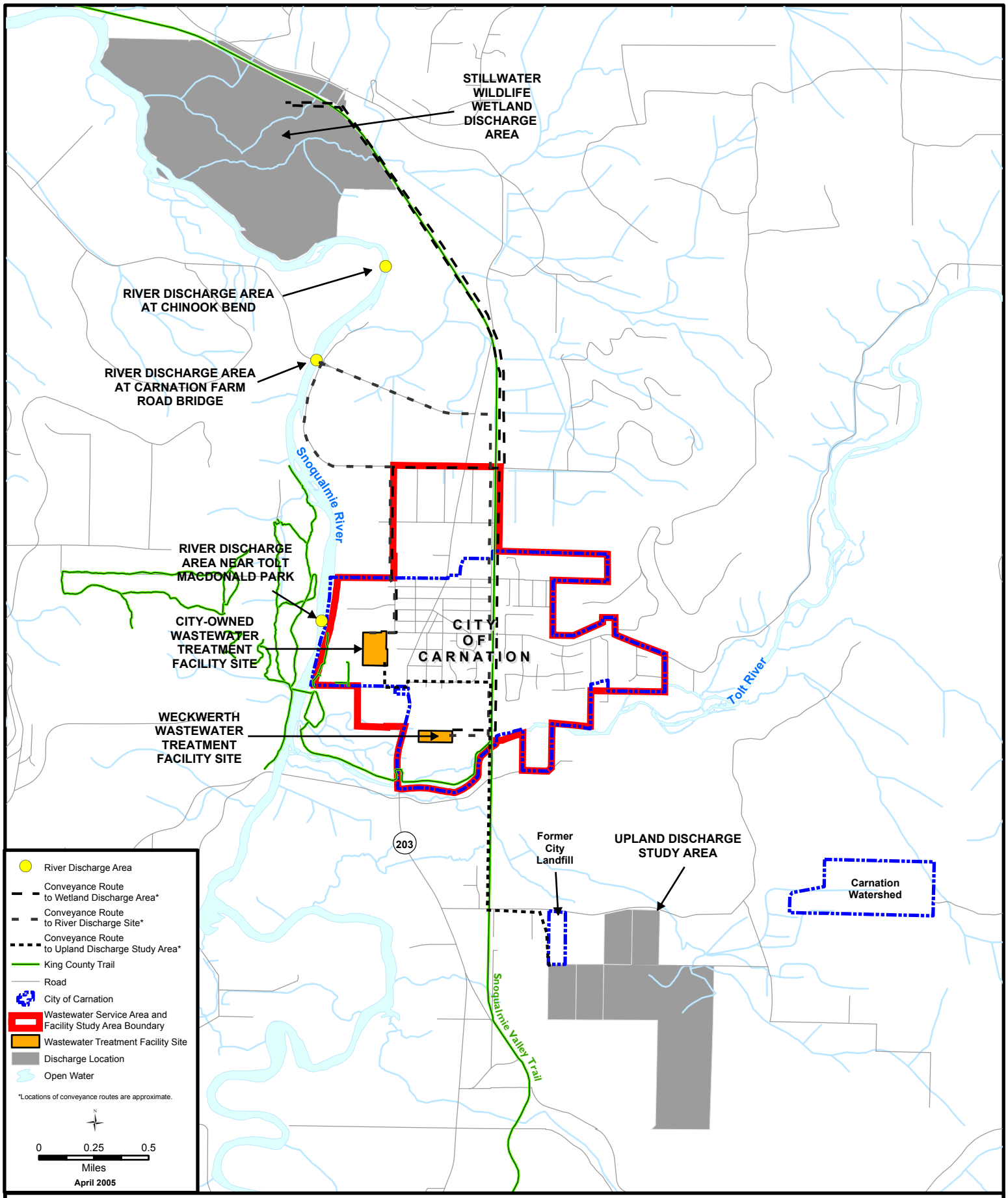

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Figure 1.2

Study Alternatives

CARNATION WASTEWATER TREATMENT FACILITY

The Executive decided to carry forward the river outfall and wetlands discharge alternatives for further study. As documented in the EIS[23] and other previous reports, the upland discharge to groundwater alternative was eliminated as a viable option based on available hydrogeologic information, environmental review, and cost considerations. Wetland discharge to the SWA provides environmental benefits and has public support but requires $2.2 million more in capital costs than a river outfall discharge at the Bridge. Design and permitting activities will proceed with the river outfall discharge alternative but the County continues to actively pursue potential partnerships and grants to make wetlands enhancement an environmental amenity and an economically viable future reuse opportunity for this project.

The County is currently working with the City and other partners to explore additional opportunities of water reuse for creating or enhancing wetlands as a second phase of the project in a cost conscious manner. The County understands that an impairment analysis, as well as other environmental and permitting requirements, must be completed before any reuse can occur. If the City wanted to use the reclaimed water from the treatment plant for another purpose, the interlocal agreement between the City and County would have to be amended. If the wetlands alternative becomes financially feasible, the County will also prepare an amendment to the Facilities Plan to include additional components associated with reclaimed water (at that time) such as chlorination and a river impairment analysis.

A review and confirmation of the recommended outfall location on the Snoqualmie River was completed in order to address public comments and refine project costs. This evaluation consisted of a review of previously available information, river cross-section profiles at the two locations, and detailed fisheries data on the Tolt Delta Reach (TDR) of the Snoqualmie River. The combination of technical, scheduling, public perception, and overall cost parameters evaluated demonstrated that the Bridge discharge location is preferred over the Park discharge location. Although the cost comparison of the two locations shows a $1 million total capital savings for the Park, the comparison does not account for other potential increased impacts such as additional environmental review, and more difficult permitting requirements. In addition, the Bridge discharge location will allow the discharge pipeline to be supported across the bridge to the west pier. This construction alternative would minimize the amount and duration of in-water activities and thus minimize the impact to sensitive habitat by not disturbing the existing riverbed. In addition, discharging the highly treated water at the bridge will decrease the exposure risk in areas with documented Chinook and steelhead redds based on 2004 data.[24]

A review and confirmation of the selected conveyance route to the Snoqualmie River was then completed in order to address public comments and refine project costs. Three conveyance routes to the Bridge were initially identified during preliminary design efforts, as detailed in Technical Memorandum (TM) No. 14.[25] Two routes were selected for further review. Both routes avoid traversing areas that serve as major city thoroughfares, attempt to provide the most direct conveyance route to the discharge location, and minimize

construction impacts to the community. Based on the discovery of sensitive areas between 60th Avenue NE and Carnation Farm Road, including jurisdictional wetlands and a stream crossing, one of the routes was eliminated

Therefore, the route recommended during preliminary design has been confirmed as the preferred route with a lower risk of unforeseen costs and schedule impacts. The route begins at the City-owned site and continues a short distance east on Entwistle Street. The route then heads due north along Stewart Street to the Bagwell Street intersection and continues north along the UGA boundary to 60th Avenue NE (which becomes 310th Avenue as the road turns northward). The route follows 310th Avenue NE to the outfall located at the bridge. Figure 1.2 illustrates the proposed CWWTF and discharge locations.

1.6 Recommendation and Costs

The recommended treatment system consists of a MBR treatment facility, conveyance pipeline, and discharge through an outfall to the Snoqualmie River at the north side of the Carnation Farm Road Bridge. Table 1.3 provides the preliminary present worth estimate of the total project costs for the CWWTF.

Table 1.3 Conceptual Level Cost Estimate
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Cost Parameter	Cost ($)
CWWTF	
Construction cost	9,377,000
Allied cost	3,092,000
Conveyance and discharge	
Construction cost	1,352,000
Easement allowance	38,000
Allied cost	358,000
Total Capital Cost[a]	*14,217,000*
Annual O&M Costs	
Labor[b]	90,000
Energy	45,000
Maintenance	93,000
Chemicals	72,000
Solids Transportation	122,000
Miscellaneous	20,000
Annual O&M Cost	*442,000*

Notes:

a. Cost does not include purchase or leasing of land for the CWWTF.
b. Assumes one full-time employee equivalent during normal operation (50% operations duties, 50% maintenance duties).

Notes

[1] Kleeberg, C., Director, Environmental Health Division, Seattle-King County Department of Health, to Mayor Alan Morris, *Wastewater Treatment Compliance Schedule*, April 19, 1988.
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[5] King County Department of Development and Environmental Services, *2004 King County Comprehensive Plan*, King County, http://www.metrokc.gov/ddes/COMPPLAN/2004/index.htm, (accessed March 10, 2005).
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[7] Joy, J., *Snoqualmie River Total Maximum Daily Load Study*, Ecology Report #94-71, 1994.
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[9] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[10] Washington State Department of Ecology, *Criteria for Sewage Works Design*, 1998. G2-64.
[11] Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.
[12] City of Carnation, *Carnation Comprehensive Plan - 1996*, City of Carnation, Washington, http://www.ci.carnation.wa.us/library/COMPLAN.PDF (accessed June 1, 2003).
[13] Carollo Engineers, *Technical Memorandum No. 11 - Discharge Alternatives*, 2004.
[14] Carollo Engineers, *Technical Memorandum No. 11 - Discharge Alternatives*, 2004.
[15] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[16] Cosmopolitan Engineering Group, *Technical Memorandum No. 12 – River Outfall*, 2004.
[17] Wilson, Dean, King County Water and Land Resources Division, *Alternatives for a Direct Discharge to the Snoqualmie River from the Proposed Carnation Wastewater Treatment Plant,* 2004.
[18] Carollo Engineers, *Technical Memorandum No. 5 - Upland Disposal Alternatives*, 2004.
[19] Carollo Engineers, *Technical Memorandum No. 5A – Upland Disposal Alternatives*, 2004.
[20] Carollo Engineers, *Technical Memorandum No. 5B – Hydrological Aspects of the Wetland Disposal Alternative*, 2004.
[21] Wilson, Dean, King County Water and Land Resources Division, Memorandum to King County Wastewater Treatment Division Project Manager Regarding *Proposal for Habitat Enhancement Using Reclaimed Water from the Proposed Carnation Wastewater Treatment Plant Memorandum,* October 1, 2003.
[22] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[23] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[24] Lucchetti, G., "Salmonid Use of the Snoqualmie River - Tolt Delta Reach", King County Department of Natural Resources and Parks, 2005.
[25] Carollo Engineers, *Technical Memorandum No. 14 - Plant Alternatives Development*, 2004.

2.0 PURPOSE AND SCOPE

2.1 Purpose

This Facilities Plan for the Carnation Wastewater Treatment Facility (CWWTF), hereafter referred to as the Facilities Plan, was prepared in accordance with Washington Administrative Code (WAC) 173-240[26] for submittal to the Washington Department of Ecology (Ecology). This plan is designed to demonstrate how the siting and design of the CWWTF will meet the applicable guidelines, regulations, and approval requirements for the issuance of a discharge permit. In addition, the Facilities Plan will serve as a comprehensive guide to the project. The City of Carnation (City) has approved and is independently submitting to Ecology a Sewer Facilities Plan[27] for the collection and conveyance of the raw sewage to the CWWTF.

2.2 Background

The City is located on the Snoqualmie River within the Snoqualmie Valley (see Figure 2.1)[28] and is an incorporated city within King County (County). The U.S. Census 2000 population estimates indicate that the City had a residential community of 1,893, including 511 zoned residential units within the city limits and potential annexation area (PAA).[29] The entire City, including the downtown business district and surrounding residential areas, is currently served by individual onsite septic tanks and drain fields for wastewater disposal. Development within the City is limited by the capacity of the existing onsite wastewater disposal systems and lack of sewage collection and treatment facilities.

Construction of a new collection and treatment system will enable the City to continue to grow in accordance with the City of Carnation 1996 General Comprehensive Plan.[30]

2.3 Previous Wastewater Studies

The City has attempted to resolve capacity issues with their current septic tank systems for over a decade. In 1990, R.W. Beck and Associates (R.W. Beck) evaluated the City's needs and service area and screened potential alternatives. The resulting plan identified limited land, aging septic systems not in compliance with existing code, and progressively failing systems as reasons for pursuing alternative disposal methods in the future.[31]

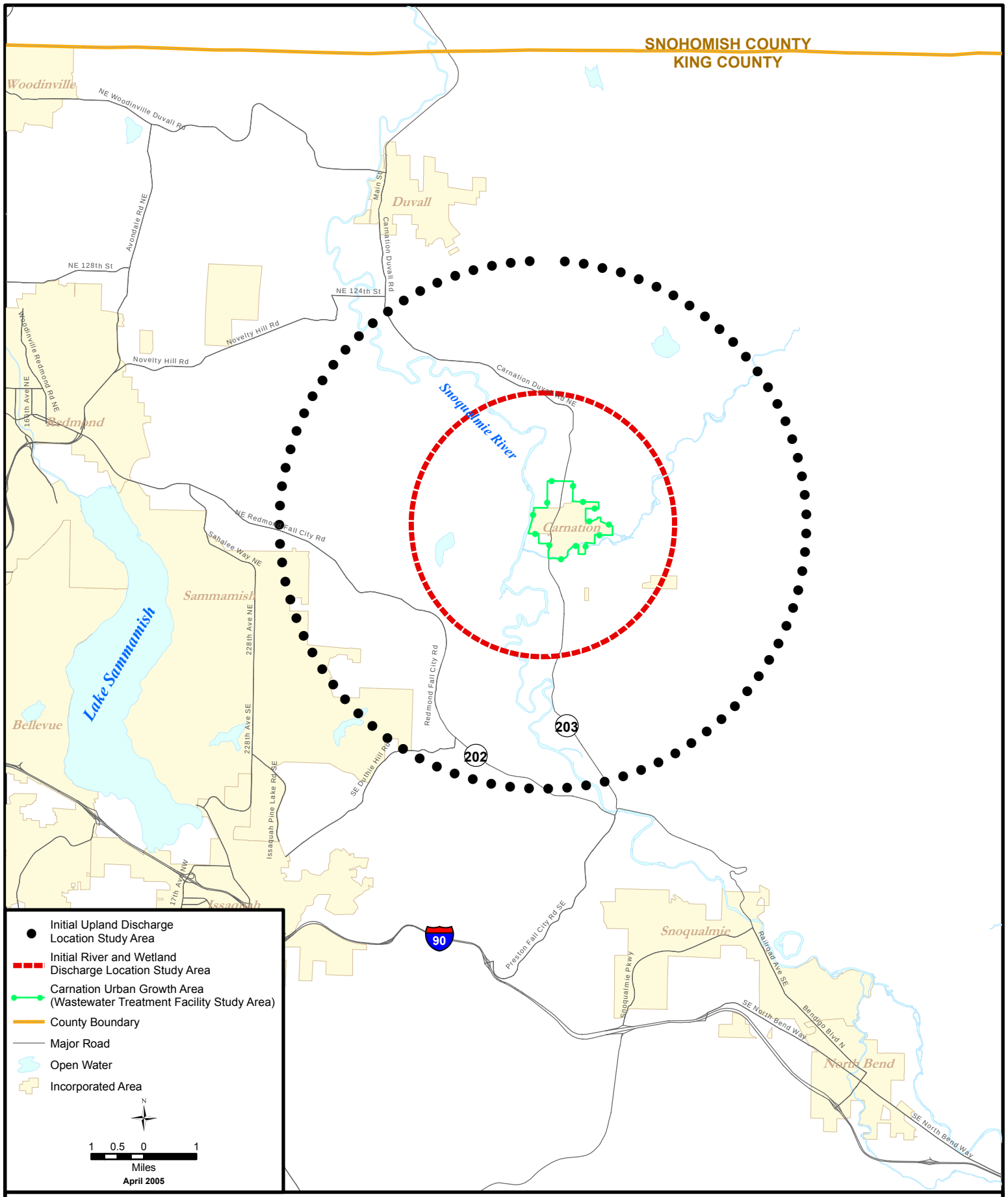

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Figure 2.1

Project Study Areas in Carnation and Vicinity

CARNATION WASTEWATER TREATMENT FACILITY

In 1991, R.W. Beck submitted a draft Wastewater Facilities Plan[32] along with an Environment Impact Statement (EIS)[33] to Ecology. However, the project was not continued at that time in large part due to the fact that the principal service needs were within the central business district, and there was a general lack of support. Although there were concerns of groundwater contamination within the community, no definitive documentation substantiated those concerns.

In 1996, HDR Engineering (HDR) re-evaluated the wastewater treatment alternatives for the City, including an alternative for centralizing treatment among the incorporated cities within the Snoqualmie Valley basin.[34] Later that year, the City adopted a general land use and development comprehensive plan, the City of Carnation 1996 General Comprehensive Plan,[35] which acknowledged the health concerns associated with the existing onsite septic systems and encouraged "pursuing a public sewer system that can adequately serve the needs of the City."[36] In May 2000, American Engineering Corporation (American) drafted an updated Comprehensive Sewer and Facilities Plan,[37] which was not approved by the City Council and therefore not submitted to Ecology for approval. The draft plan proposed a new sewage collection system that used grinder pumps and low-pressure force mains and a new CWWTF that used the extended-aeration activated sludge process. American recommended that the new CWWTF be sited on a ten acre parcel located west of the downtown business district (between the downtown business district and the Tolt MacDonald Park [also known as the Tolt River – MacDonald Memorial Park]), and two discharge alternatives were provided for the treated effluent: discharge to the Snoqualmie River or discharge upland.[38]

In 2002, the City tasked Roth Hill Engineering Partners (Roth Hill) to prepare another updated Comprehensive Sewer and Facilities Plan and to design a sewer conveyance system. The City accepted Roth Hill's recommendation to install a vacuum sewer collection system as the means of conveying the sewage to a central location within the City for treatment.[39] In April 2004, the City adopted the updated plan (readopted in October 2004).[40] The 2004 Comprehensive Sewer Plan was approved on January 31, 2005 by the Metropolitan King County Council (County Council) and enacted on February 9, 2005 through King County Ordinance 15116.

The executive summary of the 2004 Comprehensive Sewer Plan is included in Appendix A of this document. The 2004 Comprehensive Sewer Plan further develops cost projections and the implementation of a capital improvement program for sewer installation based on revised population projections for the City. In addition, the 2004 Comprehensive Sewer Plan acknowledges the City's steadily increasing population and growth management needs. The 2004 Comprehensive Sewer Plan also outlines the City's long-term wastewater management needs as they relate to current and projected city populations and establishes goals and policies that necessitate a CWWTF. These goals and policies were initially introduced in the 2000 Comprehensive Sewer and Facilities Plan and then developed further in subsequent ordinances adopted by the Carnation City Council (City Council) and

referenced in the 2004 Comprehensive Sewer Plan. This includes Ordinances 650 and 655, which specifically relate to the need for a CWWTF and were passed in 2003.

In September 2004, the City Council approved the draft Sewer Facilities Plan to implement the next phase of design.[41] The executive summary of the Sewer Facilities Plan, City review draft is included in Appendix B of this document. The Sewer Facilities Plan addresses the design, construction, and operation of a new vacuum sewer collection system. The City is in partnership with the County through an interlocal agreement to provide the design, construction, and operation of a local CWWTF.

The following documents list the previous studies, reports, and memoranda prepared, serving as a basis for this Facilities Plan.

- Adolfson Associates, Inc., Carnation Study Area On-site Sewage Disposal System. Alternative Needs Assessment. Draft. January 24, 1990.
- American Engineering Corporation, Draft City of Carnation Comprehensive Sewer and Facilities Plan, May 2000.
- Carollo Engineers, Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT, December 2004.
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- Carollo Engineers, Technical Memorandum No. 3 - Geotechnical Reconnaissance, 2003.
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- Carollo Engineers, Technical Memorandum No. 9 - Support Facilities, 2003.
- Carollo Engineers, Technical Memorandum No. 10 – Electrical, Instrumentation and Control Needs, 2004.
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- Wilson, Dean. Water Quality Planner, King County, Memorandum to King County Wastewater Treatment Division Project Manager Regarding *Alternatives for a Direct Discharge to the Snoqualmie River from the Proposed Carnation Wastewater Treatment Plant.* September 17, 2003.
- Wilson, Dean, King County Water and Land Resources Division, Memorandum to King County Wastewater Treatment Division Project Manager Regarding *Proposal for*

Habitat Enhancement Using Reclaimed Water from the Proposed Carnation Wastewater Treatment Plant Memorandum, October 1, 2003.

- Ken Ziebart, Washington Department of Ecology, e-mail message and attachment to Carollo Engineers, October 20, 2003.
- Ken Ziebart, Washington Department of Ecology, e-mail message and attachment to Carollo Engineers, February 3, 2005.

2.4 City of Carnation – King County Partnership

The County has had many years of experience in the design and operation of wastewater treatment facilities. In addition, the County has the staffing resources to undertake such a major capital improvement project, resources that the City does not possess. In 2002, the City and County developed a partnership to design, construct, and operate a local CWWTF. Negotiations between the two municipalities resulted in the County being contracted to design, build, operate, and take ownership of the resulting CWWTF. The City will own and maintain the sewer collection system up to the point of treatment. The CWWTF is scheduled to be operational by late 2007. The Agreement for Sewage Disposal between the City and the County is included in Appendix C of this document.

Negotiations between the County and the City to form a partnership for a design/build/operate (DBO) project began in 2001. At that time, HDR was tasked with performing an analysis of the American 2000 Comprehensive Sewer and Facilities Plan to evaluate the option of directly conveying untreated wastewater to an existing County wastewater interceptor as compared to constructing a new local CWWTF for the County. HDR concluded that constructing a local CWWTF was more cost-effective than conveying the sewage to an existing interceptor.[42] In 2003, the County tasked Carollo Engineers (Carollo) with planning, designing, and providing construction assistance for a new CWWTF. The County released a draft EIS of the treatment and discharge facilities for public review in June 2004 as part of the State Environmental Policy Act (SEPA) process.[43] Resulting comments from eight governmental agencies and 20 individuals or groups were addressed, and the final EIS was released in October 2004.[44]

2.5 Study Area

The 2004 Comprehensive Sewer Plan was developed in compliance with the Washington State Growth Management Act (GMA)[45] in order to guide future decisions related to land use, downtown development, housing, parks and recreation, transportation, utilities, and capital facilities. Passed in 1990, and last amended in 1997, the GMA requires the state's fastest growing counties, and the cities within them, to prepare general land use and development comprehensive plans. The City of Carnation is located within eastern King County, one of the state's fastest growing counties. In accordance with the GMA, the County is required to designate urban growth areas (UGA) within which urban growth will

be encouraged and outside of which growth can occur only if it is not urban in nature. The GMA further states that each city located in such a county will be included within a UGA. A UGA, as defined by GMA, includes compact development densities and urban facilities such as wastewater treatment facilities. The City Council adopted a Capital Facilities Element in the City of Carnation 1996 General Comprehensive Plan[46] that acknowledges the designation of the UGA. The City's UGA includes the area within the current city limits as well as three potential annexation areas.

The sewer and CWWTF service area is limited to the City boundaries at the present time, with the possibility of service to the remaining UGAs in the future.[47] The siting study area for the CWWTF was originally limited to areas within the city limits, but discharge locations for the highly treated effluent (herein referred to as highly treated water) were expanded based on the initial identification of a suitable area beyond the city limits. A 2.5-mile radius was selected as the study area boundary for the discharge location based on the professional judgment of the project team. Screening criteria were applied to this area to identify facility sites as detailed in Chapter 6. Study areas selected for detailed evaluation are presented in Figure 2.2.[48]

2.6 Selection of Siting Alternatives

The King County Geographic Information System (GIS) database and mapping to begin detailing the study area. This data was the main source of information for all site-screening processes, as detailed in Technical Memorandum (TM) No. 1.[49] Information from the County's Parcel Viewer application,[50] and County[51] and City[52] general land use and development comprehensive plans was also used. The Ecology water well database was searched for information about wells in the study area. Finally, Carollo used information from the Federal Emergency Management Agency (FEMA) to confirm floodway and floodway fringe boundaries provided in the County GIS database.

The study area includes the locations for a CWWTF, conveyance pipeline, and discharge structure. All project elements are located in or near city limits. The two CWWTF site alternatives selected for detailed evaluation are both within city limits and are located at: 1) the western end of Entwistle Street (the City-owned site), and 2) immediately east of the fire station (the Weckwerth site). Three discharge alternatives were selected for evaluation. The river outfall discharge alternative at the Carnation Farm Road Bridge (Bridge) was selected for evaluation in the EIS. However, the possibility of discharging the highly treated water into the Snoqualmie River near Tolt MacDonald Park was later evaluated as a possible cost-saving measure and is detailed in Chapter 7 of this document. The wetlands discharge alternative was located about two miles north of the City in the Stillwater Wildlife Area (SWA). The upland discharge alternative was located immediately southeast of the

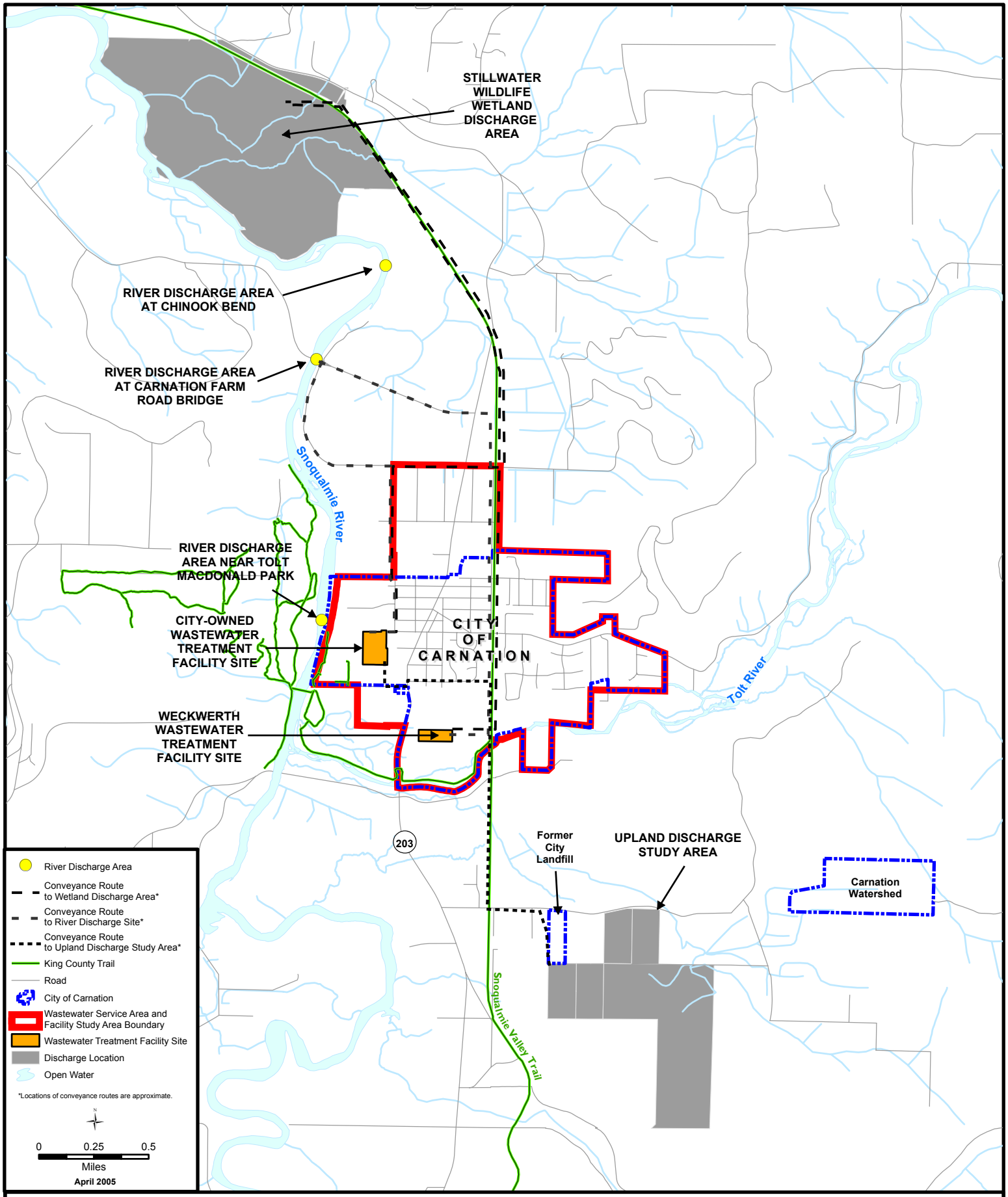

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Figure 2.2

Study Alternatives

CARNATION WASTEWATER TREATMENT FACILITY

former city landfill. Conveyance routes for all three alternatives mainly followed existing rights-of-way along City streets, County roads, and the Snoqualmie Valley Trail between the CWWTF and the discharge locations. The selection criteria and evaluation of alternatives are detailed in Chapter 6.

In Fall 2004, the King County Executive (Executive) selected the City-owned site for the CWWTF. Based on the environmental review and cost considerations, the Executive directed the County to carry forward the river outfall and wetlands discharge alternatives for further study. Although discharge to the SWA offers an opportunity for the use of reclaimed water from the CWWTF to enhance wildlife habitat, preliminary estimates indicate that the wetlands discharge alternative at SWA will cost approximately $2.2 million more than the river outfall discharge alternative at the Bridge. Design and permitting activities are proceeding with the river outfall discharge alternative but the County will continue to actively pursue potential partnerships and grants to make wetlands enhancement an environmental amenity and an economically viable reuse opportunity. Additional opportunities to enhance wetlands closer to the CWWTF are also currently being evaluated to beneficially provide habitats in a cost conscious manner. The CWWTF design flexibility will allow the facility to be easily retrofitted to meet reclaimed water standards,[53] should the County be interested in applying the highly treated water for reuse applications in the future. If the wetlands alternative becomes financially feasible, the County will prepare an amendment to the Facilities Plan, and complete permitting and environmental requirements such as impairment analysis.

2.7 Planning Period

The CWWTF planning horizon was based on the 2000 US Census data for households, population, and employment within the City's UGA. Planning estimates were developed in negotiations between the City and County in 2004 and presented in the 2004 Comprehensive Sewer Plan.[54] As part of this effort, planning populations were developed as summarized in Table 2.1.

Table 2.1 Projected Population Growth Estimates Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks			
Year and Milestone	**Projection Estimates**		
	Population	**Households**	**Employees**
2007 – CWWTF startup	2,185	733	634
2012 – Full sewer system[a]	3,816	1,281	809
2017 – Residential saturation[b]	3,871	1,300	1,254
2030 – Design year[c]	3,871	1,300	2,175

Notes:

a. End of the anticipated rapid increase in population (5% annual growth rate until the buildout density is reached) after the vacuum sewers are available.

b. The residential saturation was determined based on the buildout density of the residentially zoned land within the UGA.

c. References population projection for the ultimate design period. The cost-effective alternative analysis and selection is based on a 20-year planning period.

Source: Roth Hill Engineering Partners, LLC, *City of Carnation 2004 Sewer Facilities Plan*, *City Review Draft,* September 2004.

2.8 No Action Alternative Impact

Under the No Action Alternative, no wastewater collection or treatment facilities would be built, and thus, there would be no direct resource impacts due to construction or operation of a CWWTF. Wastewater would continue to be disposed by means of onsite septic systems. The probability that the onsite septic systems will fail appears to be relatively high in much of the City due to: 1) the criteria under which most of the existing systems were designed, and 2) the age of the systems. Risk to surface and groundwater quality (e.g., bacterial, viral, and contamination by nutrients, metals, and man-made compounds) would remain at present or increased levels. The diminished water quality could potentially result in the decreased availability of water-related recreational resources and could adversely affect biological resources of the Snoqualmie Valley over time.

The No Action Alternative fails to meet the adopted City of Carnation 1996 General Comprehensive Plan goals and policies for managing growth in compliance with the GMA.[55] The City cannot achieve their targeted urban densities due to the large corresponding areas necessary for onsite drain fields. The developed areas of the City already face severe land development restrictions due to Public Health – Seattle & King County (Public Health), formerly known as the Seattle-King County Department of Public Health (SKCDPH), code requirements for onsite wastewater treatment. These requirements would continue to restrict redevelopment and new development in the downtown area if no action is taken. Public Health requirements would likely require the City to continue limiting some

development and possibly impose a moratorium on all new development. The ability of the City to meet its density targets and provide urban levels of service would be severely hampered under the No Action Alternative.

Public Health has estimated that approximately 50 percent of the disposal systems within the City involve the use of sumps or drywells.[56] In 1988, Public Health declared the City a public health hazard area based on the number of inadequate septic systems and the likely contamination of the unprotected aquifer from which drinking water is derived.[57] A recent Public Health letter stated, “Since this 1987 declaration little has changed in regards to the disposal-only septic systems and their potential to contaminate groundwater.”[58] On September 28, 2005, the Health Department issued a letter that indicates that due to continued public exposure to surfacing sewage and untreated sewage entering the groundwater aquifer, current on-site sewage disposal practices in the City of Carnation are clearly inadequate and present a severe public health hazard to the community. Additional information has been added regarding the documented concerns and steps taken by the agency. A copy of the most recent correspondence from Public Health is provided as Appendix D of this plan. Copies of the previous letters can be found in Appendix C of the EIS.

Possible adverse impacts during construction of the treatment, conveyance, and discharge facilities that would be avoided under the No Action Alternative include additional noise, traffic, dust, odors, erosion and sedimentation, runoff, and light, as well as potential chemical leaks or spills. Operation of the CWWTF would slightly increase the noise and traffic levels and potentially produce odors, stormwater runoff, and the remote possibility of a partially treated wastewater or chemical spill. Maintaining the existing septic service in the City would decrease the possibility that humans and animals would be exposed (via skin contact) to the treated water.

2.9 Project Chronology

Table 2.2 summarizes the decision process milestones to date.

Table 2.2 Decision Process Milestones
Carnation Wastewater Treatment Facility
King County Department of Natural Resource and Parks

Decision Date	Decision Summary
June 18, 2002	The City Council passes a resolution approving an interlocal agreement for sewage disposal with County.
January 2003	City Council and County jointly form a Citizen's Advisory Committee (CAC) to support siting of the treatment facility and evaluation of discharge options.
July 1, 2003	City Council passes a resolution approving the siting criteria and process developed by the CAC. • Treatment facility sites within the UGA were considered. • Discharge options within 2.5 miles of the City were considered: – Upland discharge study area south of the City and Tolt River. – River outfall study areas at three locations: Chinook Bend, the Bridge, and the Park.
July 28, 2003	County issues 30-day public notice and request for comments on the scope of the EIS. A public EIS scoping meeting is held on August 6, 2003. • Two treatment facility sites (City-owned and Weckwerth) were proposed. • Two discharge options were proposed: – Upland discharge sites near former City landfill. – River outfall on east side of Chinook Bend.
October 7, 2003	City Council passes Resolution No. 288 approving the treatment facility sites and discharge options to be evaluated in the Draft EIS. • Two treatment facility sites (City-owned and Weckwerth) were selected. • Three discharge options were selected, based on public input: – Upland discharge study area near former City landfill. – River outfall at the Bridge. – Wetland enhancement at SWA.

Table 2.2 Decision Process Milestones Carnation Wastewater Treatment Facility King County Department of Natural Resource and Parks	
Decision Date	**Decision Summary**
April 20, 2004	City Council Resolution No. 291 approving the decision process and environmental review strategy for selecting a treatment facility site, discharge option, and conveyance route. • Cost, engineering, environmental, community and policy criteria will be considered.
June 28, 2004	County issues the Draft EIS for 30-day public comment. A public hearing is held on July 14, 2004.
August 5, 2004	City Council is briefed on preliminary evaluation of decision factors.
September 2004	County issues Final EIS. The Final EIS does not recommend a preferred alternative.
September 9, 2004	City and County hold a public meeting to share decision process, criteria and preliminary results.
October 19, 2004	City Council is briefed on the staff recommendation on the treatment facility site, discharge options, and conveyance route.
November 2, 2004	City Council passes Resolution No. 297 accepting the staff recommendation on the treatment facility site, discharge options, and conveyance route. • The City-owned site west of the business district was selected for the treatment facility. • Upland discharge was dropped. • River outfall at the Bridge and wetland discharge at SWA would be further evaluated.
December 10, 2004	Executive sends a letter to City Mayor, concurring with the City Council's recommendation. The Executive stated, "Since the estimated cost of the wetland alternative is considerably higher than a river outfall, we will seek grant funding for implementing the alternative. If we cannot obtain adequate funding, the County will begin designing the river outfall in April 2005."

Table 2.2 Decision Process Milestones Carnation Wastewater Treatment Facility King County Department of Natural Resource and Parks	
Decision Date	**Decision Summary**
April 12, 2005	County staff briefed the City Council on its progress on obtaining funding for wetland discharge. • The County is moving forward with design and permitting a river outfall at the Bridge to meet its commitments to the City. • The County will continue to pursue funding for a future wetland in a second phase. A wetland at the SWA and other options closer to the treatment facility will be considered.

Notes:

Bridge	Carnation Farm Road Bridge
CAC	Citizen's Advisory Committee
EIS	Environmental Impact Statement
Executive	King County Executive
Park	Tolt MacDonald Park
SWA	Stillwater Wildlife Area
UGA	Urban Growth Area

Notes

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3.0 EXISTING ENVIRONMENT

The City of Carnation is a small community at the confluence of the Tolt and Snoqualmie Rivers in eastern King County. The City lies within the Puget Sound lowlands, where climate is greatly influenced by the Pacific Ocean, the Cascade and Olympic mountain ranges, and weather patterns. The Puget Sound basin has a mild, modified marine climate characterized by cloudy, cool, wet winters and relatively dry, mild summers. Temperatures are generally moderate with few extremely cold or hot days throughout the year.[59] Much of the information in this chapter has been summarized or directly excerpted from the information compiled for and presented in the EIS.[60]

3.1 Population

Historical population estimates were presented in the 2004 Comprehensive Sewer Plan.[61] In addition to listing total populations, the 2004 Comprehensive Sewer Plan provides separate population estimates for each basin within the city limits as well as for the PAA. Historical population data for the City are summarized in Table 3.1.

Table 3.1 Historical Population Estimates
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Years	Historical Population Estimates	Estimated Growth per Year (%)
1981-1990	951 to 1,243	2.91
1991-2000	1,272 to 1,893	4.32

3.2 Existing Wastewater Collection and Treatment Facilities

3.2.1 City of Carnation

The City has historically used onsite septic systems as the sole method of wastewater treatment and disposal. Although many of the septic systems have been upgraded to septic tanks and drain fields, some cesspools and seepage pits are still in use. Public documents indicate that aging infrastructure and a lack of available drain fields have become areas of particular concern with regard to public health.[62,63,64] These concerns are based on the failure of some business and residential onsite septic systems, as well as changes in onsite septic system regulations.

3.2.2 Surrounding Cities

Within the greater Snoqualmie Valley, the incorporated Cities of North Bend, Snoqualmie, and Duvall and the Echo Glen Children's Center collect and treat wastewater at central facilities.[65]

The City of North Bend has a wastewater collection system that is currently rated for a maximum wet weather flow of 1.2 million gallons per day (mgd). The domestic wastewater is treated by pumping it to the head of the facility and processing the wastewater using a comminutor, aerated grit chamber, oxidation ditch, and secondary clarifier, followed by ultraviolet (UV) disinfection prior to discharge to the Snoqualmie River. The wasted solids from the secondary clarifier are thickened by gravity and transported to the City of Edmonds wastewater treatment facility for further processing.

The City of Snoqualmie currently has an oxidation ditch treatment system for the advanced removal of organic material, solids, and nutrients. The wastewater (2.15-mgd peak flow) is pumped through a set of screens, a grit chamber, and an oxidation ditch with selectors, followed by secondary treatment, tertiary filtration with chemical addition, and UV disinfection. The highly treated water is discharged to the Snoqualmie River or used as irrigation water for landscaping and a golf course.

The City of Duvall has a wastewater treatment facility that treats the domestic wastewater by gravity through a set of fine screens, an oxidation ditch, and secondary clarifiers prior to UV disinfection. Duvall is upgrading and expanding the facility to add an aerated grit chamber, second set of fine screens, and membrane bioreactors (MBRs) to provide up to 4-mgd flow capacity. An equalization basin will allow the facility to be able to handle up to 5.25 mgd. The upgraded facility is expected to be operational by July 2005 and will handle the solids through aerobic digestion and use of a belt filter press.

3.3 Surrounding Environmental Sensitivity

3.3.1 Special-Status Plant and Wildlife Species

As presented in Chapter 7 of the EIS,[66] special-status species include those classified as endangered, threatened, sensitive, or candidate by the Washington Department of Fish and Wildlife (WDFW), as well as species classified as endangered, threatened, candidate, proposed, or species of concern by the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service – National Oceanic and Atmospheric Administration (NOAA). Documented special-status species include Chinook and coho salmon, bull trout, bald eagles, great blue and green herons, osprey, and bog clubmoss. Other special-status terrestrial species listed by the USFWS and/or WDFW may be present but have not been mapped by WDFW within two miles of the two potential treatment facility sites. These species are not specifically addressed because of the low potential for them to be affected by construction or operation of the CWWTF.

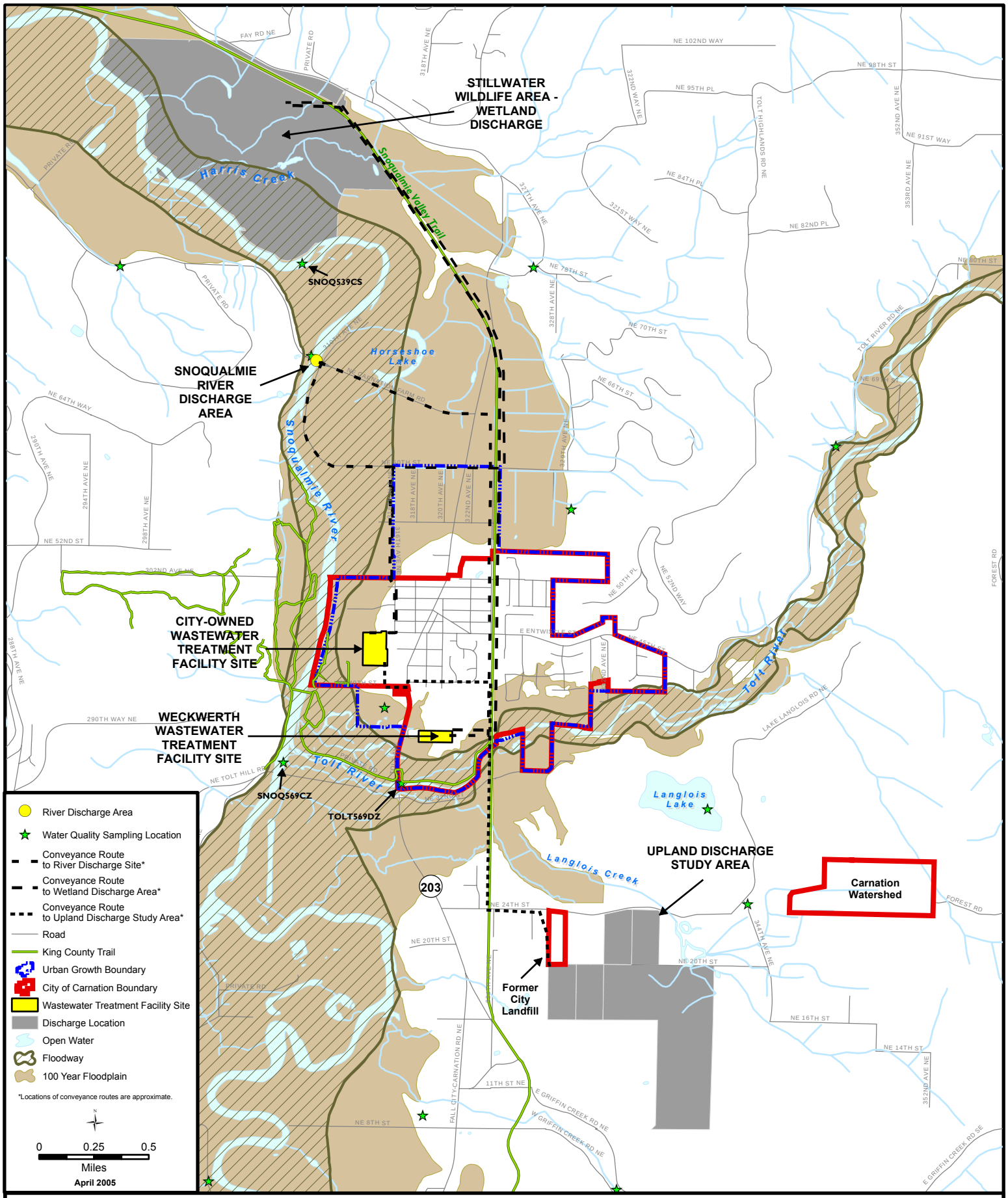
No federally or state-listed special-status species or priority habitats have been mapped by the federal government or WDFW within the boundaries of the City-owned site. The site is more than one mile from the documented occurrences of special-status bird species. The site is within a larger general area where bog clubmoss, a state-sensitive species, has previously been documented. Mapped priority habitats (riparian areas and wetlands associated with the Snoqualmie River) are located offsite to the west.

3.3.2 Floodplains and Floodways

The Snoqualmie and Tolt River regulatory floodways and 100-year floodplains were reviewed in relation to the proposed CWWTF footprint, conveyance route, and evaluated river outfall discharge areas. Floodway and floodplain mapping is based on the FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs). The maps identify which properties are subject to floodplain regulations. Figure 3.1[67] shows a graphical representation of the existing floodway and floodplain areas using County GIS data.

The County GIS data indicates that the ten acre City-owned property proposed for the CWWTF site is approximately 70 percent within the 100-year floodplain. Detailed surveying was completed in December 2004 to update the elevation contours within the proposed site. Ground elevation at the City-owned site ranges approximately between 66 and 74 feet (North American Vertical Datum [NAVD] 1988) with the 100-year floodplain elevation at 72.6 feet. City building codes require building setbacks of 25 feet from the east property line and 30 feet from the north property line. Building setback limits and floodplain limits restrict the area available to site the treatment facility structures to a triangular area of approximately 0.6 acre. The preliminary CWWTF layout indicated that the structural footprint would have fit within the restricted area of the site, outside of the current 100-year floodplain. Hence, floodplain review of the facility was not initially required. As presented in Chapter 6 of the EIS,[68] outfall conveyance and discharge to the river will operate below the surface and therefore were not anticipated to impact the flood storage area or the County floodway and floodway fringes.

However, the County, in collaboration with FEMA and Snohomish County, has begun work on the Lower Snoqualmie and Skykomish River Flood Study. The study will update flood hazard maps for the lower Snoqualmie River as part of a FEMA Map Modernization Program. The project schedule calls for the draft maps to be prepared by mid-2005, preliminary FIRMs in 2006, and official FIRMs in 2007.[69] According to the draft map provided by the County on June 27, 2005, the 100-year flood elevation around the CWWTF facility site is proposed to be set at 74.11 feet (NAVD 88) and the 500-year flood elevation is at 75.60 feet (NAVD 88). This would place the sited facility entirely within the 100-year floodplain.



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

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Data Source: King County GIS

Figure 3.1

Floodways and Floodplains

CARNATION WASTEWATER TREATMENT FACILITY

According to the City's municipal code 15.64.050, "critical facilities constructed within the Special Flood Hazard Area (SFHA) (100-year floodplain) shall have the lowest floor elevated three feet or to the height of the 500-year flood, whichever is higher".[70] It is also sound engineering judgment to insure that the treatment facility remains fully operational during a 100-year flood event.[71] Assuming that the next revision to the FIRM document would be no more conservative than the draft map elevations, City code would dictate that the floor slabs be set at a minimum of 77.11 feet (three feet above the proposed 100-year floodplain elevation). Initial discussions with both the City's planner and County staff agree on the interpretation of the code's intent. To comply with this requirement, the lowest floor elevation for the CWWTF was revised to be at an elevation of 77.20 feet. In addition, the City's municipal code requires that access to and from the facility should be protected from flooding at the same elevation and access routes around the facility be protected to the extent possible.

3.3.3 Wetlands

The Snoqualmie Valley is part of the Pacific avian flyway route, providing stopover habitats for migratory birds as well as serving as habitat for many native species of wildlife. Within the initial discharge study area (as defined in Figure 2.1), the SWA consists of natural wetlands within the elevation range of a shallow groundwater regime. The SWA is situated on the floodplain of the Snoqualmie River, east of the river and southwest of the valley wall. The floodplain on which the site is situated can be described as a generally flat plain incised by remnant abandoned channel segments or oxbows. During non-flood conditions, surface water enters the floodplain area from the upland area to the northeast as flow from Harris Creek, an unnamed stream, and from various smaller and intermittent surface water drainages. Though groundwater is assumed to flow into the valley from the uplands, there is no observable manifestation of groundwater discharge on or around the SWA site. Three oxbow features dominate the site with a fourth feature, which is either shallower or more filled with sediments or organic material than the others, occupying part of the northwestern portion of the site. The oxbows and swales originate from historical migrations of the Snoqualmie River.

Previous discussions with regulatory agencies and special-interest groups have indicated that the supply of highly treated water from the CWWTF could provide a unique opportunity to restore natural wetlands in the SWA. Owned and managed by the WDFW, the SWA is approximately 540 acres and currently serves as public land for recreational use, including hunting. In the past, the area was used for tenant farming. The northern part of the area contains a number of fields, which could continue to serve as a viable agricultural production area. Most of the area south of Harris Creek has been overgrown, effectively cutting off access routes to farmers. It is bordered to the south by privately owned properties, to the west by the Snoqualmie River, to the north by the King County Stillwater Natural Area, and to the northeast by Highway 203 (Carnation-Duvall Road NE). Natural berms create favorable landscapes for complex communities of wildlife and microhabitats.

A number of invasive species, including reed canary grass, blackberries, and a number of conifer trees have infiltrated the area.

3.4 Potable Water

The City's main potable water supply is a 380-gallon-per-minute (gpm) capacity, gravity-fed natural spring, located to the southwest of the city limits. The existing water system also includes a well with a 700-gpm capacity serving as a backup source located within the city limits, a storage reservoir, and transmission/distribution mains. The City's current water pumping capacity is estimated to have sufficient capacity to satisfy the projected growth beyond the 2030 wastewater treatment facility design year. At present, the spring supplies approximately 90 percent of the City's daily water demand. Potable water from the spring is directed to an intake structure and chlorinated (the water from the well is not chlorinated) and conveyed to the central distribution system. As both the well and the springs utilize the same distribution system, the overall distribution system maintains a residual chlorine content. [72] In addition, a number of residents both within and outside of the UGA use private wells.[73] None of the well logs on file with Ecology indicate that water is being withdrawn from the shallowest groundwater regime. Instead, all water appears to be drawn from deeper aquifers.[74]

3.5 Hydrogeology

Located within the East King County Groundwater Management Area, most of the valley surrounding the City is designated as a critical aquifer recharge area.[75] The GMA[76] requires the establishment of developmental regulations to protect recognized critical areas. As such, the County approved a critical aquifer recharge ordinance (Ordinance 15051) in October 2004. Figure 3.2 indicates that the entire area around the City is highly susceptible to groundwater contamination.[77] The groundwater table in the UGA is estimated to be relatively shallow, generally five to ten feet below the ground surface. East of the UGA, the shallow groundwater regime is generally deeper at 15 to 20 feet below ground surface. The King County Soil Survey[78] indicates that seasonally high water tables in the floodplain area are approximately one to three feet below ground surface, likely a result of increased precipitation.[79]

The upper soils within areas of the City are suitable for infiltration. Those areas identified have a surface geology dominated by recessional outwash gravels and related soil types. The recessional deposits are, in turn, underlain by thin, possibly discontinuous till deposits. These are in turn underlain by pre-Vashon silt and clay deposits. Well logs examined for wells in this area indicate that Vashon advance deposits are locally absent. Till and pre-Vashon deposits act similarly to impede vertical groundwater flow.

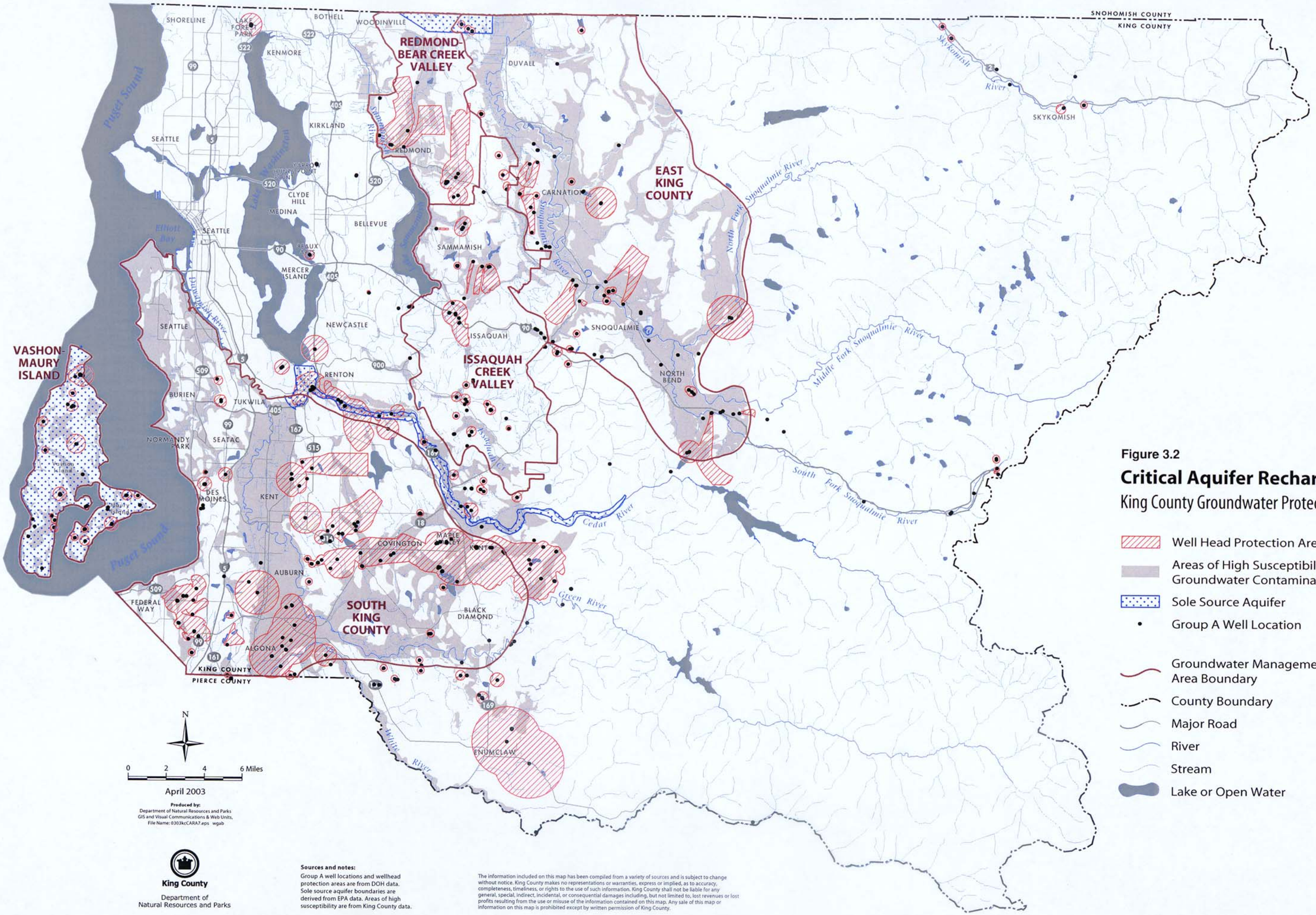


Figure 3.2

Critical Aquifer Recharge Areas

King County Groundwater Protection Program

- Well Head Protection Area
- Areas of High Susceptibility to Groundwater Contamination
- Sole Source Aquifer
- Group A Well Location
- Groundwater Management Area Boundary
- County Boundary
- Major Road
- River
- Stream
- Lake or Open Water

Recharge to this area occurs primarily through direct precipitation. Precipitation typically infiltrates quickly into the subsurface in areas where recessional outwash gravels and materials is at the surface. Additional recharge to the recessional outwash-covered area is also derived from surface runoff and shallow subsurface flow moving downgradient from higher elevations. Initially, the major component of infiltrating water moves vertically downward through the recessional materials until it reaches the base of the unit. Once the water encounters the lower-permeability till and clay units, it saturates the recessional sediments until it has generated a sufficient gradient to cause the water to flow laterally through the more permeable sediments downgradient to the floodplain area, eventually discharging to either the Tolt or Snoqualmie Rivers.

The septic system drain fields that currently serve the City's sewage needs release water to the ground, which also provides some recharge to the shallow groundwater regime. The drain fields recharge the shallow groundwater regime, although downward seepage ultimately reaches the lower confined aquifer. In addition to the downward seepage, the shallow groundwater regime likely discharges to local streams and wetlands.

The near-surface geology in the SWA is dominated by silt and clay deposits and underlain by presumably more permeable fluvial deposits from the Snoqualmie River. Little surface water and groundwater interaction is expected due to the presence of low-permeability sediments at the surface.[80] Surface water entering the area through stream flow or precipitation does not likely reach groundwater, and it is unlikely that there is considerable upward transfer of water in the area.

3.6 Surface Water

3.6.1 Snoqualmie River

The major surface water body in the initial discharge study area is the Snoqualmie River, which defines the western edge of the City and generally flows from the southeast to northwest. The Snoqualmie River, part of the Snohomish watershed, joins the Skykomish River to form the Snohomish River. The upper drainage basin is mainly forestland managed by the U.S. Forest Service (USFS) or private entities, along with commercial and residential pockets of development. Population centers and mixed agricultural uses such as dairies, berry fields, pastures, and row crops are numerous throughout the lower valley.[81] Snoqualmie Falls, located 17 miles upstream of the City at River Mile (RM) 40.4, is a predominant feature of the river.

The Snoqualmie River system is highly valued for its recreational, aquatic habitat, and domestic water supply uses.[82] Documented salmonid species in the lower Snoqualmie River include Chinook, chum, coho, pink, and sockeye salmon; mountain whitefish, steelhead (winter and summer); and bull, cutthroat, and rainbow trout.[83] Typical summer

activities on the Snoqualmie River include inner-tubing, canoeing, swimming, and the use of small watercraft.

As presented in Chapter 6 of the EIS,[84] the Snoqualmie River near the City is reported by U.S. Geological Survey (USGS) to have a mean annual flow of over 3,700 cubic feet per second (cfs) and winter peak flows of over 15,500 cfs. Since 1930, the USGS has maintained a stream flow gauging station (Number 1214900) near the City at RM 23.0. Based on 73 years of records, the average discharge at this station is 3,738 cfs, with a maximum discharge of 65,200 cfs recorded on November 24, 1990, and a minimum discharge of 239 cfs recorded on August 21, 1945.[85] Historically, most of the major floods in the Snoqualmie River have occurred between the months of November and February. Under the existing surface water quality regulation, the Snoqualmie River is designated as "Salmon and Trout Spawning, Core Rearing, and Migration for extraordinary primary contact recreation" (formerly Class A) waters from RM 9.1 to the headwaters of the South Fork.[86] The headwaters mainly originate from the Alpine Lakes Wilderness in the central Cascade Mountains,[87] east of the City. Portions of the Snoqualmie River are included on the 1998 list of impaired water bodies for temperature and pH.[88] Historical water quality data for the Snoqualmie River have indicated previous violations of the former "Class A" Surface Water standards[89] for dissolved oxygen, pH, and fecal coliform bacteria.[90] Agricultural, residential, and silvicultural areas have been documented as nonpoint sources of pollutants throughout the lower Snoqualmie River system.[91]

3.6.2 Tolt River

As presented in Chapter 6 of the EIS,[92] the Tolt River, which drains a 101-square-mile basin, is the largest tributary to the lower Snoqualmie River. The Tolt River enters the Snoqualmie River just south of the City at RM 24.9. The upper reaches of the Tolt River watershed are forestland. The Tolt River watershed is sparsely developed with roads and residences.[93]

The County collected water quality samples from the Snoqualmie and Tolt Rivers from February 2003 to January 2004 as part of the CWWTF project to further assess ambient water quality conditions.[94] Monthly samples were collected at three river locations and tested for pH, dissolved oxygen, temperature, ammonia, ortho-phosphorus, total phosphorus, total suspended solids (TSS), turbidity, and bacteria. Testing results from these samples indicate that pH did not meet the minimum "Salmon and Trout Spawning, Core Rearing, and Migration for extraordinary primary contact recreation" water quality standard of 6.5 to 8.5 pH on some occasions. Dissolved oxygen, ammonia, fecal coliform bacteria, and turbidity met state water quality standards on all occasions. "Salmon and Trout Spawning, Core Rearing, and Migration for extraordinary primary contact recreation" water quality standards do not exist for ortho-phosphorus and TSS. Water quality samples were also collected quarterly at the three stations and tested for trace metals and trace organics. Testing results from these samples reveal low levels for both total and dissolved metals, many of which were at or below the method detection limit (MDL) or the reporting

detection limit (RDL), and most of the organics were at or below the MDL. These levels were all well below water quality standards or aquatic effects thresholds, indicating that the river continues to be consistent with its use designation. The concentration ranges for the samples collected are summarized in Table 3.2.

3.6.3 Harris Creek

Harris Creek enters the Snoqualmie River from the east at RM 21.3.[95] Riparian conditions within the lower reaches are considered good to fair with a fairly natural shoreline.[96] Harris Creek is a classic small Coho stream with good spawning productivity. Other fish species that use the creek include Chinook salmon, chum salmon, winter steelhead, and cutthroat trout.[97]

The surface water in the area is monitored as part of the County's gauging station network. The Harris Creek gauge, upstream of the SWA, shows an annual minimum daily base flow discharge of 0.41 and 0.14 cfs for the 2002 and 2003 water years, respectively.[98] Wet-season mean daily flows are generally around 50 cfs with peak flows of over 400 cfs. Using similar base characteristics, the average flow of the approximately two-square-mile catchment associated with the unnamed creek immediately north of Harris Creek should be approximately 10 cfs.[99]

3.7 Soils

As reported in Chapter 4 of the EIS,[100] the City is situated near the eastern edge of the Puget Sound Lowlands. This regional basin is generally trough-shaped and trends approximately north-south between the Olympic and Cascade mountain ranges. Within the study area, Tertiary-age bedrock (alternating sequence of glacial and interglacial sediments) is interpreted to occur between 200 and 400 feet below the surface and outcrops at the surface less than three miles to the east.[101]

The King County Soil Survey[102] generally classifies soils in the area as part of a group of soils known as the Oridia-Seattle-Woodinville Association.[103] This soil group occurs in major stream valleys or nearby level areas. Major soil types within this group include Oridia soils, Seattle soils, and Woodinville soils. Minor soils in the group include Briscot, Edgewick, Newberg, Nooksack, Pilchuck, Puget, Puyallup, Renton, Si, Sultan, Snohomish, Shalcar and Tukwila soils. In general, soils in the Oridia-Seattle-Woodinville Association are well-suited for farming and pasture. However, poor drainage and a seasonal high water table result in moderate to severe limitations for urban development. Geologic units present at effective depths within the study area are composed exclusively of unconsolidated sediments and can be subdivided into three general categories, from youngest to oldest: 1) recent alluvium associated with local rivers, 2) deposits of the Vashon Glaciation, and 3) pre-Vashon non-glacial or transitional deposits.[104]

Table 3.2 Concentration Ranges for Samples Collected on the Snoqualmie and Tolt Rivers Near Carnation from February 2003 to January 2004
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Units[a]	Sampling Location		
		Snoqualmie River, Chinook Bend	Snoqualmie River, Upstream of Tolt	Tolt River, Upstream of Snoqualmie[)]
Turbidity	ntu	.81 to 13.7	0.91 to 9.04	0.69 to 27.2
TSS	mg/L	23.3 to 1	0.6 to 20.1	< 1 to 44.6
Fecal coliform bacteria	CFU/100mL	2 to 21	3 to 68	0 to 50
pH	pH	6.3 to 7.1	6.1 to 6.9	6.6 to 7.7
Dissolved oxygen	mg/L	9.2 to 13.1	8.5 to 12.3	10.5 to 14.1
Ammonia-N	mg/L	< 0.01 to .017	< 0.01 to .015	< .01 to .011
Phosphorus, total	mg/L	.023 to .0067	.007 to .0235	< .002 to .024
Ortho-phosphorus	mg/L	< .002 to .0043	< .002 to .0049	< .002 to .0123
Arsenic, total	mg/L	.00095 to .0013	.0011 to .0014	< .0005
Arsenic, dissolved	mg/L	.00058 to .00096	.00065 to .0012	< .0005
Copper, total	mg/L	.00061 to .0013	.0006 to .00201	.00043 to .00436
Copper, dissolved	mg/L	< .0004 to .00063	.0004 to .0008	< .0004 to .00081
Cadmium, total	mg/L	< .0001	< .0001	< .0001
Cadmium, dissolved	mg/L	< .0001	< .0001	< .0001
Chromium, total	mg/L	< .0004 to .0015	< .0004 to .0014	< .0004 to .00249
Chromium, dissolved	mg/L	< .0004	< .0004	< .0004
Lead, total	mg/L	< .0002 to .00029	< .0002 to .00029	< .0002 to .00051
Lead, dissolved	mg/L	< .0002	< .0002	< .0002
Mercury, total	mg/L	< .000005	< .000005	< .000005 to .0000093
Mercury, dissolved	mg/L	< .000005	< .000005	< .000005
Nickel, total	mg/L	< .0003 to .0014	< .0003 to .0013	< .0003 to .00214
Nickel, dissolved	mg/L	< .0003	< .0003	< .0003
Zinc, total	mg/L	< .0005 to .0021	< .0005 to .0021	< .0005 to .00394
Zinc, dissolved	mg/L	< .0005	< .0005	< .0005

CFU = colony forming units
mg/L = milligrams per liter
mL = milliliter
ntu = nephelometric turbidity units

a. Conventional parameters were collected on a monthly basis; 12 samples are reported. Metals were collected quarterly; 4 samples are reported.

Source: King County Department of Natural Resources and Parks, Water and Land Resources Division, *Draft Existing Water Quality Conditions in the Snoqualmie River near the City of Carnation: 2003-2004 Monitoring Results*, February 2005.

Recent alluvium (Qal) includes fluvial materials deposited on present-day floodplains and adjacent to the major streams in the area. Grain size and associated permeability of the Qal are variable within the study area, ranging from low-permeability clay and silt in floodplain deposits, to coarser, high-permeability sand and gravel in deposits more closely associated with stream channels.

Vashon glacial deposits generally include the extensive sequence of glacial material deposited in the Puget Sound Lowland during the Vashon Stade of the Fraser Glaciation. These deposits are usually laid down by meltwater or deposited in-situ from the advancing Vashon glacier. This geologic unit is typically composed of compacted sand and gravel with variable amounts of silt. As such, deposits are usually highly impermeable and act to constrain groundwater flow. The thickest till deposits found in the area generally form caps on the tops of the hills in the higher upland areas. However, thin till-like deposits (likely lodgment till deposited directly below the advancing glacier) are indicated by well logs to be present within the shallow subsurface below the floodplain, and some lower deposits are also found in the initial upland discharge study area. Coarser materials were laid down by meltwater streams, and finer material was deposited in lakes or other still-water environments formed by or associated with the receding glacier. Due to the nature of the depositional mechanism in the study area (i.e., stagnating ice melting in place), the recessional deposits tend to be less sorted than the advance deposits within the primary area of interest. Inasmuch as they were not overridden by the glacier, they tend to be less compacted. Generally, the recessional deposits are moderately to highly permeable in comparison to the underlying till. Within the lower portions of the upland area (east of the Snoqualmie floodplain), recessional outwash accounts for much of the surficial geology and ranges in thickness from a thin veneer to several hundred feet.

Pre-Vashon interglacial or transitional deposits are the oldest sediments identified in the study area. The majority of these deposits consist of thick sequences of lower-permeability silts and clays interspersed with much thinner, discontinuous lenses of sand and gravel. The generally fine-grained nature of the unit indicates that it functions as an aquitard in the regional hydrogeology, impeding the vertical movement of groundwater from the Vashon outwash sediments to deeper groundwater regimes.

3.8 Land Use and Shoreline Areas

The Snoqualmie Valley has been shifting away from a historically natural resource-based economy (e.g., agriculture and forestry) toward one that is more retail and service oriented. Developing capital facilities and services, including wastewater facilities and services, to accommodate planned growth are integral to achieving the goals identified in the City of Carnation 1996 General Comprehensive Plan.[105] Recently, the industrial sector has more than doubled the amount of land it occupies within city limits.[106] The historical industrial lands consist mainly of older warehouse buildings. It is anticipated that much of the future commercial development will occur within the City's existing downtown area. The expansion

of the City's commercial base will depend on the provision of a sound wastewater treatment system that has the capacity to accommodate new development and will protect important sources of groundwater and surface water.

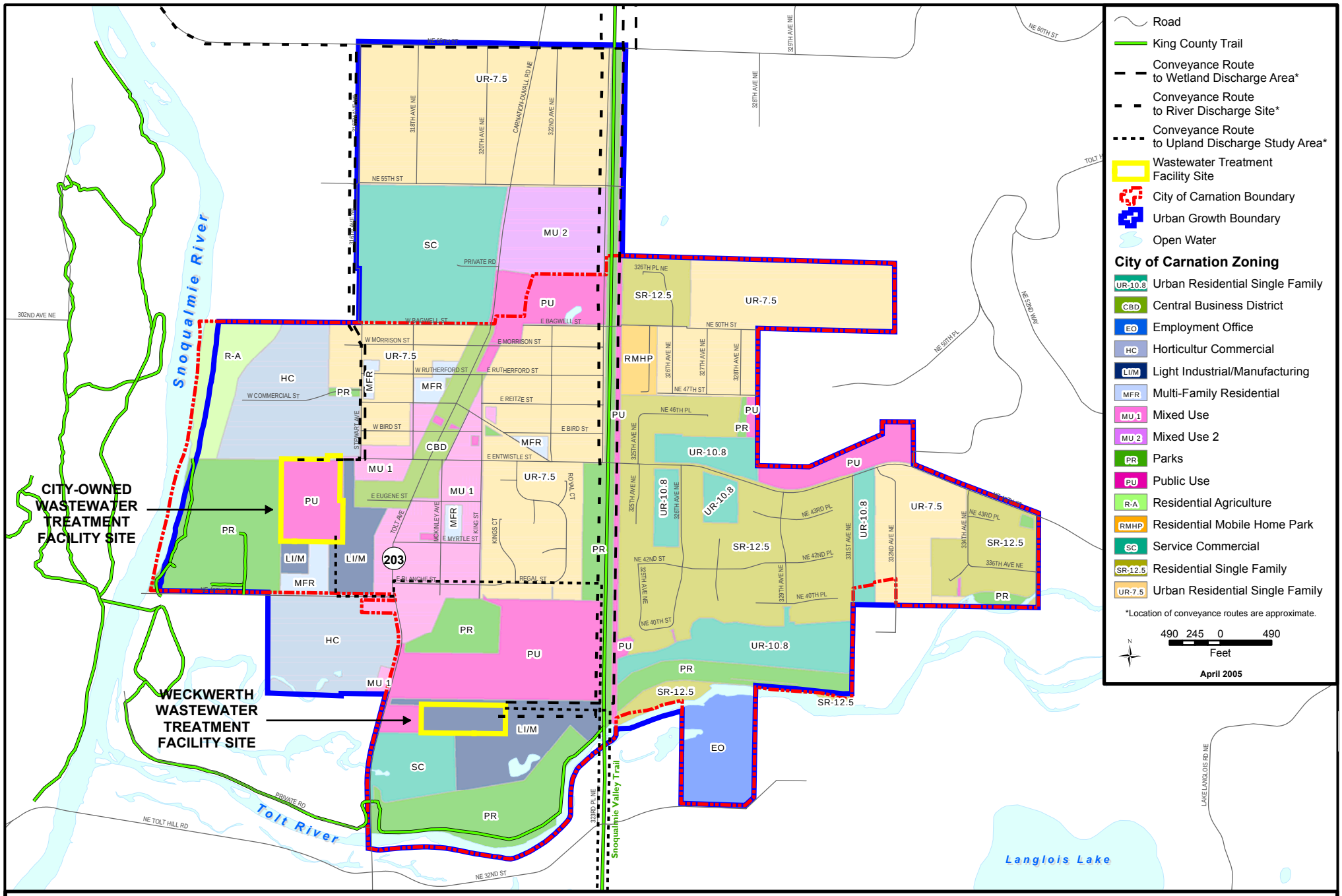
Figure 3.3[107] illustrates the current zoning designations within the City. Figure 3.4[108] illustrates the designated shoreline environment in the area surrounding the City.

3.9 Air Quality

As reported in Chapter 5 of the EIS,[109] the City lies within the Puget Sound airshed, where air quality is greatly influenced by urban development, the Pacific Ocean, the mountains, and weather patterns. When onshore airflow to the region is interrupted, the combination of urban activities, weather, and topography can lead to air stagnation and rising air pollution.[110] The average wind velocity within the Puget Sound Lowland is less than ten miles per hour (mph). The prevailing wind direction is primarily from the southwest during the wet season (winter) and north or northwest during the summer. Occasional severe winter storms produce strong northerly winds. Existing air quality in the City is typical of urban residential, commercial, rural, and agricultural areas. The proposed project is located in the eastern part of King County. This area is currently a "maintenance area" under the U.S. Environmental Protection Agency (EPA) classifications.[111] The standards for carbon monoxide and ozone have been violated in the past but are now being met and closely monitored under a State Implementation Plan (SIP) for attainment of air quality standards. The proposed treatment facility site lies within the carbon monoxide and ozone maintenance areas, and thus the facility will be subject to the requirements of the SIP.

3.10 Historic and Archaeological Sites

As reported in Chapter 13 of the EIS,[112] the study areas are within the hunter-fisher-gatherer territory of the Snoqualmie and Tulalip Tribes. A historical village that served as an administrative center for the Snoqualmie Tribe was located on the west bank of the Snoqualmie River near the confluence with the Tolt River. Evidence of this village and an associated burial ground area has been obliterated by successive flooding of the Snoqualmie River.[113] In the *Carnation Wastewater Treatment Facility Project EIS Cultural Resources Overview,* the report studied an area encompassing Sections 4, 5, 9, 10, 15, 16, 21, 22, and 27 of Township 25 North Range 7 East.[114] Eleven former areas occupied or used by hunter-fisher-gather peoples, such as villages and encampments and traditional were identified in the cultural resources overview. In addition, Government Land Office (GLO) records refer to the "Snoqualmie Trail," a trail that extends along the east bank of the Snoqualmie River. This trail may have been part of a well-established trail network that the Snoqualmie used to trade and socialize with neighboring tribes.[115]



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

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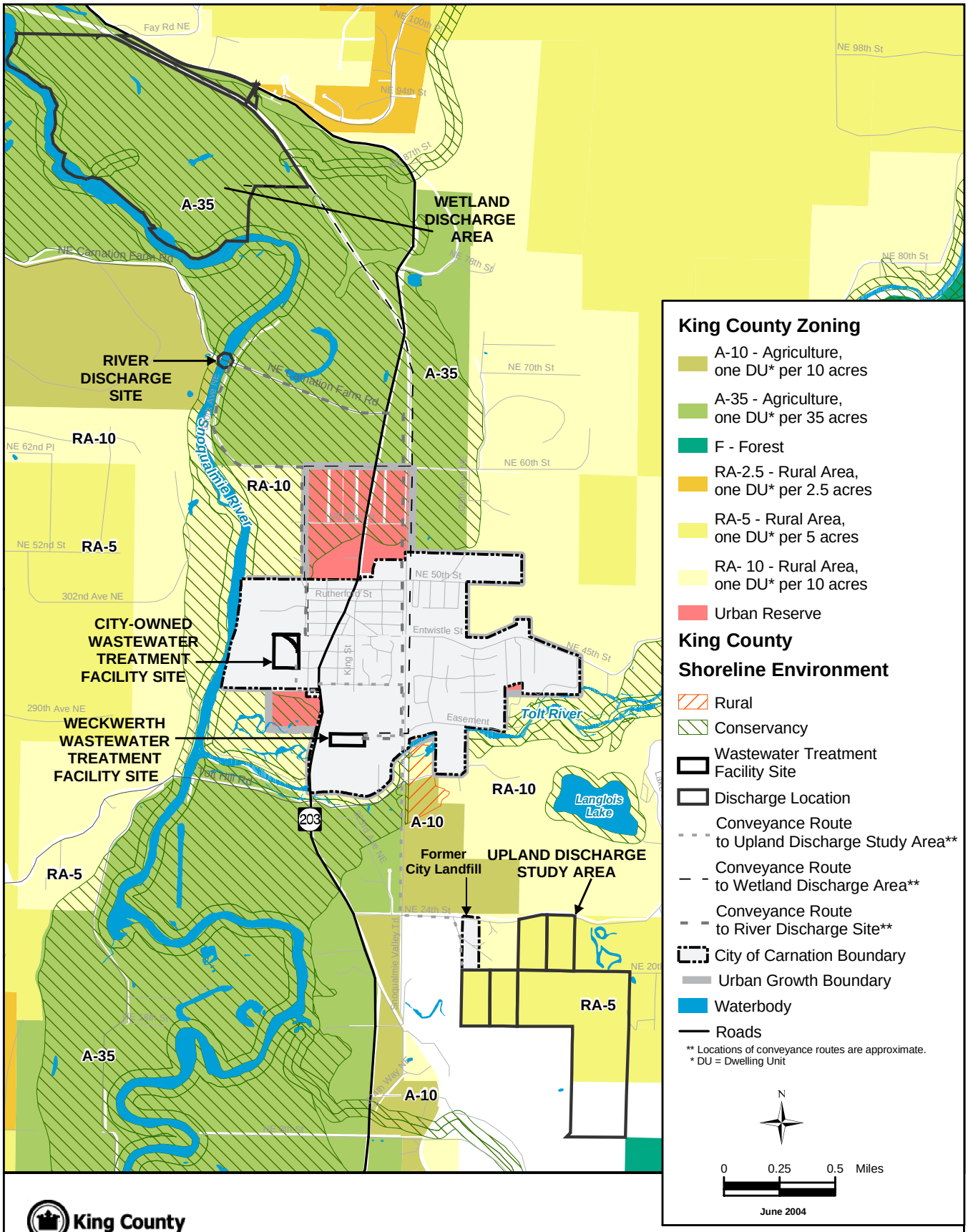
Data Source: King County GIS

Figure 3.3

City Zoning Areas

CARNATION WASTEWATER TREATMENT FACILITY



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Department of
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Wastewater Treatment Division

Figure 3.4

King County Zoning and Shoreline Designations
CARNATION WASTEWATER TREATMENT FACILITY

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Data Sources: King County GIS, 2003 **File Name:** L:\ENVIR IMPACTS\2003 Projects\23016 Carnation WWTP\GIS\KC&carnation_Zones.mxd 6/18/2004 cm **Prepared by:** King County WLR Visual Communications & Web Unit

The overall discharge study area in and around the City contains numerous sites and resources and in recent years has continued to reveal sites for excavation.[116] The Cultural Resources Overview reported at least 17 archaeological resources studies conducted within approximately two miles of their study area between 1980 and 2003.[117] Typical sites documented include hunter-fisher-gatherer sites on the Snoqualmie River floodplain, which suggests that additional intact archaeological deposits may be buried under relatively shallow deposits of alluvial soils, near abandoned channels or the confluences of rivers.[118]

Properties and structures listed on the National Register of Historic Places (NRHP), the Washington Heritage Register (formerly State Register of Historic Places), and/or the Register of King County Landmarks have been inventoried and evaluated for their local historical significance. The locations of these properties and structures in relation to the proposed CWWTF alternatives are shown on Figure 3.5.[119] A Cultural Resources Overview[120] also identified 14 other historic buildings (i.e., buildings more than 40 years old) that are within 50 feet of the conveyance alignments or near CWWTF and discharge site alternatives but are not identified in Figure 3.5. The EIS concluded that there would be no significant unavoidable adverse impacts to cultural resources at any of the site alternates or corridors investigated. All potential impacts are avoidable or can be mitigated.

No recorded archaeological sites listed on federal, state, or local registers are located on or immediately adjacent to the proposed CWWTF site. The site has a high probability for unrecorded hunter-fisher-gatherer, ethnographic period, and historic Indian period archaeological resources and a moderate to low probability for historic period archaeological resources. Shovel probe surveys that were conducted in 2004 and 2005 by professional archaeologists in conjunction with the monitoring of the geotechnical exploration during the CWWTF design process did not identify materials of cultural significance directly on the City-owned site. It is not anticipated that cultural or historical resources will be affected by construction or operation and maintenance of the CWWTF. As the project moves ahead, further survey work and or construction monitoring by a professional archeologist may occur on the City-owned site.

The proposed outfall conveyance pipe lies along a 1.6-mile-long route located almost entirely within previously disturbed rights-of-way. Two buildings (one of which has been historically inventoried) are located within 50 feet of the alignment and could potentially be affected by construction vibration. However, this type of construction activity rarely results in vibration levels that could cause structural damage to buildings.[121] Although no historical or culturally significant sites listed on federal, state, or local registers are located on or immediately adjacent to the proposed conveyance route, the route has a high probability for containing unrecorded hunter-fisher-gatherer, ethnographic period, and historic Indian period archaeological resources, and a low probability for historic period archaeological resources. It is possible that trench excavation below the depths previously disturbed material may encounter archaeological resources.

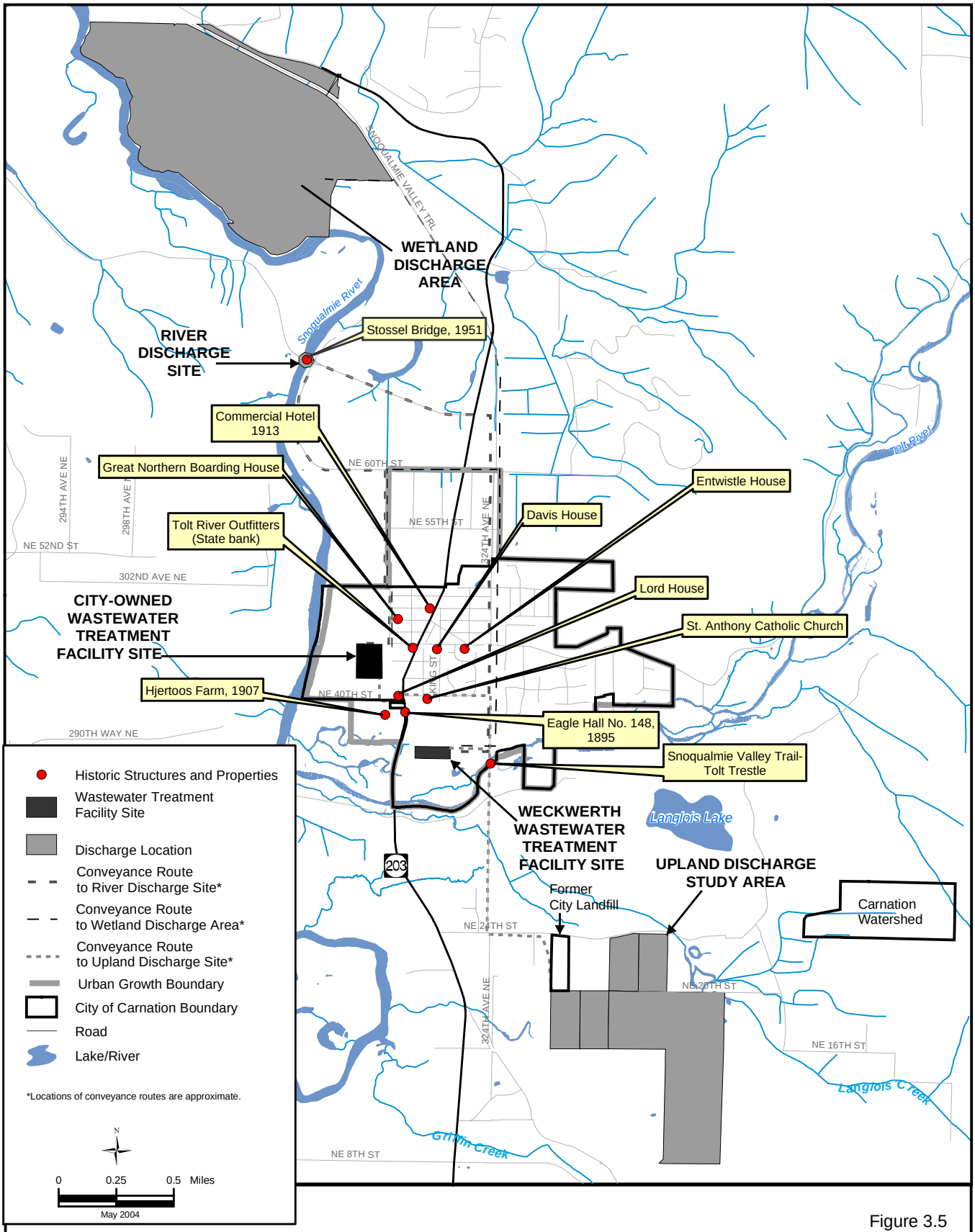

Figure 3.5

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

Historic Structures and Properties

CARNATION WASTEWATER TREATMENT FACILITY

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Data Sources: King County GIS, 2003 **File Name:** L:\ENVIR IMPACTS\2003 Projects\23016 Carnation WWTP\GIS\historic.mxd 5/13/2004 cm **Prepared by:** King County WLR Visual Communications & Web Unit

The proposed river outfall is located at the right-of-way intersection of NE Carnation Farm Road and the Snoqualmie River at the Bridge (also referred to as the Stossel Bridge). The bridge is a designated County landmark, listed on the Washington State Register and eligible for listing on the NRHP. Impacts to the bridge could include vibration from heavy machinery operating in close proximity to the bridge. Although no historical or culturally significant sites listed on federal, state, or local registers are located immediately adjacent to the Bridge, the immediate area has a high probability for containing unrecorded hunter-fisher-gatherer, ethnographic period, and historic Indian period archaeological resources and a low probability for historic period archaeological resources.

Notes

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4.0 DISCHARGE STANDARDS

Most of the Snoqualmie Valley is designated as a critical aquifer recharge area and recognized as such in several documents, including the County's Comprehensive Plan.[122,123,124] The area is environmentally sensitive, with stretches of the Snoqualmie River serving as habitat for salmonids, other fish, and other aquatic life. The Discharge Alternatives TM[125] details the water quality criteria categories mandated by the State of Washington and the EPA for various discharge methods. In addition, the River Outfall TM[126] evaluation provides detailed discussions on the water quality goals required to meet the anticipated discharge limits. The following section discusses the analyses and findings of these two TMs. It is anticipated that the CWWTF design will allow the highly treated water to meet the water quality requirements for the selected discharge alternative as summarized in Table 4.1.

4.1 Discharge Alternatives

Five discharge alternatives were originally evaluated for the CWWTF based on current[127] and previous[128] work: 1) direct discharge to the Snoqualmie River, 2) wetlands creation or enhancement, 3) upland discharge, 4) conveyance to existing County force mains, and 5) water reuse. During the initial phase of the project, three discharge alternatives were recommended for further study: 1) direct discharge to the Snoqualmie River, 2) wetlands enhancement, and 3) upland discharge.[129] These three alternatives were further refined in the EIS as 1) Snoqualmie River discharge at the Bridge, 2) wetland discharge at SWA, and 3) upland discharge in area southeast of the City.[130]

In general, "disposal" discharge alternatives are subject to Washington State's anti-degradation policy, which dictates that the receiving water quality must maintain any existing beneficial uses and that its quality cannot be degraded from current conditions.[131,132] The applicable water quality standards will depend on the discharge alternative selected, as follows:

- Disposal via an outfall to the Snoqualmie River must meet surface water[133] and total maximum daily load (TMDL) standards[134] to ensure that the water quality and uses of the river are protected.

- Discharge to create and/or enhance wetlands must meet reclaimed water standards.[135] Enhancement of natural wetlands or construction of wetlands hydraulically contiguous with surface waters must also meet surface water[136] and TMDL standards.[137]

Table 4.1 Estimated Maximum Allowable Discharge Limits (Months of August, September, and October) Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks

Parameter	Discharge Alternatives			Water Reuse Class A
	River Outfall Snoqualmie River	Upland Reclamation/Disposal Surface Percolation[a]	Natural Wetlands Beneficial Use	
BOD_5, mg/L	8.2[b]	30	20[c]	30
BOD_5, kg/ha/d	NR	NR	5[c]	NR
TOC, mg/L	NR	NR	NR	NR
TSS, mg/L	30	30	20[c]	30
TSS, kg/ha/d	NR	NR	9[c]	NR
Fecal coliform, cfu/100 mL				
Geometric mean – 50th percentile	50	NR	50	NR
Geometric mean – 90th percentile	100	NR	100	NR
Total coliform, CFU/100 mL				
7-day average	NR	≤ 1	≤ 2.2	≤ 2.2
Sample maximum	NR	≤ 5	≤ 23	≤ 23
pH	6.5 - 8.5[d]	6.5 - 8.5	6 - 9	6 - 9
DO, mg/L	≥ 9.5[e]	present	present	present
Turbidity, ntu				
Average monthly	NR	≤ 2	≤ 2	≤ 2
Maximum	5+background	5	5	5
Total N, mg/L	NR	NR	NR	NR
Total N, kg/ha/d	NR	NR	1.2[c]	NR
TKN, mg/L	NR	NR	3[c]	NR
NH_3-N, mg/L	2.7[b]	1.5	1.5[f]	NR
NO_3-N, mg/L	NR	< 10	R	R
SRP, mg/L	0.58[g]	NR	NR	NR
Total P, mg/L	NR	NR	1[c]	R
Total P, kg/ha/d	NR	NR	0.2[c]	NR
Residual Cl_2, mg/L	< 0.5	> 0.5[h]	> 0.5[h]	> 0.5[h]
Metals	SWQ[i]	WQGW/DWS	SWQ[f]	D
Temperature, ^{0}C	16.0[j]	NR	SWQ[f]	NR
Maximum total dissolved gas, percent of saturation	≤ 110	NR	NR	NR

Table 4.1 Estimated Maximum Allowable Discharge Limits (Months of August, September, and October) Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks

BOD_5 = five-day biochemical oxygen demand
C = Celsius
CFU = colony forming unit
Cl_2 = chlorine
D = dependent on likelihood of exposure to humans and habitats
DO = dissolved oxygen
DWS = Drinking Water Standards
GW = groundwater
kg/ha/d = kilograms per hectare per day
mg/L = milligrams per liter
mL = milliliter
N = nitrogen
NH_3-N = ammonia-nitrogen
NO_3-N =nitrate-nitrogen
NR = not regulated
ntu = nephelometric turbidity unit
P = phosphorus
R = reserved by Ecology (depends on fate of water)
SRP = soluble reactive phosphorus
SWQ = based on Surface Water Quality Standards
TMDL = total maximum daily load
TOC = total organic carbon
TSS = total suspended solids
WQGW = Water Quality for Groundwater Standards

a. Groundwater beneath the infiltration site will be required to meet the Drinking Water Standards (WAC 246-290-310) unless a lesser standard is specifically authorized by Ecology or the Washington Department of Public Health.
b. Based on the 1994 TMDL study[138] for mass discharge loading and projected average annual flow of 0.37 mgd. (May be required for other discharge options based on continuity with the river.)
c. Average annual basis.
d. Human-caused variation within acceptable range, less than 0.2 unit.
e. Lowest 1-day minimum, no DO decrease greater than 0.2 mg/L when the receiving water body is lower than the criteria due to natural conditions.
f. Compliance at point of discharge to beneficial-use wetland.
g. Guidelines established in the 1994 TMDL study[139] during low-flow conditions with the recommendation that additional SRP monitoring continue. The TMDL states, “If guideline is exceeded, discharger would need to demonstrate the increased SRP load has no deleterious effect on the river.”
h. Maintained in water during conveyance from reclamation facility to use area.
i. Compliance at dilution zone boundary.
j. Cannot exceed 16.0^{o}C on a 7-day average of the daily maximum temperatures; no temperature increase can raise the receiving water temperature by greater than 0.3^{o}C if natural temperature exceeds criteria. Incremental water temperature increases resulting from point source activities cannot exceed t=28/(T+7), where t = maximum permissible temperature increase at mixing zone boundary and T = highest ambient temperature in vicinity of discharge outside of mixing zone (WAC 173-201A).

Sources: Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.;
Water quality standards for surface waters of the state of Washington, *WAC 173-201A* (2003).;
Joy, J., *Snoqualmie River Total Maximum Daily Load Study*, Ecology Report #94-71, 1994.;
Water quality standards for ground waters of the state of Washington, WAC 173-200 (1990).;
Maximum Contaminant Levels (MCLs) and Maximum Residual Disinfectant Levels (MRDLs), Chapter 246-290-310 WAC, (2004).;
Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.

- Disposal via upland infiltration must meet groundwater quality standards.[140] If the high quality water is reclaimed for demonstrated beneficial use purposes, the water must be treated according to the Class A reclaimed water standards,[141] with an additional step to reduce nitrogen prior to discharge. Groundwater beneath the infiltration site would be required to meet the drinking water standards[142] unless a lesser standard is specifically authorized by the Washington Department of Health (DOH) and Ecology.

In 2003, the County made a commitment to the City that the flexibility of the CWWTF design would allow the highly treated water to meet the water quality requirement for the selected discharge alternative. This commitment will allow the facility to be capable of meeting the Class A reclaimed water standards[143] should either the County or the City desire to reuse the water fore beneficial purposes in the future. Class A reclaimed water would allow for unrestricted, non-potable contact applications as well as be required for the restoration or enhancement of sensitive natural wetlands. The following subsections summarize the discharge standards associated with each of the three discharge alternatives.

4.1.1 Direct Discharge to the Snoqualmie River

Ecology is required per Section 303(d) of the Clean Water Act (CWA)[144] to recommend pollutant-loading limits for each river system identified as water quality impaired. As such, Ecology has conducted several investigations on the lower Snoqualmie River basin to identify existing and potential water quality problems during the summer low-flow season. The TMDL for the Snoqualmie River was approved in 1994.[145] TMDL parameters include biochemical oxygen demand (BOD_5), ammonia-N (NH_3-N), and fecal coliform bacteria; guidelines for soluble reactive phosphorus (SRP) were also established. Temperature, which violates the surface water quality standards, is also included on the Section 303(d) list for impairment.[146] An Ecology monitoring study is underway to determine to what degree the Snoqualmie River meets water quality standards and what the potential capacity of the river would be for the waste load allocations of the new CWWTF.[147]

The 1994 TMDL study[148] conducted by Ecology on the Snoqualmie River dictates stringent discharge standards for the protection of both wildlife and human health. Highly treated water discharged to the evaluated Snoqualmie River must meet the Surface Water Quality Standards for designated use ("Salmon and Trout Spawning, Core Rearing, and Migration" [previously known as Class A])[149] as well as the seasonal NPDES discharge permit requirements.[150] The recently approved redefinition of the surface water "class" distinctions (to use-based classifications) and criteria modifications are designed to provide protection of threatened and endangered species.[151]

Municipal effluent discharges from wastewater treatment facilities to surface waters must receive a National Pollutant Discharge Elimination System (NPDES) permit. Ecology bases the NPDES permit on technology, water quality, and TMDL considerations. Technology-

based limitations are based on the Code of Federal Regulations Section 40, Part 133 (40 CFR Part 133), and WAC 173-221,[152] which dictate maximum discharge limits for secondary treatment. Water quality-based limitations are determined by the State of Washington and based on ambient river water quality. The regulations also establish criteria for toxic substances that may degrade the receiving water, both in terms of aquatic life and human health. In particular, municipal discharges to surface waters must comply with "All Known Available and Reasonable methods of prevention, control, and Treatment" (AKART), which means that all pollutant discharges must be minimized according to the best practical methods available.[153,154] TMDL-based limitations were calculated by Ecology using the QUAL2E numerical model to establish maximum pollutant load discharges from point and non-point sources based on the 1994 TMDL study. The 1994 TMDL study determined the recommended maximum loading capacity for BOD_5, NH_3-N, fecal coliform bacteria, and SRP to the Snoqualmie River.[155]

WAC 173-201A states that a mixing zone will only be allowed if its presence is not expected to significantly impact the sensitive habitat, damage the local ecosystem, or adversely affect public health.[156] Based on initial discussions, it is anticipated that a dilution credit will be allowed within the Snoqualmie River outfall location by Ecology.[157] Cosmopolitan Engineering (Cosmopolitan) calculated the most stringent anticipated dilution factors based on the allowable mixing zones, dilution were performed by using the 1) maximum monthly and maximum daily flows of 0.62 mgd and 0.93 mgd, respectively [initially developed flows during preliminary design of the CWWTF[158]], 2) river depth, 3) river velocity, 4) river width, and 5) the 7-day critical low flow, 10-year recurrence interval (7Q10) condition. The 1994 TMDL study[159] had reported the 7Q10 flow as 443 cfs. The lowest flows in the mainstem Snoqualmie River occur in the months of August, September, and October.[160] Limiting acute and chronic dilution factors for discharge to the Snoqualmie River were calculated to be 8.7 and 116, respectively. Acute conditions are defined as "the changes in the physical, chemical, or biological environment which are expected or demonstrated to result in injury or death to an organism as a result of short-term exposure to the substance or detrimental environmental condition."[161] Chronic conditions are defined as "changes in the physical, chemical, or biologic environment which are expected or demonstrated to result in injury or death to an organism as a result of repeated or constant exposure over an extended period of time to a substance or detrimental environmental condition."[162] Using current design flows, the acute and chronic dilution factors would be 10.4 and 153, respectively. Table 4.2 summarizes the resulting potential NPDES permit limitations for the highly treated water discharged to the Snoqualmie River during critical-flow months based on the preliminary planning and design calculations.[163] Using the current dilution factors, the second set of allowable water quality concentrations such as ammonia, copper, and lead (Constituents B) would likely exceed the values provided in the table. The NPDES permit limitations will be developed and set by Ecology.

Table 4.2 Potential NPDES Permit for the Snoqualmie River Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks

	Non-TMDL Season Limitations (Nov - July)		TMDL Season Limitations (Aug - Oct)	
Constituents A	**Average Monthly[a]**	**Average Weekly[a]**	**Average Monthly[a]**	**Average Weekly[a]**
BOD_5[b]	30 mg/L, 155 lb/day	45 mg/L, 233 lb/day	30 mg/L, 25 lb/day[c]	45 mg/L
TSS[b]	30 mg/L, 155 lb/day	45 mg/L, 233 lb/day	30 mg/L, 155 lb/day	45 mg/L, 233 lb/day
Fecal coliform bacteria	200 colonies/ 100 mL	400 colonies/ 100 mL	200 colonies/ 100 mL	400 colonies/ 100 mL
pH	Daily minimum $\geq$ 6 standard units, daily maximum $\leq$ 9 standard units		Daily minimum $\geq$ 6 standard units, daily maximum $\leq$ 9 standard units	
Constituents B[d]	**Average Monthly (mg/L)**	**Maximum Daily (mg/L)**	**Average Monthly (mg/L)**	**Maximum Daily (mg/L)**
Ammonia-N	40.1	95.6	40.1 8.4 lb/day[c]	95.6
Total residual chlorine	0.063	0.165	0.063	0.165
Arsenic	2.14	3.13	2.14	3.13
Copper[e]	0.025	0.036	0.025	0.036
Cyanide	0.131	0.191	0.131	0.191
Cadmium[e]	0.005	0.007	0.005	0.007
Chromium (Hex)	0.90	0.131	0.90	0.131
Chromium (Tri)	1.05	1.53	1.05	1.53
Lead[e]	0.050	0.073	0.050	0.073
Mercury	0.001	0.002	0.001	0.002
Nickel[e]	2.61	3.81	2.61	3.81
Silver[e]	0.002	0.003	0.002	0.003
Zinc[e]	0.204	0.297	0.204	0.297
SRP	NONE	NONE	3 lb/day[c]	NONE

BOD_5 = 5-day biochemical oxygen demand
lb/day = pounds per day
mg/L = milligrams per liter
SRP = soluble reactive phosphorus
TSS = total suspended solids

a. The average monthly and weekly effluent limitations are based on the arithmetic mean of the samples taken with the exception of fecal coliform bacteria, which is based on the geometric mean.

b. The average monthly effluent concentration for BOD_5 and total suspended solids cannot exceed 30 mg/L or 15 percent of the respective monthly average influent concentrations, whichever is more stringent.

c. Daily maximum.

d. Calculated assuming a CWWTF maximum daily flow of 0.93 mgd developed during preliminary design.

e. Assumes Snoqualmie River natural hardness of 25 mg/L as calcium carbonate ($CaCO_3$).

Source: Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.

Ecology has permitted six wastewater discharges within the lower Snoqualmie River. Three NPDES permits regulate municipal wastewater treatment plant discharges from the cities of North Bend, Snoqualmie, and Duvall. One state permit regulates process and stormwater discharges to and from the Weyerhaeuser mill pond in Snoqualmie. The Weyerhaeuser mill has been closed since November 2004.[164] Another state permit covers the WDFW hatchery at Tokul Creek. Domestic wastewater and dairy manure from Carnation Research Farms are spray-applied to fields after treatment under discharge limitations established by the State of Washington.

4.1.2 Wetland Discharge

The State of Washington requires the treatment of wastewater effluent to reclaimed standards before discharge to constructed or natural wetlands for beneficial use. Considerations for reclaimed water discharges to wetlands are detailed in the Revised Code of Washington (90.46 RCW)[165] and the Water Reclamation and Reuse Standards.[166] These regulations require Class A reclaimed standards for natural, mitigated, and any wetlands that may be subject to human contact. In addition, natural and beneficial use wetlands are considered as “waters of the state.” Various classes of natural wetlands allow annual average hydraulic loadings of two to five centimeters of depth per day (cm/day). Higher hydraulic loadings may be approved by Ecology if net ecological benefits can be demonstrated.[167]

Several wetlands are located downstream of the Tolt Delta Reach (TDR) in the Snoqualmie River. The TDR has been identified in previous studies as being heavily used for spawning by Chinook and other salmonids.[168] Reclaimed water discharged to one of the smaller wetland areas could provide a measurable addition to the base flow for fish species. The elevated wastewater temperature will decrease through exchanging heat with the surrounding ground as the reclaimed water travels to the discharge point.[169] Discharge to wetlands would also decrease the incremental risk because exposure to the highly treated water would mainly be limited to areas used by rearing coho salmon and cutthroat trout. The flows from the wetlands north of the City would ultimately discharge into the Snoqualmie River below almost all mainstem spawning habitats.[170]

Reclaimed water quality compliance is regulated prior to entering a beneficial use wetland. Therefore, reclaimed water either discharging to natural wetlands or constructed wetlands hydraulically contiguous with surface waters must meet stringent NPDES water quality standards without the allowance of a mixing zone. Such standards may be of potential concern with regard to concentrations of metals such as copper and zinc, which may be slightly elevated because of the corrosiveness of the City’s potable water on water transmission pipes and plumbing fixtures.

To further understand the environmental effects of using Class A reclaimed water to create wetlands in the SWA, the County undertook the collection and analysis of water quality samples collected in the SWA and from the City’s potable water system. Samples were

collected August 10, 2004, by King County Environmental Services staff to provide some indication of the quality of the receiving water (the sampling point was the oxbow pond in the northwest quadrant of the SWA) and the source water that would be conveyed to the CWWTF (sampling points were the City potable water source and a faucet in the Carnation City Hall kitchen).[171]

The water samples were analyzed for total and dissolved copper and zinc, hardness, and pH. The results showed that dissolved and total metals concentrations for the source well water and the oxbow pond were low, either at or below detection limits and well below water quality standards. However, the copper concentration in the sample taken from City Hall was measured as 32.6 micrograms per liter (µg/L). Calculating the acute and chronic water quality criteria using the hardness data collected from the oxbow pond, results in copper concentrations of 5.1 µg/L and 3.8 µg/L, respectively. The total and dissolved copper concentrations measured in the City Hall sample may stem from the corrosivity of the source water on plumbing fixtures between the well source and the faucet.[172]

Wastewater plants in Washington traditionally meet their metals discharge limits to rivers through a mixing zone. Although wetlands are not allowed the use of a mixing zone, the State also has successful projects that utilize effluent to enhance wetlands for beneficial use or promote further wastewater treatment through wetlands. The City of Yelm, Washington, produces Class A reclaimed water using sequencing batch reactors, continuous backwash upflow sand media filtration, chlorine disinfection, and a constructed wetland. The wetland polishes the flow and recharges the groundwater. Discussions with the City of Yelm staff have indicated that they had faced a similar metals concentration problem stemming from their drinking water. To solve the problem, the City of Yelm proceeded to treat its drinking water with caustic prior to distribution to raise the pH and decrease the corrosivity. Treatment was successful, and the Yelm reclaimed water facility currently meets all metals standards.

4.1.3 Upland Discharge

Presently, the shallow groundwater regime beneath the City receives leachate from onsite septic systems. Likewise, the highly treated water would provide some recharge capacity to the shallow groundwater regime via surface percolation. Based on hydraulic head relationships between the shallow groundwater regime and the deeper confined aquifer, it appears much of the water from the shallower groundwater regime infiltrates downward to the lower aquifer. A review of Ecology's well logs within a 2,000 foot-radius of the sites indicates a total of nine recorded wells, which produce water from the confined aquifer (or other aquifers at approximately the same depth). TM No. 5A[173] details the geologic and hydrologic review of the identified upland discharge sites as well as the potential impacts of the upland discharge alternative. Dependent on whether the discharge is classified as a disposal or demonstrated beneficial use purpose, the highly treated water is subject to differing water quality standards.

Disposal via upland infiltration must meet groundwater quality standards.[174] The regulation dictates the maximum contaminant concentrations for a wide range of groundwater quality parameters and includes an anti-degradation policy that prohibits groundwater contamination. Upland discharge from the proposed CWWTF can be regulated either at monitoring wells down gradient of the discharge site or at the bottom of the infiltration basin.

If the highly treated water is reclaimed for demonstrated beneficial use purposes, the water must be treated according to the Class A reclaimed water standards,[175] with an additional step to reduce nitrogen prior to discharge. No specific nitrogen limit is presently set by Ecology at the point of discharge. The reclaimed water will percolate through the soil and become part of the base flow for the shallow groundwater regime. Groundwater beneath the infiltration site will be required to meet the drinking water standards,[176] unless a lesser standard is specifically authorized by DOH and Ecology.

4.1.4 Water Reuse

Reclaimed water regulations in 90.46 RCW[177] and the Water Reclamation and Reuse Standards[178] require Class A treatment for non-potable waters that may potentially come into direct contact with humans. A minimum of Class C treatment is required for the irrigation of commercial non-crop vegetation, with requirements that irrigation occur during times during which there is the least potential for human contact. Health and safety procedures, including normal hygiene and procedures for emergencies such as accidental ingestion, must be followed.

Implementation of water reuse will require the County to study the resulting impairment potential on existing downstream water rights, including in-stream impairments. The point of compliance for reclaimed water discharge is anticipated to be immediately prior to usage. Reuse for non-potable commercial purposes such as toilet flushing requires a minimum setback distance of 50 feet between the reclaimed water pipeline and any potable water supply well. Reuse of reclaimed water for the irrigation of commercial non-food crops with potential contact by humans requires minimum setback distances of 100 feet, and 100 feet between any potable water supply well and any reclaimed water pipeline and irrigated perimeter. Any hydraulic and nutrient loading considerations must be addressed by balancing the crop uptake and evapotranspiration rates.

4.2 Influent and Effluent Quality

Since there is currently no centralized wastewater treatment in the City, the quality of wastewater entering the proposed CWWTF (influent) cannot be accurately characterized at this time. There are no combined flows that can be sampled or monitored to provide an indication of the chemical characteristics of the waste stream to be treated. Concentrations of substances in the highly treated water discharged from the CWWTF also cannot be precisely characterized. However, given the capabilities of the treatment technology chosen for the facility, the concentrations of many substances in the highly treated water can be

confidently predicted to be at or better than regulatory standards. The temperature of the highly treated water is also an unknown but can be approximated based on the temperatures of effluent from existing wastewater treatment facilities in the area. Although the precise levels of various parameters cannot be predicted, several factors will act to ensure that the levels will be at or better than regulatory standards:

- The MBR technology is one of the best available technologies for treating municipal wastewater and therefore provides the best opportunity for treating most types of pollutants that will be discharged by the CWWTF. MBR provides better and more consistent overall treatment than conventional activated sludge secondary treatment or tertiary treatment methods such as sand filtration.

- When the CWWTF begins operation, businesses discharging to the City's sewer system will be subject to regulatory restrictions on the types and amounts of potentially harmful substances, such as metals or solvents that could be discharged into the system. These restrictions apply to all dischargers in the County's wastewater service area. The King County Industrial Waste Program works with industrial dischargers in the service area to help them comply with these restrictions.

- The County's policy for treating wastewater is to comply with or exceed all applicable standards and regulations. The County would continue to take any necessary action(s) to ensure that the applicable discharge limits are met whether 1) more stringent discharge limits are regulated, 2) influent characteristics to the CWWTF are different than originally those expected or change, or 3) any other reason the County's ability to meet the regulatory limits may be jeopardized.

4.3 Emerging Pollutants of Concern

Endocrine disrupting compounds (EDC) are molecules that interfere with or mimic natural hormones responsible for reproduction, growth, and development in humans, wildlife, fish, and birds. These compounds enter into the environment through a variety of pathways, including wastewater treatment plant effluent, onsite septic system discharge, and agricultural runoff. However, EDCs also enter the environment through many of the products and conveniences that have become part of our everyday lives. Scientists around the world are studying this emerging area of environmental concern.

The County, like all municipalities throughout the United States, treats and discharges wastewater according to the applicable water quality standards described above. These permits place limits on the quantity and concentration of pollutants that may be discharged into surface or groundwaters. Currently, there are no federal or state regulatory standards for surface water or groundwater discharges of EDCs.

King County is closely following the research on EDCs as well as other emerging compounds of potential concern, such as pharmaceutically active compounds and personal care products. The County will respond appropriately to amended regulations as more is known about these issues.

Notes

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5.0 FUTURE CONDITIONS

5.1 Population Development

Between the spring of 2003 and summer of 2004, staff from the City's consultant (Roth Hill) and the County developed an approach to forecast the City's population and wastewater design flows. The results of this work were incorporated into the 2004 Comprehensive Sewer Plan[179] and TM No. 2.[180] These estimates were based on an analysis of the population distributions identified within sewer basins and took into account residential populations, employment, industrial flows, schools, and parks. Population projections were based on the assumption that the new sewer system would be operational in the year 2007 and that growth rates would be modest until that time. It was further assumed that the compound annual growth rate would be one percent for the period from the 2000 base year to year 2007. After completion of the entire sewer system, growth rates would increase to a compound rate of five percent until the date estimated for the phased completion of sewer system throughout the entire city (2012). After 2012, a more modest growth rate of three percent would be sustained until the calculated build-out population was reached. Roth Hill determined the build-out population to be 3,871 persons, based on an analysis of the zoning for each proposed sewer basin. According to this analysis, the saturation population would be reached in 2017. The detailed methodologies used for projecting population increases within the City are documented in the 2004 Comprehensive Sewer Plan.[181]

Population projections are shown in Table 5.1. These estimates will be used for the projection of flow and pollutant loadings for the WWTF. Though Roth Hill estimated that the residential population saturation level would be reached by 2017 and that there would be no further increase in population after that year, it was estimated that employment would not reach the employment saturation level until sometime between 2023 and 2050.

Table 5.1 Population Projections for the City Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
	Milestone and Year			
Population	Startup 2007	Full Sewer[a] 2012	Residential Saturation[b] 2017	Design Year 2030
Residential	2,185	3,816	3,871	3,871
Commercial	634	809	1,254	2,175
Industrial (Remlinger Farms)	880	880	880	880
Middle school	757	1,323	1,342	1,342
High school	725	1,266	1,284	1,284
Elementary school	419	732	743	743
Park	60	60	60	60

a. End of the anticipated rapid increase in population (5% annual growth rate until the buildout density is reached) after the vacuum sewers are available.

b. The residential saturation was determined based on the buildout density of the residentially zoned land within the UGA.

Source: Roth Hill Engineering Partners, LLC, *City of Carnation 2004 Sewer Facilities Plan*, *City Review Draft,* September 2004.

5.2 Flow Development Methodology

5.2.1 Average Annual Flow

Table 5.2 summarizes the unit flow rates adopted for each population category . All of these unit flow rates are comparable to the rates presented in the *Criteria for Sewage Works Design Manual* (Orange Book),[182] with the exception of the residential per capita rate. The Orange Book provides a recommended value of 100 gallons per day (gpd) for each resident in the State of Washington. This value includes a standard allowance for inflow and infiltration (I/I) to the sewers. Based on previous studies, the City has decided to implement a vacuum-based sewer collection system. The planned design of the vacuum-based system will reduce I/I to negligible volumes. The City estimated an average historical residential per capita water demand of 56 gpd, based on an analysis of the City's metered residential water use in 2000, 2001, and 2002.

Table 5.2 Unit Rates for Wastewater Flow Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks		
Facility Type	**Design Unit**	**Flow (gpd)**
Residential	Per person	65
Commercial	Per employee	30
Industrial	Per employee	30
Elementary school	Per person per 8 hours	10
Middle school	Per person per 8 hours	16
New high school	Per person per 8 hours	10
Park	Per developed campsite	100
gpd = gallons per day		

The historical water usage includes a large percentage of "unaccounted for" water consumption in the City. Overall, the City's non-revenue water (unaccounted for and unmetered water) is estimated to be 40 percent of water produced. Typically, 10 to 20 percent of water production is not accounted for within a water system.[183] Of the 40 percent non-revenue water within the City, an estimated 15 percent is unmetered water.[184] The unmetered amount is therefore equivalent to six percent of the City's total water production. Although no information on the composition of the unmetered demand within the City is available, municipal uses such as for streets, medians, and parks dominate the unmetered usage category in other cities. For planning purposes, the current engineering design for residential wastewater flow allows for a per capita rate of 65 gpd, which includes an allowance of 15 percent for unexplained water entering the sewer system, water meter inaccuracies, and a small I/I contingency. This design rate does not account for any potential future per capita demand reductions based on more efficient appliances. See Chapter 7 for a discussion of future demand reductions.

Residential water demand accounts for approximately 70 percent of the historical total indoor water demand, as illustrated in Figure 5.1. Therefore, the majority of the City's wastewater flow will be derived from homes. This flow is not anticipated to contain large quantities of commercial or industrial waste. Major commercial and industrial contributors identified include QFC, Custom Concrete, and Remlinger Farms.

5.2.2 Inflow and Infiltration

Inflow and infiltration are terms used to describe extraneous water flows into a sewer system. Inflow refers to flows that result from stormwater runoff through a direct connection to the sewer system, which can cause a rapid increase in flow. Inflow access points include manhole covers, roof leaders, and yard drains. Specifically, infiltration refers to water that enters a sewer system from the ground through defective interceptors, pipe joints,

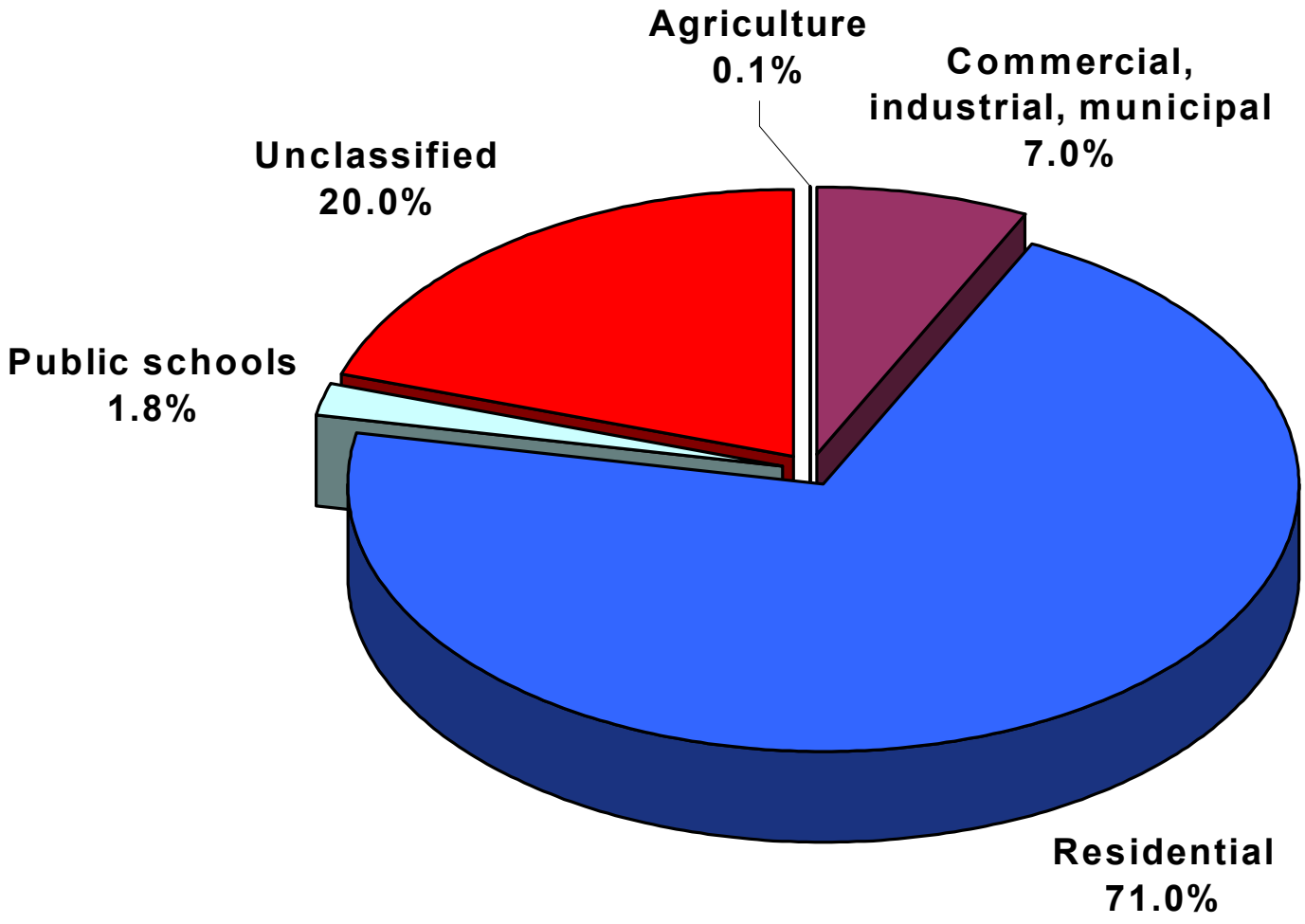


Figure 5.1

2002 City Potable Indoor/Non-seasonal Water Use
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

connections, or manhole walls. I/I is typically included as part of projecting wastewater flows. The 2000 Comprehensive Sewer and Facilities Plan[185] assumed there would be no I/I contribution with the use of a grinder pump-based collection system (the system recommended in the plan). Subsequent to the completion of the 2000 Comprehensive Sewer and Facilities Plan, the City decided to implement a vacuum-based sewer collection system. Although the vacuum-based system will include several gravity side sewers, the City presently assumes that I/I will account for a negligible amount of flow.[186]

5.2.3 Peaking Factors

To establish the maximum monthly flow (MMF), maximum daily flow (MDF), and peak hourly flow (PHF) projections for the CWWTF, the following sources were consulted:

- Orange Book[187]
- City's monthly water consumption data (January 2000 to December 2002)
- Hourly operating data from Ocean Shores, Washington (January to December 2003)

Ocean Shores had the first and, to date, the only large vacuum-based sewer collection system in the State of Washington. However, the City's demographic profile is different than that of Ocean Shores. The City is a suburban/rural residential community with a stable seasonal population, whereas Ocean Shores has a large proportion of vacation homes. Hence, Ocean Shores would be expected to have peak flow occurrences higher than the City because of the seasonal and part-time nature of the residential community. Detailed discussions of the data from each source are provided in TM No. 2.[188] Table 5.3 provides a summary of the peaking factors determined based on the data and the proposed factors for the CWWTF design.

Table 5.3 Comparisons of Peaking Factors
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Peaking Factor		
	City Water Records	Ocean Shores	Proposed for Design
Minimum daily flow	0.98	0.71	0.8
Average annual flow	1.00	1.00	1.0
Maximum monthly flow	1.14	1.63	1.3
Maximum daily flow	1.41	2.32	2.1
Peak hourly flow			
Residential	1.71	2.60	3.0
Schools	1.71	2.60	6.0

Projections using the City's winter water records from 2000 to 2002 result in a maximum monthly peaking factor of 1.14, while the Ocean Shores data produce a higher factor of 1.63. If no I/I is considered, the wastewater maximum month peaking factor for the City should be similar to the potable water maximum month peaking factor. In addition, given the highly seasonal nature of the Ocean Shores population, the lower peaking factor is more realistic for the City, even if a small fraction of I/I is considered. Therefore, it is proposed that the design assume a maximum monthly peaking factor of 1.3, to account for a conservative flow fraction for inflow and infiltration and serve as an intermediate factor between the City's water records and Ocean Shores data. The peaking factor is not atypical of this community size. For example, the City of Birch Bay, WA received an average flow of 0.66 MGD with a 1.24 maximum month wastewater peaking factor between 2001 and 2005. The maximum daily peaking factors from the City's winter water records and Ocean Shores data are 1.41 and 2.32, respectively. An intermediate factor of 2.1 is proposed for design, based on the diurnal flow curve for Ocean Shores and the overall peak flow developed for the City.

5.3 Wastewater Design Loads

The Orange Book provides recommended BOD and TSS design loads for sewage collection systems. These concentrations are consistent with those for the wastewater influent to the County's South Treatment Plant, which is assumed to serve a population with a residential makeup that is similar to that of the City. The following design average annual load (AAL) projections for residential wastewater flows to the CWWTF, have been assumed:

- BOD = 0.2 lb BOD / equivalent population / day
- TSS = 0.2 lb TSS / equivalent population / day
- TKN = 0.032 lb N / equivalent population / day
- Total phosphorus = 0.005 lb P / equivalent population / day

The following AAL projections for wastewater from commercial, industrial, and middle/high school sources have been assumed:

- BOD = 0.04 lb BOD / equivalent population / day
- TSS = 0.04 lb TSS / equivalent population / day
- TKN = 0.006 lb N / equivalent population / day
- Total phosphorus = 0.001 lb P / equivalent population / day

The following AAL projections for wastewater from the elementary school (without showers) have been assumed:

- BOD = 0.025 lb BOD / equivalent population / day
- TSS = 0.025 lb TSS / equivalent population / day
- TKN = 0.004 lb N / equivalent population / day
- Total phosphorus = 0.001 lb P / equivalent population / day

The following AAL projections for wastewater from the Tolt MacDonald Park have been assumed:

- BOD = 0.10 lb BOD / equivalent population / day
- TSS = 0.10 lb TSS / equivalent population / day
- Total Kjeldahl nitrogen (TKN) = 0.016 lb N / equivalent population / day
- Total phosphorus = 0.003 lb P / equivalent population / day

For unit process sizing for the CWWTF, projections have been developed for average annual and maximum monthly loads (MMLs) for the various wastewater constituents. Due to a lack of data on historical wastewater flows and loads generated within the City service area, MML projections have been based on an assumed peaking factor. An MML peaking factor of 1.3 was applied to the AAL to estimate the MML matching the peaking flow factor. This peaking factor value is consistent with Carollo's previous experience with wastewater utilities, as well as the existing and projected service area characteristics of the City. With little I/I in the system, it is reasonable to assume that MMF and MML could occur simultaneously. Table 5.4 summarizes the flow and load projections for the CWWTF. Projections are shown for major milestones through the 2030 design year.

Although the overall pollutant loading increases as the facility approaches design year, the anticipated pollutant concentration decreases after 2017. Based on the methodology used for projecting the City's population increase, residential build out is anticipated to occur by 2017.[189] Meanwhile, the continued growth of commercial establishments increases the overall flow and loading input to the facility. With lower pollutant concentrations and an increased fraction of flow stemming from commercial wastewater sources, decreasing influent concentration trends are anticipated to occur after 2017.

Table 5.4 Flow and Load Projections
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Load Projections by Milestone and Year			
	Startup 2007	Full Sewer 2012	Residential Saturation 2017	Design Year 2030
Flow, mgd				
Average annual	0.21	0.32	0.34	0.37
Maximum monthly	0.27	0.42	0.44	0.48
Maximum daily	0.43	0.67	0.71	0.77
Peak hourly[a]	0.63	0.72	1.29	1.4
BOD, lb/day				
Average annual load	538	923	954	991
Maximum monthly load	700	1,200	1,240	1,288
Maximum daily load	915	1,570	1,622	1,684
BOD, mg/L				
Average annual load	314	340	334	321
Maximum monthly load	409	442	434	417
Maximum daily load	534	579	568	546
TSS, lb/day				
Average annual load	538	923	954	991
Maximum monthly load	700	1,200	1,240	1,288
Maximum daily load	915	1,570	1,622	1,684
TSS, mg/L				
Average annual load	314	340	334	321
Maximum monthly load	409	442	434	417
Maximum daily load	534	579	568	546
TKN, lb/day				
Average annual load	86	148	153	159
Maximum monthly load	112	192	198	206
Maximum daily load	146	251	259	269
TKN, mg/L				
Average annual load	50	54	53	51
Maximum monthly load	65	71	69	67
Maximum daily load	86	93	91	87
Total P, lb/day				
Average annual load	13	23	24	25
Maximum monthly load	17	30	31	32
Maximum daily load	40	69	72	74
Total P, mg/L				
Average annual load	8	9	8	8
Maximum monthly load	10	11	11	10
Maximum daily load	24	26	25	24

BOD = biochemical oxygen demand

TSS = total suspended solids

TKN = total Kjeldahl nitrogen

P = phosphorus

a. See Chapter 7 for a discussion on satisfying the peak-hour facility capacity through increased MBR flux rates and MBR feed pump wet well equalization.

Notes

[179] Roth Hill Engineering Partners, LLC, *City of Carnation 2004 Comprehensive Sewer Plan*, October 2004.
[180] Carollo Engineers, *Technical Memorandum No. 2 - Population, Flow, and Loads*, 2004.
[181] Roth Hill Engineering Partners, LLC, *City of Carnation 2004 Comprehensive Sewer Plan*, October 2004.
[182] Washington State Department of Ecology, *Criteria for Sewage Works Design Manual*, 1998.
[183] National Drinking Water Clearing House, *Water Conservation Measures Fact Sheet*, 1998.
[184] Roth Hill Engineering Partners, LLC, *City of Carnation 2004 Comprehensive Sewer Plan*, October 2004.
[185] American Engineering Corporation, *Draft City of Carnation Comprehensive Sewer and Facilities Plan*, May 2000.
[186] Roth Hill Engineering Partners, LLC, *City of Carnation 2004 Sewer Facilities Plan*, *City Review Draft,* September 2004.
[187] Washington State Department of Ecology, *Criteria for Sewage Works Design Manual*, 1998.
[188] Carollo Engineers, *Technical Memorandum No. 2 - Population, Flow, and Loads*, 2004.
[189] Roth Hill Engineering Partners, LLC, *City of Carnation 2004 Comprehensive Sewer Plan*, October 2004.

6.0 PRELIMINARY DEVELOPMENT OF PRINCIPAL ALTERNATIVES

6.1 Vacuum-Based Sewer Collection System

The sewer system is being designed and will be owned and operated by the City. Gravity, grinder, and vacuum-based sewer collection systems were evaluated by the City's consultant (Roth Hill) in the *2004 Carnation Sewer Facilities Plan,*[190] which discusses the preliminary development of principal alternatives and cost considerations. Vacuum-based systems were selected by the City as the most cost-effective alternative.

6.2 Wastewater Treatment Facility

6.2.1 Site Alternatives

Potential sites for the new CWWTF were evaluated through a systematic process of screening for favorable site characteristics. The study area for the CWWTF was restricted to the City's UGA boundary lines, consistent with the City of Carnation 1996 General Comprehensive Plan.[191] Coarse-screening of sites within the study area narrowed the search to 15 land parcels that met the minimal critical land use, geographic, technical, and environmental criteria. Of the 15 identified land parcels, nine were judged to have higher designated land-use compatibility (e.g., recreational) and acquisition cost impacts and therefore lowered acceptability for locating a wastewater treatment facility. Existing uses of the nine sites included schools, parks, a historic site, and urban residential uses. Consequently, only six sites were evaluated further.

These six sites were then rated based on the following fine-screening criteria using GIS information, visual observation, and other County data.

- Land use compatibility and acquisition, including cost of property acquisition
- Geographic location, including visual impacts, traffic disruption, access to infrastructure
- Technical feasibility, including groundwater level and presence of contamination
- Environmental impacts, including shoreline management and sensitive areas, endangered species, and wells

Upon completion of the fine-screening evaluation, two site alternatives remained under consideration by the County, the City-owned site and the Weckwerth site, as shown in Figure 2.2. TM No. 1[192] details the screening process and site characteristics evaluated.

The City-owned site is approximately a ten-acre parcel located at the end of Entwistle Street (31500 West Entwistle Street), west of the City's business district and Highway 203. Purchased by the City for development of a wastewater treatment facility, the site is zoned for light industrial and manufacturing use and is the planned location of the City's Vacuum Station No. 1. The site is generally flat and undeveloped with the exception of a single-family residence located on the northeast corner of the property. As discussed in Chapter 3, the current FIRM map places approximately 70 percent of the land parcel within the 100-year floodplain of the Snoqualmie River. The draft map prepared by the County in June 2005, places the entire site within the 100-year floodplain. Hence, the structural footprint of the CWWTF has been modified to reflect the impacts of the potential floodplain change. The operating floor level for electrical and mechanical equipment in the CWWTF will be constructed at least one foot higher than the proposed 100-year base flood elevation of 74.11 feet (NAVD 88) at that site as required by the City's municipal code.[193] The site is bounded to the west by a King County park, to the south and east by industrial properties, to the north by an empty field, and to the northeast by residential properties. If chosen as the preferred site, the City and County will be involved in discussions to come to an agreement for long-term use of the area.

The Weckwerth site is a 5.1-acre parcel at 3700 Fall City-Carnation Road NE, east of Highway 203. The site is in a light industrial/manufacturing area and located adjacent to a specialty concrete fabrication business, which currently owns the parcel. The average elevation of the site is approximately 82 feet, remaining above the 100-year floodplain. If selected as the preferred location for the CWWTF, sewage from the City's Vacuum Station No. 1 (located at the City-owned site) would be pumped to the higher site elevation and conveyed a distance of approximately 4,200 feet. The Weckwerth site is bounded by the Riverview School District Middle School to the north, the City fire station to the west, a concrete manufacturing facility to the east, and vacant parcel of land that is prone to flooding from the Tolt River to the south.

6.2.2 Discharge Alternatives

Five discharge alternatives were originally evaluated for the CWWTF based on current[194] and previous[195] work: 1) direct discharge to the Snoqualmie River, 2) wetlands creation or enhancement, 3) upland discharge, 4) conveyance to existing County force mains, and 5) non-potable water reuse. During the initial phase of the project, three discharge alternatives were recommended for further study: 1) direct discharge to the Snoqualmie River, 2) wetlands enhancement, and 3) upland discharge.[196] These three alternatives were further refined in the EIS as 1) Snoqualmie River discharge at the Bridge, 2) wetland discharge at SWA, and 3) upland discharge in area southeast of the City.[197] Conveyance to existing facilities was eliminated from further study based on excessive cost and

environmental impact.[198] Reclaimed water use for irrigational and commercial purposes was determined to have a greater cost than other discharge alternatives, due in part to the limited number of users, and thus was deferred for consideration in the future. [199] Evaluations of each of the five discharge alternatives are summarized in the subsections that follow.

6.2.2.1 Direct Discharge to the Snoqualmie River

The river outfall study area included evaluating channel areas along the Snoqualmie River within a 2.5-mile area of the City. The initial screening process for the alternative was based on maximizing the desirable characteristics for an outfall location. Aerial photographs from 1938 through 2002 were examined to historically assess the areas of channel stability.[200] Although the photographs indicated no main channel movement or transient gravel bars present within the study area, the historical photographs did indicate several areas where gravel bars are likely to be present or stream channels have moved less over time. Those areas were deemed as having conditions that would support an outfall.

For the historically stable areas identified in the initial screening process, Cosmopolitan[201] calculated the corresponding TMDL water quality impact to the CWWTF, using the following methodology:

- Define critical mixing zone parameters for the river based on state water quality standards for this reach of the river
- Determine river dilution factors from flow data using FEMA information
- Determine river mixing zone dimensions from modeling
- Apply TMDL limitations to the potential river outfall locations
- Identify impacts on wastewater treatment process requirements to meet TMDL criteria at the areas identified
- Select promising areas for further evaluation

The screening process identified three potential outfall areas based on Cosmopolitan's methodology: near the Park, near the Bridge, and at Chinook Bend. The location on the Snoqualmie River near Tolt MacDonald Park is an area with a wide bed and a slight bend. The sides have a solid foundation and are steep, riprapped to the east, and gravelly to the west. The Bridge location also has a wide bed with existing footings and piers from the existing bridge as well as from a previous bridge. On the west bank, USGS currently operates a gauging station (No. 12149000). At Chinook Bend, the river forms a 90-degree bend to the west, and has riprap to the east.

These three potential outfall locations were further evaluated based on technical considerations, such as conveyance routing to the area, permitting, and land acquisition,

current and future compatibility, and habitat conservation and enhancement project plans by the City, County, and nongovernmental organizations.

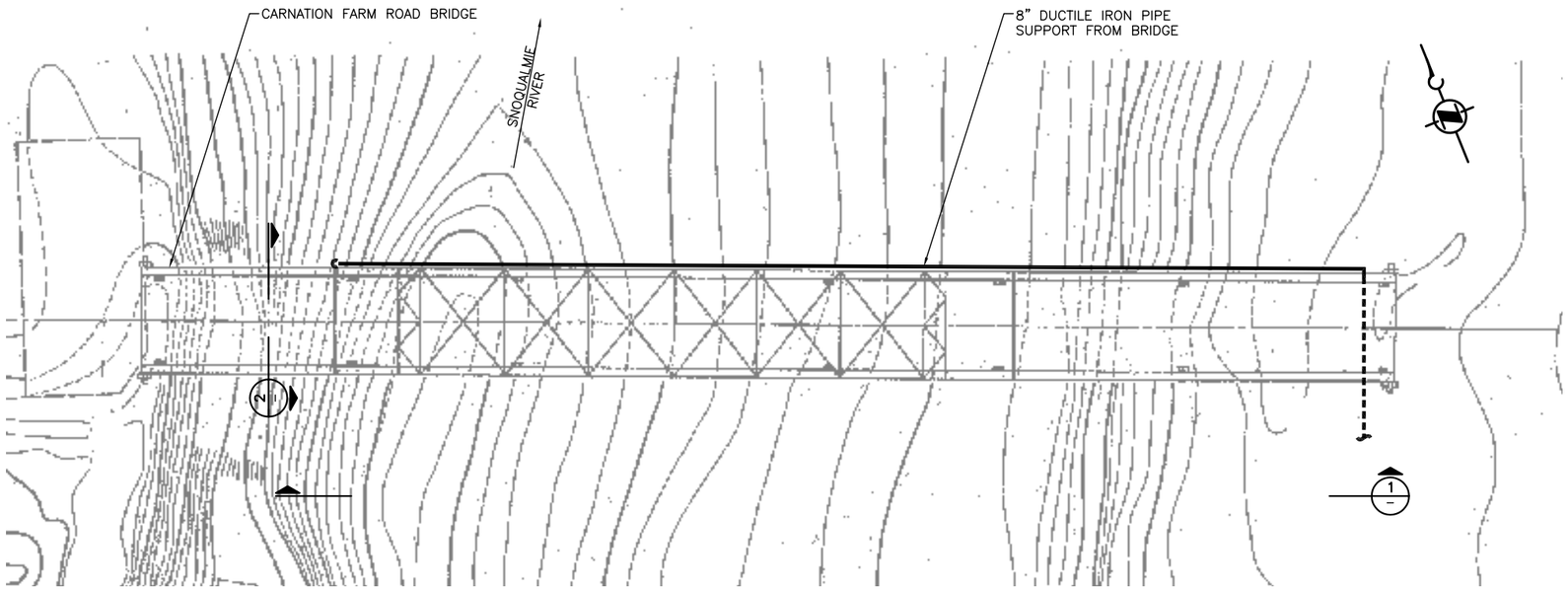
As a result of applying these criteria, Chinook Bend was eliminated as a discharge location because the Water Resource Inventory Area (WRIA) 7 Salmon Recovery Forum has identified the area as prime for restoration projects to help in the recovery of listed salmon in their near-term action agenda.[202] If carried out, the project would remove the hardened levees on the west bank of the bend and allow the river to meander in a more natural manner. The resulting river movement would make the area unsuitable as an outfall location. Also, the conveyance line would be much longer than for either of the other two locations.

The area near the Bridge, as shown in Figure 2.2, was the river outfall location evaluated during the EIS process. The Snoqualmie River channel bed has historically remained reasonably stable around the bridge area. The area around the Bridge offered advantages over the Park location because of the presence of the bridge.[203] The stability of the bridge abutment would provide the long-term bank stability needed for an outfall structure.

Adjacent properties are designated “Agricultural” in the County general land use and development comprehensive plan (Comprehensive Plan).[204] The County’s Shoreline Management Program[205] designates the site for “Conservancy,” preventing affected areas from intense development. Numerous other County designations apply to the site, particularly those related to sensitive or critical areas.

In addition, the Snoqualmie River is designated as a wildlife network. Previous studies have shown the reach of the river between the confluence with the Tolt River and the downstream end of Chinook Bend to be heavily used for spawning by listed Chinook salmon.[206,207] The river outfall discharge alternative is also located within King County Flood Hazard Area and within the Snoqualmie River Valley Agricultural Production District.

The conveyance pipe to the outfall at the Bridge is anticipated to consist of a 12-inch high-density polyethylene (HDPE) pipe, then reducing to an eight-inch ductile iron pipe supported by the bridge. The highly treated water would be discharged to the river using a diffuser check valve that would extend into the Snoqualmie River as shown in Figure 6.1. Using 2005 survey data, the 7Q10 low (7-day low flow with a 10-year recurrence interval) flow critical condition at the Bridge was estimated for river depth and optimal depth of water at the proposed outfall to be 9.4 feet and 7.5 feet (port centerline), respectively from the water surface.[208] The check valve is a simple device that would prevent backflow into the diffuser from the Snoqualmie River and distribute the highly treated water more effectively during periods of low discharge. Chapter 7 details the subsequent review and confirmation process used to select the preferred Snoqualmie River outfall location at the Bridge.



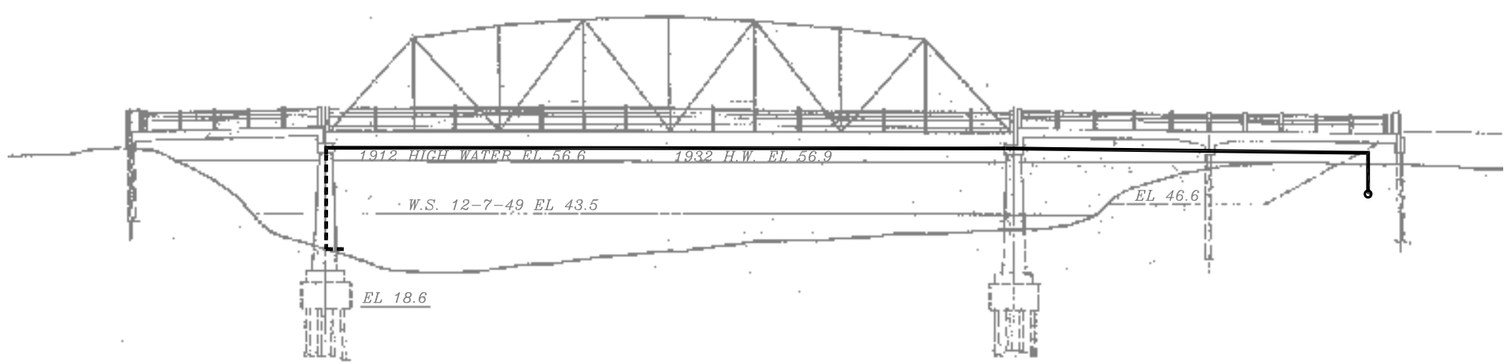
CARNATION FARM ROAD BRIDGE

PLAN

SCALE: 1" = 40'

GENERAL NOTES:

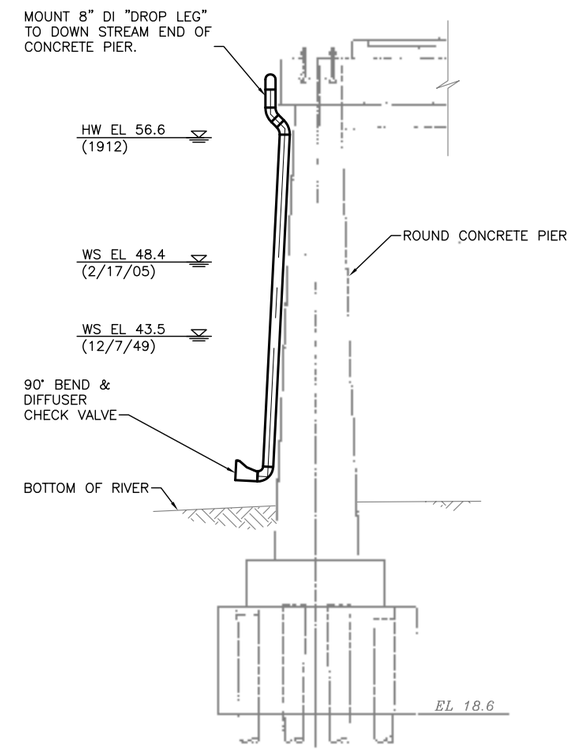
1. CARNATION FARM ROAD BRIDGE AND RIVER PROFILES PREPARED IN APRIL 1950. ELEVATIONS SHOWN ARE BASED ON NAVD 88 DATUM.



BRIDGE

ELEVATION (1)

SCALE: 1" = 40'



PIER

ELEVATION (2)

SCALE: 1" = 10'

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED/DRAWN: SEF	SCALE: NONE
PROJECT ENGINEER: SML	
DESIGN APPROVAL:	
FINAL APPROVAL:	CONTRACT NO: C_____C

KING COUNTY

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 6.1
CONCEPTUAL
RIVER OUTFALL DISCHARGE

DATE:

FILE NO: 423528/###

DRAWING NO:

SHEET NO: OF

H:\Client\KingCo-DNR_SEA\6620a10\Div\Dwg\FIGURE_6.1 3-14-05 10:51am sfroker XREFS: D-TTL-KC-CARN BRIDGE_ELEV; BRIDGE_PLAN; PIER;

6.2.2.2 Upland Discharge Study Area

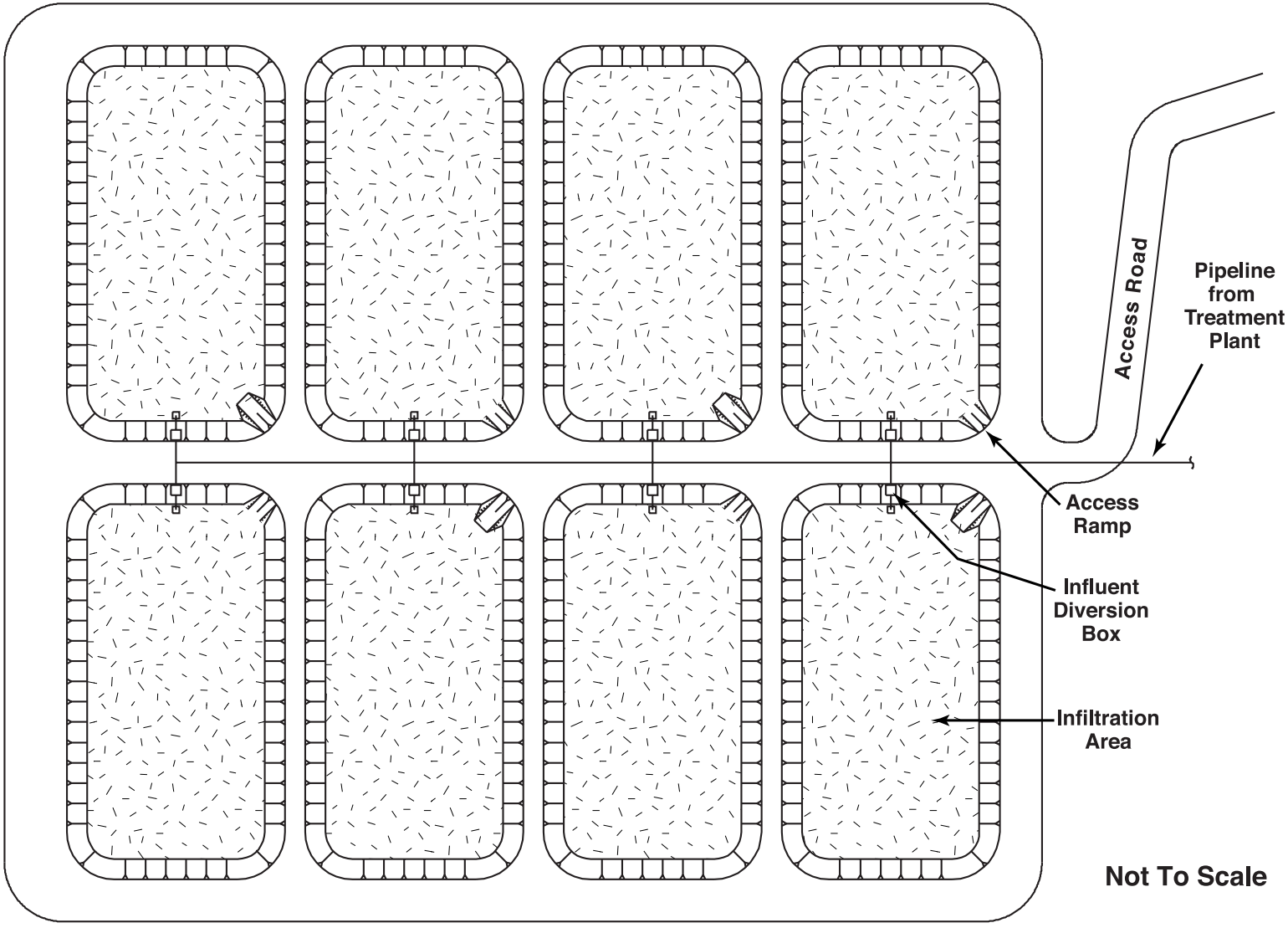
A 2.5-mile radius around the City, as illustrated in Figure 2.1, was initially examined to identify areas that would be suitable for surface percolation/infiltration.[209] Land parcels with the highest infiltration potential from the hydrogeological perspective are centered in an area located southwest of the UGA, each with a minimum of ten acres with suitable infiltration soils. Preliminary designs indicate eight half-acre basins, as shown in Figure 6.2, will be required to handle the ultimate peak hourly flow. A landscaped border will surround the overall area.

The soil suitability within the refined study area, as illustrated in Figure 2.2, was determined based on the following screening and selection criteria:

- Presence and wide distribution of the acceptable Everett gravelly sandy loam or Ragnar-Indianola Association soils, which exceed the minimum infiltration rate
- Land slopes of less than ten percent
- Land area not within the 100-year floodplain
- Availability of a minimum undeveloped ten-acre parcel of land
- Presence of an unsaturated area between the infiltration point and the water table
- Ultimate projected hydrologic fate

Coarse-screening of the suitable infiltration area identified seven sites that met broad land use, geographic, technical, and environmental criteria. Figure 2.2 shows five sites remaining following fine-screening at the seven sites. Two sites were eliminated because they were determined to have higher impacts due to the presence of occupied residences and because they were smaller and farther away, making them less acceptable locations for the upland discharge site. The key steps in evaluating the five parcels during fine-screening included:

- Develop detailed fine-screening criteria
- Conduct windshield surveys to assist in applying each criterion
- Submit the fine-screening criteria to the CAC for review and modify the criteria in response to CAC comments
- Rank and tally criteria for each site to indicate high, medium, and low impact (based on available GIS information)
- Select the fine-screening shortlist



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: 0403_03-6_Figure.eps **Prepared by:** King County WLR Visual Communications & Web Unit

Figure 6.2
Conceptual Upland Discharge

CARNATION WASTEWATER TREATMENT FACILITY

The five sites are located in close proximity to the former City landfill and are generally higher in elevation than either identified CWWTF site alternative. The southern edge of the landfill property borders one of the sites; the distance between the landfill and the furthest site is approximately 1,600 feet. Surface geology, soil, water-level monitoring, and monitoring well drilling and testing data that were used to evaluate the five sites were derived from samples obtained from the southern portion of the landfill; direct access to the potential discharge sites was never established.[210]

Aerial photographs taken of the area in August 2001 by the Washington Department of Transportation (WDOT) showed few or no apparent wetlands or surface water features on the identified sites. Soil borings taken from the landfill property show the presence of recessional outwash gravels generally five to 15 feet from the surface. A discontinuous fine-grained unit resides beneath the gravel and can perch the water above on a local scale. In general, the unit does not cause water to reside within the gravel layer. Beneath the gravel or unit, a sequence of silty sands confine the water and form the uppermost, widespread saturated zone. The silty sands appear to have low permeability. Based on monitoring well data from September 2003 to February 2004, the water level in the water table aquifer rose approximately 4 feet in response to precipitation. National Weather Service records recorded 19.45 inches of precipitation approximately 30 miles to the west (Seattle-Tacoma International Airport) during the same period.[211]

Field studies show the shallow ground regime to be much less permeable than the gravel materials found at the surface. Mounding calculations indicate that with such a low permeability, the water table would mound and, under the proposed application rates, become totally saturated. This would raise the water table surface and could cause localized flooding. Using a typical range of permeability for similar sediments, a mound within the gravel was calculated to rise between five and 30 feet.

A minimum of two vertical feet is required between the bottom of the infiltration basin and the top of the groundwater mound for the basin to drain properly.[212] Locations within the City's landfill property with only five feet of permeable gravel at the surface would be too thin to properly allow for infiltration. It is likely that gravel would need to consistently be 15 feet thick or more across the ten acres of area for infiltration to be feasible. An additional site-specific investigation would be required to determine if the soils would have a sufficient thickness of material (gravel) to support infiltration and disposal.[213]

6.2.2.3 Wetlands Enhancement Study Area

Three options to potentially develop and/or enhance wildlife and aquatic life habitat using Class A reclaimed water from the CWWTF were evaluated within a 2.5-mile area around the City. These options included: 1) creation of off-channel rearing habitats in the undeveloped open space area of the Park, 2) creation of a creek or chain of ponds in a swale on the County property adjacent to the McElhoe Person levee, and 3) piping water to

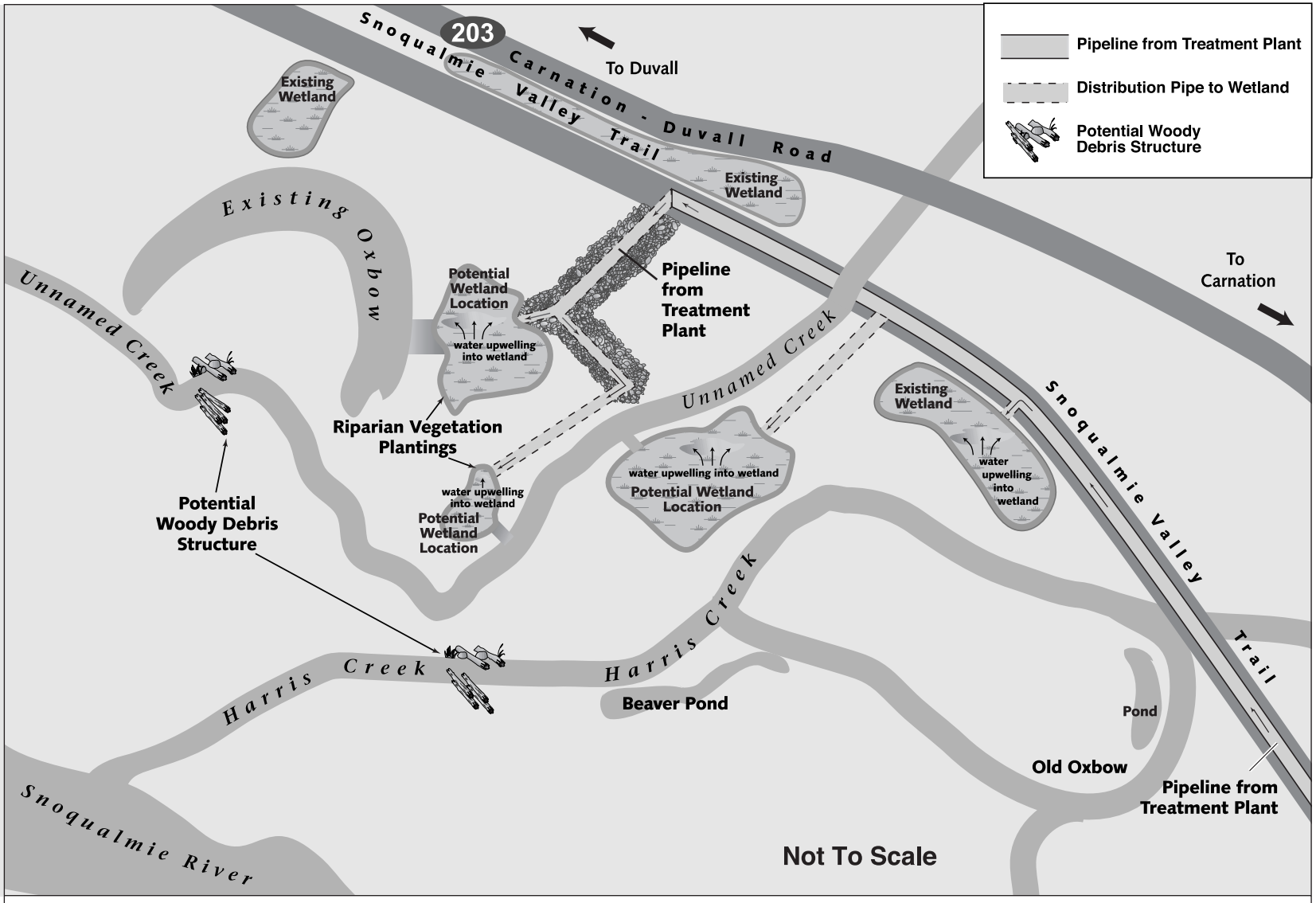
the SWA to enhance and/or create wetlands.[214] The SWA was recommended and pursued because of interest by WDFW, the property owner, and both interest and assistance from the non-profit organization, Ducks Unlimited. Ducks Unlimited agreed to participate with fundraising, design and construction of a wetlands enhancement project for this area. Wetland enhancement in the Snoqualmie Valley has great potential enhance the habitat connectivity for fish and other wildlife. The SWA has the disadvantage of requiring the longest pipeline to transport the reclaimed water to the SWA.

Use of the highly treated water to restore water to a portion of the SWA is supported by state agencies, environmental interest groups, the City, and the County.[215] The SWA is downstream of the TDR in the Snoqualmie River. The TDR has been identified in previous studies as being heavily used for spawning by Chinook and other salmonids. Reclaimed water discharged within the vicinity of smaller creeks could provide a measurable addition to the base flow as well as temperature benefits for the associated fish species. Piping from the CWWTF to the SWA would allow the water to be maintained at subsurface temperatures. Assuming a 2.5-hour delivery time to the SWA, the conveyance method could realistically lower the temperature of the reclaimed water by as much as 5.5 degrees Celsius.[216] In the summer, the additional water could potentially help maintain a cooler environment for native species while becoming a less favorable habitat for invasive warmer-temperature fish. The flows from the SWA would ultimately discharge into the Snoqualmie River below the TDR and virtually below all of the mainstem river salmonids spawning habitat.[217] Based on initial discussions with Ecology, the discharge would be required to meet Class A reclaimed water standards as well as be issued a NPDES permit.

As reported in the EIS,[218] and shown in Figure 6.3, the discharge concept to the SWA proposed the creation of two new wetlands on the property and the possible (under an expanded option) hydrologic enhancement of an existing wetland near Harris Creek. In addition, several flow-control structures could be installed along existing drainage routes to maintain water in the associated wetlands for longer periods of time than would occur naturally, independent of the delivery of new water to the site. These structures could be designed to increase the period of water inundation without requiring acreage expansion to any existing wetlands. If the SWA discharge alternative is selected for detailed design, site-specific studies may result in changes to the design described herein.

6.2.2.4 Conveyance to Existing Treatment Facilities

The evaluation of the conveyance alternative (i.e., conveying the City's sewage to existing treatment facilities rather than constructing a dedicated new facility for the City) was based on the review of previous studies. In 2001, King County contracted with HDR[219] to undertake a planning-level cost comparison of the direct conveyance of untreated wastewater to an existing County wastewater interceptor as compared to the construction of a new local wastewater treatment facility. Based on HDR's cost projections, the evaluation concluded that the costs associated with the provision of a local Class A water



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

File Name: 0403_03-5_Figure.eps
Prepared by: King County WLR Visual Communications & Web Unit

Figure 6.3
Conceptual Wetland Discharge

CARNATION WASTEWATER TREATMENT FACILITY

reclamation facility would be lower than the anticipated cost for conveyance. In addition, the environmental sensitivity and topographical landscape of the Snoqualmie Valley reduces the favorability of piping the City's wastewater to an existing County interceptor. The analysis was based on information from the 2000 City of Carnation Comprehensive Sewer and Facilities Plan[220] as well as County GIS maps. For comparison, HDR investigated areas zoned for mixed use within the City as well as over 150 acres within the anticipated UGA and identified five separate flow conveyance paths to existing wastewater interceptors.

Overall, there were several benefits to directly conveying untreated wastewater to an existing County interceptor. The volume impact of the additional wastewater flow from the City to the County's existing facilities would be minimal. Upon completion of connecting the conveyance system, the County would primarily be concerned with operating and maintaining the pipeline as opposed to a separate wastewater treatment facility, with its associated storage and disposal requirements. In addition, a relatively large land area for the construction of the facility would not be required, and a lengthy wastewater treatment facility siting process would be avoided.

Yet, each of the identified conveyance paths has disadvantages. A topographic divide separates the City, which is located in the Snoqualmie Valley watershed, from the existing County interceptors, which are located in the Lake Washington/Lake Sammamish watersheds. The divide rises over 500 feet above the Snoqualmie Valley floor and would require the use of a series of pump stations to continue conveying the flow. Each of the five proposed conveyance paths from the City to the existing County pipeline deviated either north or south to avoid pipeline construction within Lake Sammamish. The proposed routes generally followed existing road rights-of-way and minimized travel through temporary elevation gains.

In addition, rather than having the construction impact concentrated in one area, the pipeline conveyance alternative would potentially disturb several sensitive areas. HDR reported the existence of a number of habitats of endangered, threatened, and protected species along the proposed pipeline routes. These included red-tailed hawk, great blue heron, and active bald eagle nests, as well as salmon spawning grounds. In addition, the pipeline would have to traverse a number of rivers, creeks, and/or wetlands, which could be adversely affected by construction activities. The proposed pipeline routes would also traverse several identified erosion and landslide areas associated with steep slopes, vegetative cover, impermeable soils, and/or groundwater seepage. A large portion of the Snoqualmie River basin is subject to severe risk of earthquake damage as well as flooding along the water bodies. Proposed construction of the conveyance system alongside existing rights-of-way would disrupt traffic.

The County also evaluated a plan of conveying the City's wastewater to the Duvall Wastewater Treatment Plant.[221] However, the County concluded that the cost of

constructing approximately ten miles of conveyance pipeline, combined with the costs associated with increasing the capacity of the Duvall Wastewater Treatment Plant to accommodate the City's wastewater, would be substantially greater than the cost of constructing and operating a new wastewater treatment facility within the City. In addition, it would not have been possible to increase the capacity of the Duvall Treatment Plant in time to meet the City and County's agreed schedule.[222]

6.2.2.5 Non-Potable Water Reuse

The City currently has identified little industrial, residential, or irrigation demand for non-potable water. Potential major users of non-potable water identified within the UGA include the Park, Custom Concrete Casting, and Septic Technology, Inc. These three facilities currently purchase water from the City. Potential seasonal irrigation users within the UGA include the Carnation Tree Farm, Remlinger Farms, and some agricultural areas. These seasonal facilities currently either own private wells or purchase water from the Girl Scout Totem Council. Although the Carnation Golf Course and northern agricultural lands both lie outside of the UGA, they could also be interested in receiving reclaimed water for seasonal irrigation. Currently, the Carnation Golf Course obtains its water from a private well and most likely only irrigates the greens area of each hole.

Appendix E provides a copy of the letter from the City indicating that they do not believe it is prudent to pursue water reuse at this time. In general, the infrastructure required to convey reclaimed water to a small number of users is cost-prohibitive despite the associated environmental benefits. Conveyance of reclaimed water would require a separate water system with clearly marked colored piping and pump stations for distribution to end users. Year-round non-potable water requirements would use only approximately eight percent of the average annual startup flow in 2007. In the 2004 Comprehensive Sewer Plan,[223] it is estimated that the first phase of construction for the CWWTF project will cost $8.2 million. A conceptual-level estimate for conveying non-potable water to the same area would almost double the cost. The result would be prohibitively high installation and service costs for a limited number of clients spread over a large area. In addition, the majority of the irrigation needs would be seasonal, and therefore an alternative discharge method (or extended storage) would be required for up to nine months out of the year. The CWWTF will be designed to allow the non-potable reuse option to be further pursued if additional non-potable water customers materialize.

6.2.3 Conveyance Route Alternatives for Treatment Facility Discharge

Following treatment at the CWWTF, the highly treated water will be conveyed to the discharge location via a 12-inch HDPE pipeline. The Plant Alternatives TM[224] details a number of conveyance routes examined for the three discharge strategies chosen for further study during preliminary design. Figure 2.2 illustrates the single conveyance route evaluated for each of the two potential CWWTF sites to each discharge alternative.

6.2.3.1 Selection Criteria for Routing Methodology

Conveyance route alternatives were investigated by conducting a systematic evaluation of each route with regard to: 1) total construction cost, 2) operations and maintenance (O&M) costs, 3) difficulty and cost of easement and acquisition, 4) potential presence of and adverse impacts to shorelines, wetlands, and other identified environmental concerns, and 5) potential disruption impact to the community, including construction sequencing and access.

Conveyance route alternatives were developed using County GIS maps, information provided by Roth Hill and the City, and a “windshield survey” conducted by Carollo on September 30, 2003. Multiple conveyance routes to deliver highly treated water from the CWWTF site to the respective discharge location were identified for several alternatives. The conveyance route evaluation focused on identifying the most direct or feasible routes, minimizing easements on private property, and not requiring long stretches of pipe to be laid along Highway 203. Highway 203 serves as the major highway for all motorists traveling north and south through the City. Routes that cut across Highway 203 would likely be constructed by boring underneath the roadway to minimize traffic disruptions.

Historical roadways in close proximity to the Snoqualmie River were built by solidifying the foundation using split cedar rails laid perpendicular to the direction of travel. As time passed, the cedar rails sank into the ground and were covered with a layer of gravel. When these roads were modernized and paved with asphalt, the cedar rails were seldom removed. Providing a stable foundation, the rails typically lie approximately two to three feet below the asphalt and extend only a portion of the width of the pavement. The presence of cedar rails underneath any specific route is currently unconfirmed and was not included in the evaluation. As part of final confirmation of the selected discharge route, more detailed geotechnical borings will be initiated prior to construction to determine the presence of cedar rails close to the river.

6.2.3.2 Conveyance to the River Outfall

Based on an evaluation of the routing selection criteria, a single conveyance route for each of the two potential CWWTF sites was recommended to convey highly treated water from the CWWTF to the Snoqualmie River near the Bridge.

From the City-Owned Site

Three conveyance routes were initially identified to deliver treated highly treated water from the City-owned site to the proposed outfall near the Bridge. The recommended route begins at the City-owned site and continues a short distance east on Entwistle Street. The route then heads due north along Stewart Street to the Bagwell Street intersection and continues north along the UGA boundary to 60th Street NE (which becomes 310th Avenue NE as the road heads northward). The route follows 310th Avenue NE to the outfall located at the bridge. According to historical photos, flooding has submerged portions of 310th Avenue

NE along the Snoqualmie River at least once within the past 20 years, severely damaging the roadway. The route traverses areas that do not currently serve as major thoroughfares for the City and minimizes construction disruption impacts to the community. Easements will be required through sections of the route that have been designated as routes for future rights-of-way for the City (316th Avenue NE).

From the Weckwerth Site

A single route was evaluated to convey the highly treated water from the Weckwerth site to the river outfall at the Bridge. The route begins at the Weckwerth site and continues due east to the Snoqualmie Valley Trail (trail). The route then follows the trail north until reaching the same latitude as the Carnation Farm Road near that location. The route continues due west to cross Highway 203 and follows Carnation Farm Road to the outfall located at the bridge. Along Carnation Farm Road, the route crosses two small concrete bridges or culvert crossings. The pipeline would likely have to be either attached to the bridges or micro-tunneled underneath the streams.

6.2.3.3 Conveyance to Upland Discharge

Based on an evaluation of the routing selection criteria, a single conveyance route for each of the two potential CWWTF sites was recommended to convey highly treated water from the CWWTF to the upland discharge area southwest of the UGA.

From the City-Owned Site

Two conveyance routes were initially identified to deliver highly treated water from the CWWTF site to the proposed upland discharge area southwest of the UGA. An evaluation of the routes indicated that they were rated approximately equal in meeting the selection criteria. However, this did not take into account the advantage presented by one of the alternatives and the cost savings that could be realized if the pipeline were joint-trenched with the City's vacuum sewer pipes. It is anticipated that a joint-trenched pipeline would result in an approximately 15 percent direct cost savings for one of the routes. The potential direct cost savings and enhanced constructability provided sufficient advantage and led to a route recommendation. The route is anticipated to be much more favorable in constructability because it traverses the City by way of a residential street rather than through a commercial district.

The recommended alternative begins at the City-owned site and continues east along Entwistle Street, connecting with the trail. The route then follows the trail south and crosses the Tolt River on the trail. It is anticipated that the pipeline will be attached to the steel truss portion of the bridge while crossing the river. There is evidence of fire damage on the wooden portion of the bridge. For this reason, it is recommended that the wooden truss not be used for support. The route continues to follow the trail south before heading east on NE 24th Street. The route then continues due south to cross the edge of the old City landfill and connect with one of the land parcels identified as suitable for infiltration to groundwater.

From the Weckwerth Site

A single route was evaluated to convey the highly treated water from the Weckwerth site to the upland discharge parcels located southwest of the City's UGA. The route begins at the Weckwerth site and continues due east to the trail. The route then follows the trail south and crosses the Tolt River on the trail. It is anticipated that the pipeline will be attached to the steel truss portion of the bridge while crossing the river. As mentioned above, given that there is evidence of fire damage on the wooden portion of the bridge, it is recommended that the wooden truss not be used for support. The route then continues to follow the trail south before heading east on NE 24th Street. Following the right-of-way, the route continues due south to cross the edge of the old City landfill and connect with one of the land parcels identified as suitable for infiltration to groundwater.

6.2.3.4 Natural Wetland Enhancement to the Stillwater Wildlife Area

Based on an evaluation of the routing selection criteria, a single conveyance route for each of the two potential CWWTF sites was recommended to convey highly treated water from the CWWTF to the SWA. If chosen as the discharge alternative, the precise discharge location(s) within the SWA will be further developed in the design development phase. If a different wetland enhancement location is selected, a conveyance route will be developed as the site design is developed.

From the City-Owned Site

A single route was evaluated to convey highly treated water from the City-owned site to the SWA. The route begins at the City-owned site and continues a short distance east on Entwistle Street. The route then heads due north along Stewart Street to the Bagwell Street intersection and continues north along the UGA boundary to 60th Avenue NE. The route heads east on 60th Avenue NE, crossing Highway 203 and connecting with the trail. The route then travels north along the trail, crosses Highway 203 again and continues along the trail until reaching the delineated wetlands within the SWA.

From the Weckwerth Site

A single route was evaluated to convey highly treated water from the Weckwerth site to the SWA. The route begins at the Weckwerth site and continues due east to trail. The route then travels along the trail north, crosses Highway 203, and continues along the trail until reaching the delineated wetlands within the SWA.

6.3 Liquid Treatment Process Evaluation

Based on the water quality requirements identified in TM No. 11,[225] the County evaluated treatment alternatives for the CWWTF design. TM No. 6[226] details evaluations undertaken solely to select the liquid treatment processes.

6.3.1 Initial Selection Methodology

The County held a liquid process-screening workshop during which 21 different processes were compared for secondary treatment. Seven different processes were considered for filtration, three chlorination processes for disinfection, two processes for dechlorination, and three processes for UV disinfection. TM No. 6[227] documents the detailed treatment process evaluation. Selection criteria developed at the process-screening workshop included:

- Risk
- Capital cost
- O&M cost
- Footprint
- Energy consumption
- Reliability
- Operations staff familiarity
- Maintenance needs
- Odor control cost
- Enclosure cost

The selected treatment process train has to be capable of biological nutrient removal, have the flexibility to successfully meet the Class A Washington State reclaimed water quality standards,[228] and cost-effectively meet the associated reliability and redundancy requirements. From the initial list of potential treatment processes, three biological treatment alternatives, or scenarios that best met the selection criteria were identified:

- Scenario 1: sequencing batch reactors (SBR) with filtration
- Scenario 2: activated sludge biological nutrient removal (BNR) with clarification and filtration
- Scenario 3: activated sludge BNR with MBR technology

Each of these processes would be preceded by screening and grit removal and followed by disinfection for complete treatment. The type of equipment assumed in this chapter was selected solely for the purposes of comparing process costs. Equipment selection was re-evaluated in collaboration in preliminary design, as discussed in Chapter 7.

6.3.2 Preliminary Treatment

6.3.2.1 Screening

The CWWTF will require preliminary screening to protect downstream processes and associated appurtenances. In addition, screens can reduce the solids and organic loading to the downstream processes by removing smaller particulate matter. For the purpose of the cost evaluation of the SBR and BNR with clarification scenarios, it was assumed that two parallel rotary drum screens with six-millimeter (mm) openings would be installed at the CWWTF. The screenings would be conveyed to a washer-compactor to be cleaned and dewatered before disposal. A washer-compactor system would remove most of the fecal matter and reduce the volume of the wet screenings by approximately 50 percent to minimize disposal requirements.

The MBR process requires fine-screening; the recommended mesh size depends on the type of membrane selected. Fine-screening helps to maximize the effective life of the membranes and protect them from irreversible fouling and matting from hair or fibers. Flat-plate and hollow-fiber membrane manufacturers typically recommend fine screening to two mm or smaller. The preliminary cost evaluation assumes parallel perforated plate traveling band screens with two mm openings and an integrated washer/compactor/bagging unit.

6.3.2.2 Grit Removal

Grit removal is often provided to protect the downstream processes from abrasion damage, reduce pipeline and solids digester deposits, and prolong the effective service life of mechanical equipment. The grit removal system should be placed immediately upstream of the fine screens to minimize headloss and loss of screening surface area. Provisions for proper washing, dewatering, and disposal of the collected grit to minimize potential odor formation would need to be addressed. For the purpose of the preliminary cost evaluation, it has been assumed that a vortex-type grit basin would be installed.

Initial discussions with manufacturers and municipalities regarding vacuum-based sewer collection systems such as the one proposed for the CWWTF, have indicated that the influent will contain minimal volumes of grit. It is likely that a fine-screening system would remove the majority of the grit material prior to reaching the downstream basins even without a grit removal basin. It was determined that a grit-removal system would not to be incorporated in the CWWTF. Other types of grit-removal technology, such as grit cyclones will be evaluated at a later time in the event that the County chooses to retrofit grit removal equipment to the CWWTF. At that time, the County will addend the Facilities Plan prior to installation of the grit handling equipment.

6.3.3 Primary Treatment

The CWWTF will not require primary treatment prior to secondary treatment. Smaller wastewater treatment plants typically eliminate this step as a cost savings measure.

Instead, the wastewater is transferred directly from preliminary treatment to the secondary treatment process.

6.3.4 Secondary Treatment

6.3.4.1 SBR Technology with Filtration

Table 6.1 lists the major benefits and drawbacks of SBR and SBR-type processes. After consideration of the benefits and drawbacks of the two SBR-type processes, a true batch SBR system with a post-equalization basin was selected to be used for the scenario cost comparison. The SBR system would allow for complete access of basin internal mechanisms, including the diffuser system, from above the water level. In addition, the system would allow ideal quiescent settling to produce a high and consistent water quality.

Table 6.1 Evaluation of SBR and SBR-Type Processes
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Process	Benefits	Drawbacks
SBR[229]	• Smaller footprint • Recycle pumping eliminated • Ease and flexibility of operation: treatment phases may be adjusted within a cycle • Lower solids in treated water due to quiescent settling step • Lower volume of mixed liquor generated • Does not require separate clarification basins • Modular construction allows for expansion	• Has limited capacity to handle instantaneous peak flows as compared to other suspended growth systems • Flow equalization (pre and/or post) may be necessary due to traditional intermittent flow • Complex design: requires more instrumentation, monitoring devices, and automatic valves than many of the other biological processes • Skilled maintenance required for instrumentation and control devices • Higher headloss
SEQUOX®	• Has larger capacity to handle peak flows than traditional SBR systems • Uses common wall construction to best utilize available footprint • No moving equipment underneath water • Continuous flow system	• Larger footprint requirement • Requires separate clarification area • Proprietary design

Source: Carollo Engineers, *Technical Memorandum No. 6 - Treatment Process Configuration*, 2004.

6.3.4.2 Activated Sludge BNR with Clarification and Filtration

Table 6.2 provides a comparison of the benefits and drawbacks of the five activated sludge configurations capable of full biological nutrient removal. All biological processes in this scenario require a separate clarification process. Two-channel oxidation ditches with separate anaerobic selector tanks were selected with a five-stage Bardenpho configuration for the scenario cost comparison. The oxidation ditch is a proven process with little operator attention and simple control strategy required. However, this scenario would require the largest footprint of the three technologies evaluated.

Table 6.2 Evaluation of Activated Sludge BNR Processes
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Process	Benefits	Drawbacks
A^2O^{TM}	• Produces good solids settleability • Relatively simple operation and control • Energy efficient • Reduced oxygen requirement • Moderate reactor volume	• Limited P removal • Proprietary process • Limited N removal based on internal recycle ratio • Requires higher BOD/P ratio
UCT	• Good P removal • Good N removal • Moderate reactor volume • Produces good solids settleability • Relatively simple control	• Complex operation • Requires additional recycle stream
VIP	• Good P removal • Good N removal • Moderate reactor volume • Produces good solids settleability • Relatively simple control • Requires lower BOD/P ratio than UCT process	• Complex operation • Requires additional recycle stream • More equipment required for staged operation
Bardenpho (five-stage)	• Excellent N removal • Produces good solids settleability • Relatively simple control	• Limited P removal • Larger reactor volumes
Clearbrooke™ (deep shaft)	• Higher oxygen transfer	• Proprietary process • Deep excavation requirements • Limited experience • Extremely confined access for reactor maintenance

A^2O = anaerobic/anoxic/oxic process
N = nitrogen
P = phosphorus
VIP = Virginia Initiative Plant process
UCT = University of Cape Town process

Sources: C.P.L. Grady, G.T. Daigger, and H.C. Lim, *Biological Wastewater Treatment*, 2nd ed. (New York: Marcel Dekker, Inc., 1999), 496-503;Metcalf and Eddy, *Wastewater Engineering: Treatment and Reuse*, ed. G. Tchobanoglous, F.L. Burton, and H.D. Stensel, 4th ed. (New York: McGraw-Hill Inc., 2003), 809-815.

6.3.4.3 Activated Sludge BNR with MBR Technology

The MBR biological treatment train is anticipated to be configured as two reactors, with a plug flow activated sludge reactor as the first basin. The following tank would serve to house the MBR system. Separation of the MBR from the first basin from the following tank membrane basin permits independent optimization of the aeration equipment and activated sludge process as well as isolated membrane cleaning. Dual trains with a modified BNR removal configuration (similar to the A^2O^{TM} process) were combined with hollow-fiber membranes for the cost comparison. The configuration would consist of anoxic, anaerobic, and aerobic basins in series. Four times the influent flow rate would be recycled back to the anoxic zone from the MBRs. Multiple MBR tanks would allow the facility to polish the full liquid stream from the aerobic basins while one membrane basin is being serviced. Membranes produce a micro-filtered water quality and eliminate the requirement for separate tertiary filtration. Table 6.3 summarizes the benefits and drawbacks of the activated sludge BNR with MBR technology.

Table 6.3 Evaluation of Activated Sludge BNR with MBR Process
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Process	Benefits	Drawbacks
MBR	• Small footprint • Automated and flexible operation • Lowest turbidity levels • Requires a lower disinfection dosage as compared to more conventional technologies	• Requires fine screening • Has limited capacity to handle peak flows • Complex design • Skilled maintenance required • Chemical cleaning required • Limited membrane life span

Source: Carollo Engineers, *Technical Memorandum No. 6 - Treatment Process Configuration*, 2004.

MBR equipment requires fine screening, is more sensitive, and has higher skilled maintenance requirements than conventional aeration basins. An entire tank must be taken out of service for several hours to adhere to periodic chemical cleaning schedules. Routine maintenance requirements vary dependent on the membrane supplier but may be conducted as frequently as daily. In addition, the estimated life span of a membrane cassette is estimated to be between five to 10 years.

Membranes are compact processes that have small footprints and provide for automated and flexible operation. The modular equipment allows for ease and flexibility when increasing plant capacity, provided that the basins were sized for expansion. The addition of more membrane area can also serve to reduce the operating flux while maintaining the same production rate of highly treated water. Membranes use polymeric filtration media

with pore sizes in the range of 0.04 to 0.4 micron to sieve and separate solids. The physical separation barrier provided by the membranes is the most effective and reliable treatment mechanism to meet Class A reclaimed water requirements,[230] and is less susceptible to turbidity spikes during process upsets as compared to other treatment technologies.

6.3.5 Tertiary Treatment

Filtration processes including multi-media, deep sand, automatic backwash, continuous backwash, fabric, microfiltration membrane, and reverse osmosis were evaluated against the selection criteria. Granular media and cloth filters are considered to be equal, and both have been proven to meet Class A reclaimed water standards.[231] A list of benefits and drawbacks of the two processes is presented in Table 6.4. The County currently uses granular media filters to produce Class A reclaimed water at its South Treatment Facility. It is also the County's experience that cloth and continuous backwash filters are easier to operate and smaller in footprint than conventional sand filters. For the purpose of the preliminary scenario cost evaluation, it was assumed that continuous backwash filters would be installed.

Table 6.4 Comparison of Filtration Processes
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Process	Benefits	Drawbacks
Cloth filters	• Smaller footprint • High-quality treated water • Lower backwash rate • Continuous filtration during backwash • No underdrains required	• Potentially higher capital cost • Possible turbidity breakthrough • Requires backwash water
Granular Media filters	• High-quality treated water • Operational familiarity	• Less protection against turbidity breakthrough • Possible filter media loss • Possible mudball formation and buildup of emulsified grease • Requires backwash water

Source: Carollo Engineers, *Technical Memorandum No. 6 - Treatment Process Configuration*, 2004.

6.3.6 Disinfection

Although the discharge alternatives require different levels of disinfection, the County has committed to providing treatment capable of meeting Class A water reclamation standards.[232] Hence, the disinfection levels must meet a total coliform organism count not exceeding the most probable number (MPN) of 2.2 per 100 mL within a seven-day geometric average and not exceeding 23 MPN per 100 mL at any time.[233]

6.3.6.1 Ultraviolet Disinfection

Historically, design criteria for UV disinfection have been based on manufacturer recommendations, bioassay results, and/or pilot testing and approved by regulatory agencies on a case-by-case basis. In 2003, the National Water Research Institute (NWRI) published updated design criteria for UV transmittance, effective UV dosages, and maximum turbidity levels.[234] Although the NWRI guidelines have not been officially adopted by the State of Washington, the criteria represent the most current guidance for water reuse to achieve disinfection to an MPN of 2.2 per 100 mL. Ecology has indicted that the NWRI guidelines or approved equivalent will be required for reclamation facility approval.[235] Therefore, it is recommended that the design standards and technology be adopted for the CWWTF during preliminary design.

Despite optimum coagulation and filtration, granular- or cloth-filtered water will have higher comparative turbidity levels than those expected from MBR treatment. According to the NWRI standards, MBR has been proven to produce highly treated water with turbidity levels less than 0.2 nephelometric turbidity units (ntu). These are consistently lower than other tertiary filtered water that would have turbidity levels between two and five ntu.[236]
The lowered turbidity produced by the MBR process, in turn, allows for increased UV transmittance and smaller disinfection facilities than conventional processes. The UV disinfection system will be designed to provide a fully redundant train, maintaining complete disinfection should one train be required to be out of service.

6.3.6.2 Residual Chlorination (If Necessary)

If treated to reclaimed standards, regulatory compliance requires a minimum chlorine residual of 0.5 mg/L for reclaimed water according to the *Washington Reclamation and Reuse Standards*.[237] Initial discussions with Ecology have indicated that the DOH and Ecology may grant a chlorine residual waiver for discharge to wetlands or for subsurface application and flow irrigation. If the highly treated water is discharged to the Snoqualmie River, compliance limits the maximum chlorine residual to 0.5 mg/L. Adding a chlorine residual will increase the estimated capital and increase operating costs.

6.4 Solids Handling

The CWWTF produces two major sources that require solids handling: screenings and wasted solids from the secondary process. Solids from screenings include denser organic and inorganic materials, which are physically retained by the mesh material. Solids from biological or chemical processes are composed of flocculated material from cellular and suspended solids material or material from chemically attracted conglomerations, respectively. Residual solids wasted from biological processes typically encompass the majority of the material requiring disposal. Proper treatment of biological solids includes processes for both mass and volume reduction. Due to the relatively low volumes of waste flows at the CWWTF, solids will be held and/or thickened before being transported to a

regional facility. The solids will be stabilized, dewatered, and prepared for land-application at the County's regional facility. No design or construction modifications are anticipated to be required at the regional facility to accommodate the relatively low volumes of solids produced at the CWWTF. TM No. 7[238] details evaluations undertaken to select the solids handling alternatives.

Wasted solids thickening processes include gravity thickening, dissolved air flotation, gravity-belt thickening, rotary-drum thickening, and centrifugation. Many wastewater treatment facilities generally thicken onsite, increasing the solids to a typical range of three to six percent solids.[239] Gravity thickeners have larger footprints but minimal O&M costs. Dissolved air flotation processes are effective but have higher operating costs. Centrifuges have higher power demands and can produce dewatered solids concentrations. Gravity-belt thickeners have small footprints but higher polymer addition requirements to aid in conditioning, as well as other O&M costs.

6.4.1 Headworks Residuals

TM No. 6[240] recommended the collected headworks screenings and grit be cleaned and dewatered as accumulated to minimize the potential for odor production. A suitable central location will house the headworks residuals in a combined screenings, washer compactor, and bagger unit. The combined unit will prevent the residuals from increasing the ambient odor concentration in the headworks building, thereby reducing the overall handling cost. The screenings and grit chamber residuals will be transported to a local landfill for final disposal. Table 6.5 provides an estimate of the disposal volumes and weights from the headworks residuals based on typical design parameters.[241]

Table 6.5 Preliminary Estimate of Headworks Residuals Volumes Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks

Design Year Flow	Disposal Weight (lb/day)[a]	Disposal Volume (ft^3/day)[a]
Average annual	135	2.4
Maximum monthly	175	3.1
Peak daily	283	5.0

lb/day = pounds per day

ft^3/day = cubic feet per day

a. Assuming residuals are washed and dewatered with weight and volume reduced by 50 percent.

6.4.2 Handling of Wasted Solids

Solids wasted from the chosen activated sludge process will be transported to a County regional treatment facility. Two scenarios were evaluated to determine the most

cost-effective transportation method: 1) gravity-thickened solids stored in aerated holding basins until transportation and 2) mechanically thickened solids stored in aerated holding basins until transportation. Both scenarios assumed transportation to the County's South Treatment Plant, approximately 30 miles away. As a closer County regional facility (Brightwater) becomes available in the future for solids handling, the County will reevaluate the economic advantage of this location for solids discharge. Table 6.6 provides a preliminary estimate of the volumes of solids transported.

Table 6.6 Estimate of Transported Solids Volumes
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Flow	Volumes Transported by Scenario (gpd)	
	Scenario 1 Gravity-Thickened Solids	**Scenario 2 Mechanically Thickened Solids**
Solids concentration (%)	2	4
At average annual flow	2,700	1,380
At maximum monthly flow	3,100	1,580
At maximum daily flow	5,200	2,340

gpd = gallons per day

Scenario 1 assumes that the solids would be periodically pumped directly from the activated sludge basins to aerated holding basins. The covered holding basins would provide gravity thickening of solids and decanting before transportation to the South Treatment Plant. The basins would have a combined design hydraulic residence time (HRT) of nine days at maximum monthly loadings. After the supernatant is decanted, liquid haul tanker(s) would transport approximately a two percent solids concentration to the regional facility. Use of these tankers should prevent odors from escaping into the surrounding environment. The City of North Bend Wastewater Treatment Plant gravity thickens their wasted solids (oxidation ditch treatment) from a 0.5 percent solids concentration to two percent within an aerated holding tank. Thickened solids are transported each week to the City of Edmonds Wastewater Treatment Facility. Transportation generally occurs one day per week and requires approximately three trips. Operating staff at the City of North Bend Wastewater Treatment Plant indicated that gravity thickening to two percent solids could be consistently achieved.

Scenario 2 assumes that the CWWTF would require a solids-thickening unit and smaller aerated holding basins. Recent developments in MBR technology have resulted in the use of membranes for the thickening of biosolids. The Cauley Creek Water Reclamation Facility in Duluth, Georgia, has recently initiated the use of membranes for solids thickening. This process provides an improved method of decanting the liquid from the holding basins. The facility currently thickens to a solids concentration of four percent with this process.

CWWTF solids could also be thickened using a more conventional process such as a gravity-belt thickener to a four to eight percent concentration with the use of polymer. Either thickener process would likely be in operation approximately one hour per day on an average basis. The wasted solids would be held in aerobic holding basins for an average hydraulic residence time of nine days at maximum monthly loadings before being transported to the South Treatment Plant on liquid haul tanker(s).

6.5 Odor Control

King County's commitment to odor control focuses on minimizing community nuisance odor through prevention and control. The County has a recommended policy[242] for the prevention of nuisance odors from wastewater facilities as required under their Regional Wastewater Services Plan and Ordinance Number 13680, Section 5B TPP-4. Design, control, and operating requirements also stem from the County's *Odor and Corrosion Control Design Standards.*[243] These documents provide general guidance, establish minimum design standards, focus on conventional operational strategies including chemical and biological treatment, and propose operational strategies. As a result, the CWWTF design philosophy is based on minimizing the concentration of odorous compounds produced in a cost-effective manner. Potential nuisance odors can be prevented from adversely affecting the surrounding community by three direct methods:

- Prevention of odor generation at the source
- Destruction or capture of odors before release to the environment
- Dispersion of odors to below the odor detection threshold

The CWWTF will be located within the City's designated UGA. The two potential sites initially identified for the facility are located either adjacent or in close proximity to businesses or residential areas, south or southwest of downtown. Topographical maps have indicated that the majority of the City's populated areas may be up to ten feet higher in elevation than either of the potential facility sites. The prevailing winds in the greater western Washington area mainly originate from the southwest. Emitted odors from the CWWTF must therefore be substantially controlled at the source in the most economical manner to prevent nuisance odors from adversely affecting the surrounding community. TM No. 8[244] details the odor control strategies based on initial discussions with the County's Odor Task Force. The recommended design strategy has subsequently been reviewed and updated but relies on the same principles.

6.5.1 Methodology

Since both potential CWWTF sites under consideration are upwind and lower in elevation than the majority of City's structures, it is critical that the odor control system be designed in a cost-effective manner that is also sensitive to community needs. As a result, the design philosophy for the CWWTF is to incorporate conservative provisions to effectively contain

and treat nuisance odors that result from the treatment processes with the highest potential of producing detectable odors.

6.5.2 Odor Handling Strategies

There are three primary methods of treating odorous gases produced at wastewater treatment facilities: physical, chemical, and biological. Physical methods include adsorption, dilution, oxygen injection, scrubbing towers, and turbulence-inducing facilities. Chemical methods include oxidation, precipitation, neutralizing agents, acidic/alkaline scrubbing, and thermal oxidation. Biological methods include reuse of off-gas as inlet gas to aeration basins and biologically active filters. The most common odor control methods were evaluated; these included single-stage chemical scrubbers, activated carbon absorbers, biologically active filters, and thermal processes.[245] Treated air will be discharged through a vent stack designed to encourage atmospheric dilution.

In lieu of individual enclosures, mechanical forced air exhaust ventilation of the headworks building will allow easy operator access to the equipment. Air will be vented from the structure at a minimum of 12[246] air changes per hour (ACH) and sent to the odor control facility. It is anticipated that the odorous compounds from the headworks system will contain the highest concentrations of hydrogen sulfide.

The solids holding basins, anaerobic and anoxic basin zones, and membrane feed pump wet well are anticipated to be covered and mechanically vented, leaving at least two feet of freeboard space. The aerobic zones were not identified as a nuisance impact risk. The air emitted from the weir aeration into the MBR wetwell could likely contain volatile organic compounds (VOC) and require additional treatment in the odor control facilities. Air emitted from the anaerobic and anoxic biological treatment zones typically does not have high concentrations of hydrogen sulfide but may contain other oxidizable compounds that may require treatment.

The aerated solids thickening/holding basin is to be enclosed and provided with mechanical venting and odor treatment. The air stream emitted from the processing of the wasted solids will be mainly composed of VOCs and will contain sulfides. Table 6.7 presents a preliminary estimate of the minimum vent rates required for each process based on the recommendations. The odor control system will likely far exceed the required ventilation rates calculated by the model.

Table 6.7 Estimated Individual Minimum Odor Control Vent Rates Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks		
Process Location	**Design Rate (ACH)**	**Vent Rate (scfm)**
Headworks	12	5,220
Anaerobic and anoxic basin zones and membrane feed pump wet well surface	6	170
Aerated solids holding basins	6	250
Design total		**5,640**
ACH = air changes per hour scfm = standard cubic feet per minute		

6.6 Overall Cost Estimate Evaluation Criteria

6.6.1 Cost Estimating Strategy

Costs for wastewater treatment facilities can be estimated using one of three general approaches:

- Cost curves derived from as-built costs of similar facilities
- Detailed quantity estimates for the particular facility
- Major-item quantity estimates with percentage allowances

Cost curves are often used at the planning level because it is not possible to identify quantity estimates for more than a few general cost items at this level of project development. Cost estimates based on detailed quantity estimates, therefore, are not possible for planning projects. The third approach, however, combines aspects of the first two approaches. Unit quantities are developed for major costs items such as concrete and excavation, and the size and power rating of major equipment items are identified. Building costs are estimated based on the estimated square footages of facilities. Other costs, such as those for piping and miscellaneous mechanical equipment, electrical equipment, instrumentation, site work, contractor mobilization, demobilization, bond, and profit are estimated as percentage allowances, where the percentage allowances are estimated based on experience with similar projects in the past. This is the general approach taken for the CWWTF. As a check of these costs, however, TM No. 13 provides a comparison of the CWWTF costs against those from previous projects.[247]

Cost estimating criteria, in conformance with requirements specified for federal projects, were developed for use in cost comparisons. Additional details on cost assumptions as well as the cost estimating criteria used are presented in TM Nos. 6,[248] 7,[249] 8,[250] and 14.[251] All evaluations assumed a present-worth period of the facility design life (from December 2007 to 2030) with the 2004 federal discount rate of 5.875 percent.[252]

6.6.2 Treatment Facility Costs

A summary of the cost-effectiveness analysis for the proposed CWWTF is presented in Table 6.8, with detailed costs presented in Appendix F. The costs shown have been develop specifically for the purpose of comparing the various alternatives and do not necessarily reflect the actual or estimated costs for construction. These comparative costs are likely to be conservatively high but apply to all of the alternatives. It should be noted that the annualized maintenance cost for the MBR scenario includes an additional cost of approximately $27,000 for repair and replacement of the membrane cassettes.

Table 6.8 Scenario Alternatives Present Worth Cost Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Cost Type	Estimated Costs ($)		
	Scenario 1 SBR	**Scenario 2 Oxidation Ditch**	**Scenario 3 MBR**
Construction and Allied Costs			
Mobilization	650,000	600,000	500,000
Site work	965,800	907,500	665,000
Treatment and support areas	5,272,100	5,193,800	4,719,500
Odor control	665,000	600,000	500,000
Contingency (10%)	775,300	730,200	638,400
Overhead and profit (15%)	1,246,200	1,204,800	1,053,400
Sales tax (8.8%)	840,800	812,800	710,700
Consultant/owner costs	3,807,000	3,717,000	3,374,000
Capital Subtotal	14,202,200	13,766,400	12,161,000
Annual Operations and Maintenance[a]			
Labor[b]	90,000	90,000	90,000
Energy	51,000	51,000	78,000
Maintenance	102,500	97,500	129,300
Chemicals	70,000	70,000	72,000
Miscellaneous	20,000	20,000	20,000
Annual O&M subtotal	330,500	328,500	389,300
Total Present Worth[c]			
Total capital	14.2	13.8	12.2
O&M	4.1	4.0	4.7
Total Project	**18.3**	**17.8**	**16.9**

a. Does not include solids transportation costs.

b. Assumes one full-time employee equivalent, regardless of alternative.

c. Present worth costs for the design life of the CWWTF (2007-2030) are dollars in millions for Year 2004 and assumes 5.875 percent discount rate.

6.6.2.1 Wasted Solids Handling Costs

The ease of transferring waste solids to a septic tanker for transport decreases as the percent solids fraction increases. The cost estimate evaluated the relative costs of transporting three varying concentrations of thickened sludge. Based on the cost evaluation, gravity thickening (two percent solids) has a negligibly higher present worth in comparison to thickening with a MBR (four percent solids). Thickening to six percent solids by use of a gravity belt thickener was determined as much higher in cost. Decanting waste solids with an MBR is a new method of thickening with limited experience. The County may choose to membrane thicken in the future but will proceed with gravity decanting in design development. Table 6.9 compares the cost of thickening the waste activated sludge to two, four, and six percent solids onsite and transportation to another County facility.

Table 6.9 Solids-Handling Cost Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Cost Type	Estimated Costs ($)		
	Two Percent Solids	Four Percent Solids	Six Percent Solids
Installed capital cost	850,000	1,350,000	1,940,000
Annual O&M costs[a]	127,300	71,400	72,100
Present worth Analysis			
Capital	850,000	1,350,000	1,940,000
O&M	1,475,000	827,000	835,000
Total present worth (22 years)[b]	2,325,000	2,177,000	2,775,000

a. O&M costs are dollars per year in 2004. Assumes labor and transportation costs.

b. The total present worth accounts for costs incurred at the CWWTF and for solids transportation to the South Treatment Plant. It is assumed that the cost of processing the solids at the South Treatment Plant is the same for all of the three options.

Source: Einfeld, Brad. Carollo Engineers, Carnation WWTF Solids Handling Letter to John Komorita, Project Manager. July 12, 2004.

6.6.2.2 Other Wastewater Treatment and Facility Costs

Each of the three secondary treatment options defined in Chapter 6.3 have been coupled with the necessary facilities to allow cost comparisons for an operational CWWTF. The following processes have been designed with redundancy constraints to address either process constraints or regulatory requirements and form the basis for cost comparison. Additional assumptions for the cost comparison include:

- Estimates do not include any potential costs associated with the purchase or lease of land for the CWWTF.
- Each scenario assumes two single-stage screening systems installed in parallel. The second screen serves as the redundant train for the facility.
- Each scenario uses a dual-biological-train configuration.
- The design of the membrane tanks includes five tanks, with one redundant unit normally in service. The configuration allows a single membrane tank to be taken out of service for chemical cleaning or maintenance while the other tanks continue to provide full treatment at an increased membrane flux rate. Operating at the lower flux rates during normal operation increases system flexibility and may allow longer operation between maintenance cleaning cycles.
- Standby clarifiers are not required either for Class II wastewater treatment standards[253] or for Class A reclamation standards.
- Media sand filters have been designed with one redundant cell on standby.
- Cost estimates for the UV system are based on meeting design average and peak flows according to NWRI design standards for reclaimed water facilities. The system is assumed to be composed of a two-parallel-train closed-channel UV system (two modules per train). Either one or both modules from a single train will be in service, depending on the instantaneous flow. One train in service will provide full disinfection at design year. The second train will provide the necessary redundancy to maintain disinfection. The operating costs for UV disinfection assume that DOH and Ecology will grant a waiver from maintaining chlorine residual. If a chlorine residual of 0.5 mg/L is required according to the Reclamation Standards,[254] the UV system will need to include supplemental hypochlorite addition, which will require additional capital and increase operating costs.

6.6.2.3 Treatment Facility Evaluation

The planning-level cost estimates demonstrates that the difference between the scenarios falls well within the error range of the estimates. Table 6.10 provides a comparison of the three process trains for several key design criteria. Overall, the MBR technology was determined to have costs comparable to the other processes due to the negligible amount of I/I to the collection system (small peaking factor). Conversely, MBRs were determined to have the highest energy requirements in relation to the other processes.

Table 6.10 Scenario Process Comparison Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks			
Parameter	**Scenario 1 SBR**	**Scenario 2 Oxidation Ditch**	**Scenario 3 MBR**
Risk	+	+	+
Capital costs	O	O	O
O&M costs	O	O	–
Facility space requirements	–	–	+
Energy consumption	O	O	–
Process reliability	+	+	O
Operations familiarity	O	O	O
Maintenance requirements	+	+	O
Odor control costs	O	O	+
Enclosure costs	O	–	+
+ = superior O = average – = inferior			

Based on the present-worth analysis and the process comparisons, activated sludge with MBR technology (Scenario 3) was recommended for the CWWTF. The MBR technology provides the highest water quality while requiring the smallest environmental footprint. In addition, the City can have a state-of-the-art treatment facility for a cost that is comparable to a conventional treatment facility.

6.6.3 Conveyance and Discharge Costs

Table 6.11 provides a present-worth cost comparison of the evaluated conveyance and discharge alternatives. Key assumptions made in this cost comparison include:

- Costs to the upland and wetlands discharge alternatives include a 24-hour emergency storage basin.
- Easement costs were calculated in the cost comparison but did not include any assumed leasing or land acquisition costs associated with the upland discharge site.
- Annual operations and maintenance costs for the discharge alternatives include maintenance labor associated with the discharge method and energy required for conveyance pumping costs.

Table 6.11 Conveyance and Discharge Alternative Cost Comparison Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Discharge Alternative	**Approximate Conveyance Distance (mi)**	**Total Capital Cost[a] ($)**	**Annual Labor and Maintenance Costs($)**	**Total Present Worth[b]($)**
Conveyance from City-owned Site				
River	1.6	1,717,000	3,400	1,756,400
Upland	2.3	4,807,000	14,000	4,969,300
Wetlands	2.8	4,174,000	53,900	4,798,600
Conveyance from Weckwerth Site				
River	2.7	2,818,000	8,600	2,917,700
Upland	1.6	4,119,000	12,200	4,260,400
Wetlands	3.0	3,839,000	53,700	4,461,300

a. Total capital cost including direct construction, sales tax, engineering services, construction management, and allied owner costs.

b. Present-worth analysis is in 2004 dollars, a 5.875 percent discount rate, and the facility design period (2007-2030).

Based on the planning level cost analysis performed for conveyance and discharge, the river outfall discharge alternative is the least-costly alternative (capital and annual labor and maintenance) for either potential treatment facility location. The river outfall discharge alternative has the shortest conveyance distance from the City-owned site, while upland discharge has the shortest conveyance distance from the Weckwerth site. The wetlands discharge alternative is the next least-costly alternative, with capital costs of an additional $2.2 million from for the City-owned site.

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7.0 FINAL RECOMMENDED ALTERNATIVE

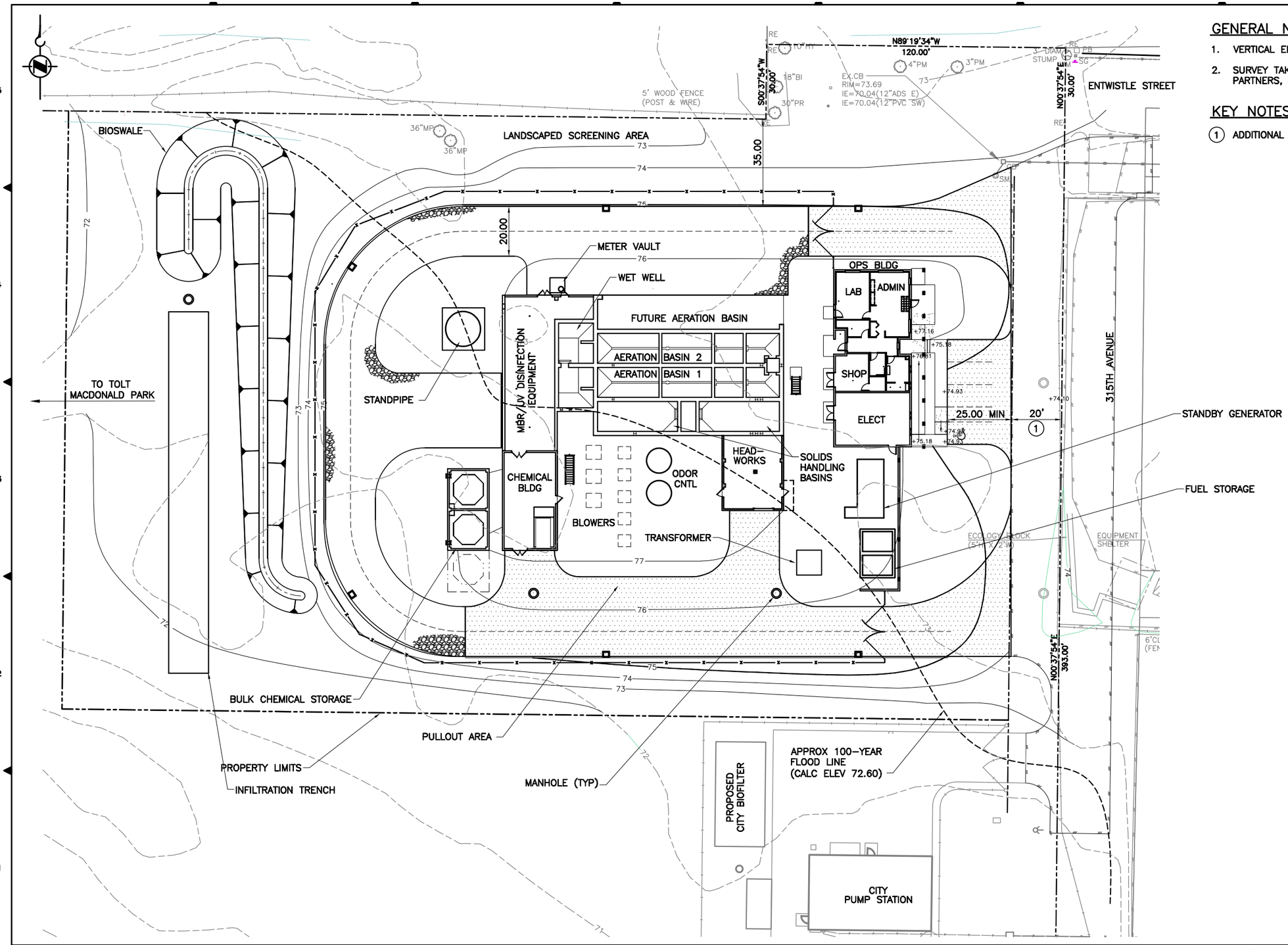
7.1 Recommended Treatment Facility Site

In Fall 2004, the Executive selected the City-owned site as the location for the new CWWTF. The recommended site was selected based on a number of considerations including: 1) the environment, 2) cost, 3) engineering, 4) community impacts, and 5) County policy associated with capital and O&M. The City-owned site will not require acquisition of land from a private entity or additional pumping between the vacuum pump station and the CWWTF headworks. The County is in negotiations to purchase as much as two acres of property, with the facilities being located on approximately 0.6 acres of land, located outside of the current 100-year floodplain. The City and County will be involved in discussions to come to an agreement for long-term use of the CWWTF site area. The City-owned site is zoned for light industrial and manufacturing use. Based on Title 15 of the City's municipal code,[255] manufacturing, processing, repairing, and assembling establishments are permitted in these areas. Although sewage treatment is an industrial process, the City requires a Conditional Use Permit be procured for the CWWTF to be constructed within this zone.

For the new CWWTF, the County will strive to achieve a building design that substantially reduces negative environmental impacts. Leadership in Energy & Environmental Design (LEED®) concepts can be followed to address environmental and worker comfort issues such as machine clearances, acoustics, and day lighting. Design of the facility in a "green" manner can reduce the overall operating costs, increase worker productivity, and reduce potential indoor air quality problems.

Initial site planning has been compatible with LEED® design concepts, and the incorporation of cost-effective green engineering elements will be continued in detailed design efforts. The proposed architectural appearance of the buildings at the site has been developed so that the facilities will blend in with the surrounding area, existing structures, and landscaping. To accomplish this, the taller (two-story) structures will be located to the rear of the site, away from other land parcels. The single-story operations building will be aligned parallel and adjacent to the roadway. Figure 7.1 provides a preliminary layout of the CWWTF.

The CWWTF will be separated into three facility/operations areas: 1) operations building; 2) headworks, activated sludge basins, and solids holding; and 3) MBR, UV disinfection, and chemical feed facility. The operations building, located on the east end of the site, includes the administrative office, restroom facility, laboratory, electrical room, and



GENERAL NOTES:

1. VERTICAL ELEVATIONS ARE BASED ON NAVD 88 DATUM.
2. SURVEY TAKEN ON DECEMBER 14, 2004 BY ROTH HILL ENGINEERING PARTNERS, LLC.

KEY NOTES:

(1) ADDITIONAL 20' CITY RIGHT OF WAY, TO BE VERIFIED.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED: JPC
DRAWN: BJE
RECOMMENDED:
APPROVED:
CHECKED:
SCALE: 1"=20'
CONTRACT NO: E23020E

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.1

RECOMMENDED WWTF SITE PLAN

DATE: SEPT, 2005
FILE NO: 423557/###
DRAWING NO:
SHEET NO: OF

H:\Client\KingCo-DNR_SEA\6820c10\Dwg\Dwg\FIGURE_7-1 9-23-05 09:34am JChessboro XREFS: D-TTL-XC-CARN; X0256-A-20-0101; x6820-C-00-111; x6820-S-30-111; x6820-C-00-101

maintenance workshop. The headworks will be south of the activated sludge basins and solids holding basins at the center of the facility site. The MBR, UV disinfection, and chemical feed structures will be located west of the activated sludge and solids holding basins. Space is available at the far west end of the facility for a potential 24-hour onsite storage tank if the wetlands discharge alternative is selected. Based on preliminary discussions, stormwater originating at the treatment facility site will be treated through a bioswale and directed to subsurface disposal.

7.2 Recommended Discharge Location

Based on the results of the environmental review and cost considerations in Fall 2004, the Executive directed County staff to carry forward the river outfall and wetlands discharge alternatives for further study. As documented in the EIS[256] and other previous reports, the upland discharge to groundwater alternative was eliminated as an option based on available hydrogeology information, environmental review, and cost considerations. Although wetlands enhancement of the SWA offers an opportunity to use reclaimed water from the CWWTF to enhance wildlife habitat, preliminary estimates place the alternative at approximately $2.2 million more than the river outfall discharge alternative. This alternative also presents other logistical and technical issues, such as permitting certainty within the time needed for plant operation. Design and permitting activities will proceed with the river outfall discharge alternative as shown in Figure 7.2, but the County will continue to actively pursue potential partnerships and grants to make wetlands enhancement an environmental amenity and an economically viable future reuse opportunity for this project. Additional opportunities to enhance wetlands closer to the CWWTF are also currently being evaluated to beneficially provide habitats in a cost conscious manner. The CWWTF design flexibility will allow the facility to be easily retrofitted to meet the Washington State reclaimed water standards,[257] should the County be interested in applying highly treated water for reuse applications in the future. If the wetlands alternative becomes technically, logistically, and financially feasible, the County will prepare an amendment to the Facilities Plan.

Three alternative discharge locations along the Snoqualmie River were evaluated prior to the EIS as possible outfall locations:[258] 1) Near the Tolt MacDonald Park, 2) At the Carnation Farm Road Bridge, and 3) Chinook Bend.

A review and confirmation of the selected outfall location on the Snoqualmie River was completed in order to address public comments and to refine project costs. This later evaluation consisted of a review of previously available information for the Park and Bridge locations, recent river cross-section profiles at the two locations, and detailed fisheries data on the TDR of the Snoqualmie River. The Chinook Bend location was not re-evaluated as the other two sites offered considerable advantages. The County's assessment of the relative risk of the two discharge locations to salmonids is provided in Appendix G. Table 7.1 summarizes the evaluation parameters and potential impacts associated with each alternative outfall location.

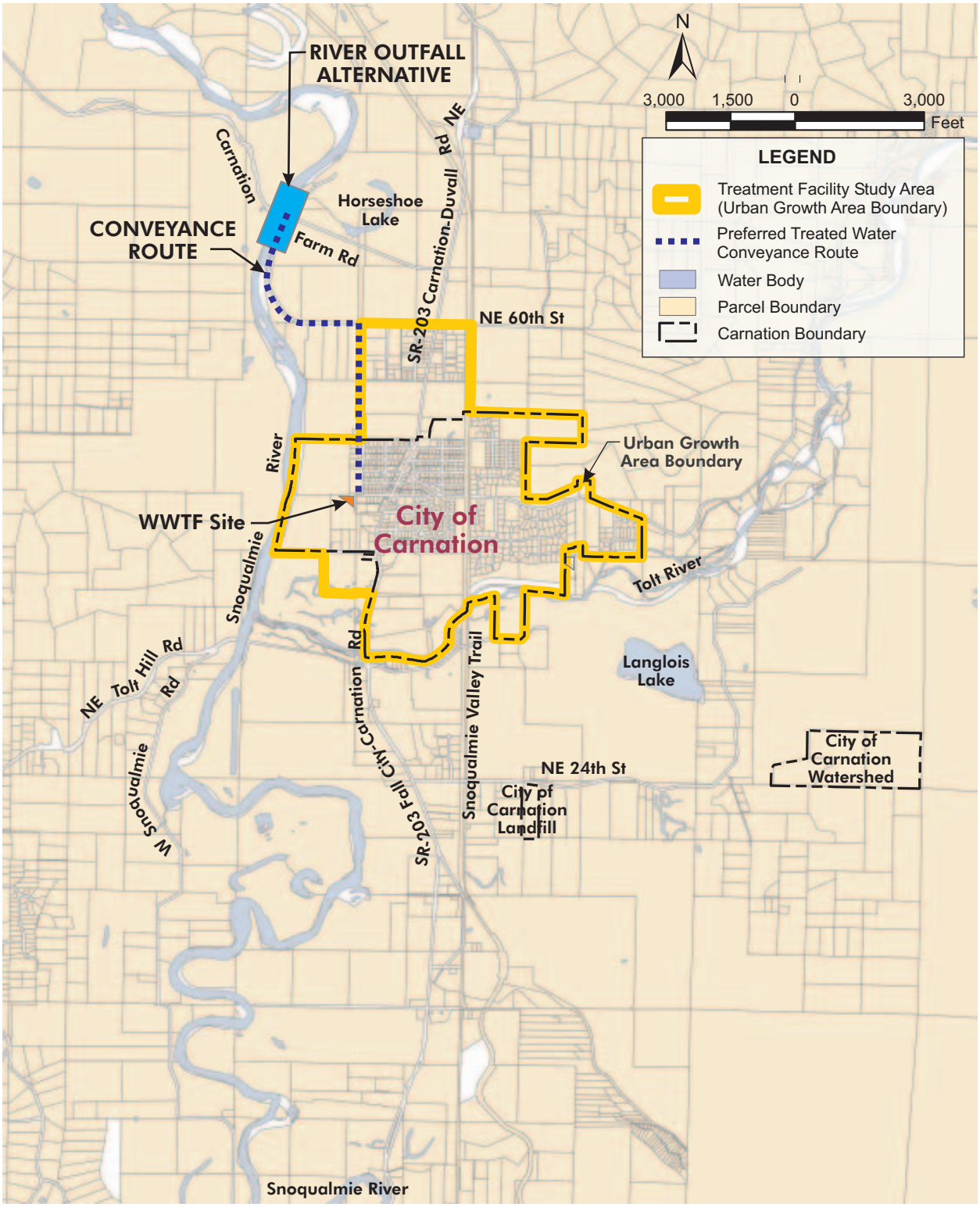


Figure 7.2
RECOMMENDED EFFLUENT DISCHARGE SYSTEM
CARNATION WASTEWATER TREATMENT FACILITY
KING COUNTY DEPARTMENT OF
NATURAL RESOURCES AND PARKS

Table 7.1 Snoqualmie River Outfall Location Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Carnation Farm Road Bridge		Tolt MacDonald Park	
	Rank	Evaluation	Rank	Evaluation
Fisheries[259,260,261]	+	The number of documented Chinook redds is lower than at the Park stretch of river (75.3 redds/mile). The reach lies downstream of the highest concentration of spawning grounds based on available detailed data.	-	The stretch has the highest density of Chinook redds per mile (86.5) for the Snoqualmie River. It accounts for roughly 30% of the total number of redds observed and 20% of the spawning Chinook.
Operational water quality impacts [262,263,264]	+	The highly treated water from the CWWTF would have no measurable effects (as required by regulation) on the existing river quality (including temperature, nutrients, and metals) beyond the anticipated allowable acute and chronic mixing zones. Based on the lower identified fish density, habitat impacts within the allowable mixing zones would be lower than at the Park. Conveyance to the Bridge would increase the amount of time available for the subsurface to cool the highly treated water.	-	Historical fisheries data show probable concentrated spawning and rearing within the potential allowable mixing zones. The relative habitat impacts within the allowable mixing zones in this area would potentially be higher (but may remain minimal) than areas further downstream. Conveyance to the Park would result in a shorter period of time available for subsurface cooling of highly treated water.
Construction impacts (in water and near shore) [265,266,267,268]	+	A vertical pipe mounted to the downstream side of the western bridge pier would convey the highly treated water to the mixing zone. The alternative would require minimal in-water and near-shore work. Construction methods and shorter work schedule decrease the sedimentation and turbidity impacts to the river. The alternative would result in negligible to no disturbance of river bottom.	-	The discharge point would be closer to the deep pool on the east side of the river. In-water work and bed disturbance would be required. There is concern of the potential impact to fish in the area by NOAA Fisheries. Potential impacts would be short term (4 weeks) and may include increased sedimentation of spawning gravels, increased turbidity, and accidental release of pollutants from construction equipment. The river velocities would disperse the impacts downstream.

Table 7.1 Snoqualmie River Outfall Location Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Carnation Farm Road Bridge		Tolt MacDonald Park	
	Rank	**Evaluation**	**Rank**	**Evaluation**
Channel migration due to WRIA 7 bank destabilization project	**O**	Long-term stability would likely not be impacted by the downstream bank destabilization project.[269] The County has an existing commitment to maintain the Bridge as part of the County's infrastructure.	**O**	Not an issue at this location.
Bank stability at discharge location[270]	**O**	The identified location is an area with a historically stable channel based on aerial photos from 1938 to 2002. The conveyance pipeline could be affected during flooding. Previously, flooding has caused a local washout of the County roadway adjacent to the Bridge. The County has an existing commitment to maintain the Bridge and its roadways.	**O**	The identified location is an area with a historically stable channel based on aerial photos from 1938 to 2002. The conveyance pipeline could be affected during flooding.
Permitting	**+**	Location would eliminate certain federal and state permit requirements (Section 404 and 401). The location is downstream of the identified prime spawning areas and would not disturb the river bed. The lesser requirements could possibly lead to a reduction in the current permit schedule.	**-**	Location would require complex federal (Section 404 and Section 7) and state HPA and Section 401) permits. The location does not appear to avoid or minimize impacts to waters of the state as required by Section 404 CWA, and NEPA, WAC 173-26-201, and SEPA regulations.
SEPA review	**+**	The environmental impacts of locating the outfall at the Bridge have been addressed in the final EIS.[271] There would be no impact on the current SEPA schedule.	**-**	The environmental impacts at locating the outfall near the Park have not been fully identified and therefore require additional SEPA review. Changing the location of the outfall may require an addendum to the EIS (potentially delaying the SEPA schedule by 4 to 6 months) or a supplement to the EIS (potentially delaying the SEPA schedule by 6 to 8 months).

Table 7.1 Snoqualmie River Outfall Location Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Carnation Farm Road Bridge		Tolt MacDonald Park	
	Rank	**Evaluation**	**Rank**	**Evaluation**
Public outreach process	**+**	Outreach to the river outfall property owners near the Bridge is underway. The SEPA public process requirements have been fulfilled.	**-**	The Park is a regional park with many facilities and used year-round. To date, public outreach activities have not focused specifically on either park or recreational users of the river. Additional public outreach would be required due to the change in outfall location and would reopen the SEPA public process. The redirection would require additional resources and potentially impact the project schedule.
Public opinion	**O**	Public outreach, to date, has indicated broad support for the wetlands enhancement project at SWA. Public opinion about a river outfall has been mostly negative, particularly from property owners near the Bridge and environmental organizations.	**O**	The opinions of the City's residents and public at large have not been solicited for this location. It is likely that both existing groups and park and recreational users of the river not yet identified would argue against the Park outfall location.
Other benefits	**+**	The location supports a potential phased approach to wetlands restoration to the north.	**+**	The conveyance distance to the Park outfall is shorter than the distance to the Bridge outfall. The construction costs and time required to install the pipeline (excluding the outfall structure) would be less than those for the Bridge location.

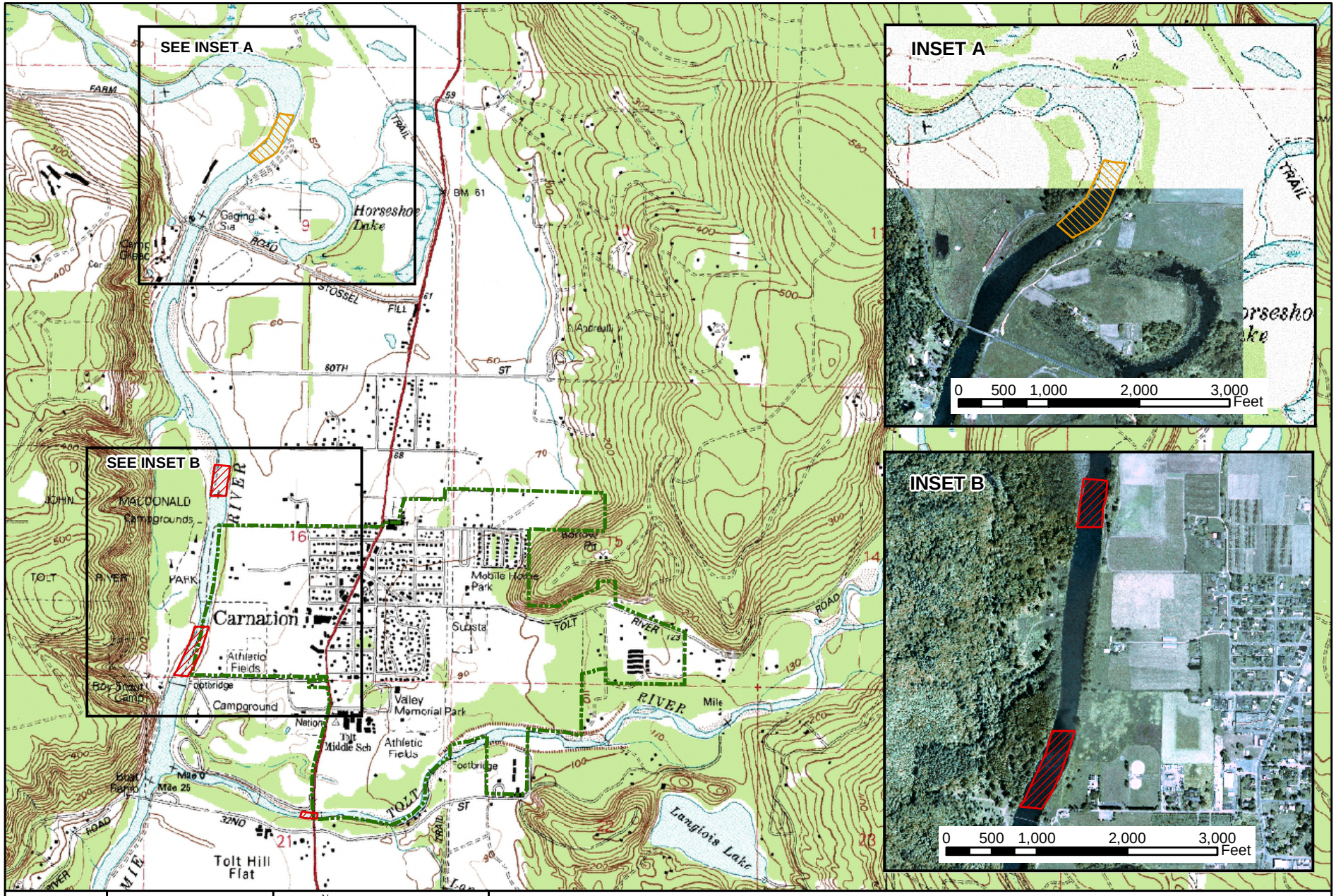
+ = more favorable
O = negligible difference in favorability
- = less favorable

Bridge = Carnation Farm Road Bridge
CWA = Clean Water Act
EIS = Environmental Impact Statement
HPA = Hydraulic Project Approval
NEPA = National Environmental Policy Act
NOAA = National Oceanic and Atmospheric Administration
Park = Tolt MacDonald Park
SEPA = State Environmental Policy Act
WAC = Washington Administrative Code

The State of Washington has designated the Snoqualmie River as “Salmon and Trout Spawning, Core Rearing, and Migration” waters from RM 9.1 to the headwaters of the South Fork.[272] The headwaters mainly originate in the Alpine Lakes Wilderness in the central Cascade Mountains,[273] east of the City. The City is located on the TDR of the Snoqualmie River and lies within this pristine stretch of river. The TDR lies between RM 20.5 and RM 24.9 and is a high-quality habitat used by nine species of salmonids.[274] Chinook, chum, and pink salmon and steelhead trout are documented to use the area at moderate to very high spawning densities. Chinook and steelhead rear in this reach for up to one and two years, respectively. Spawning activities in this area have not been documented for coho salmon, cutthroat trout, and mountain whitefish, but it is expected they are likely to rear and migrate extensively within the TDR. Bull trout activity most likely includes foraging, migration, and over-wintering. Sockeye are present, but their abundance and usage is uncertain.

The TDR exhibits high-quality characteristics for juvenile Chinook rearing, including moderate to high velocities and large pools and riffle pocket-water with extensive cobble and small boulder substrates. The condition of the freshwater habitat may be of special importance for the Snoqualmie stock because the juveniles exhibit a relatively high (upwards of 30 percent) proportion of “stream-type” behavior, in which juveniles spend upwards of a year in freshwater. In contrast, most Puget Sound Chinook populations are dominated by the “ocean-type” juvenile behavior, in which juveniles spend a relatively short time (three months) in freshwater. As a result, the Snoqualmie Chinook may have a higher reliance on freshwater habitat conditions than do other Puget Sound Chinook stocks. There are no definitive studies as to why the Snoqualmie Chinook exhibit this behavior or whether they use Snoqualmie habitats or the TDR reach preferentially.

WDFW has documented the TDR as an index area to assess salmon spawning and run size abundance for several decades.[275] The reach has the second highest six-year average and density of Chinook spawning nests, or redds, of the six main stem river reaches surveyed by WDFW. Based on 2004 surveys, Chinook spawning between the mouth of the Tolt River and the Bridge (86.5 redds/mile) has a higher redds density than the 1.5-mile stretch downstream of the Bridge (75.3 redds/mile). Figure 7.3 illustrates the redd locations from three boat survey dates in 2004 between the mouth of the Tolt River and the Bridge and air survey observations downstream of the Bridge. Data at this scale were not available from previous years for the purpose of comparison. However, data at a larger scale and information from WDFW suggest that the pattern is indicative of other years as well.[276] The limited detailed data (from 2004) within the TDR shows three main clusters of redds located: 1) at the footbridge at the Park and extending about 1,500 feet downstream, 2) approximately 4,200 feet from the footbridge and extending approximately 800 feet downstream, and 3) approximately 1,500 feet from the Bridge and extending approximately 1,000 feet downstream.[277] The data collected do not describe the absolute or relative densities found within each cluster.



File name: redds.mxd/reddsFig1.pdf
Created/last edited by: KH
Date last updated: 02/25/05

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Map data are the property of the sources listed below.
Inaccuracies may exist, and Adolfson Associates, Inc. implies no warranties or guarantees regarding any aspect of data dipiction.

High Redd Densities - Source:

- 2004 WDFW Boat Survey
- WDFW Air Survey Observations
- Carnation City Limits

FIGURE 7.3

WDFW CHINOOK REDD OBSERVATIONS
CARNATION WASTEWATER TREATMENT FACILITY

7.2.1 Tolt MacDonald Park

The river area (approximately at RM 24) near the Park had been identified as an area with a wide bed and a slight bend. The riverbanks have a solid foundation and are steep, riprapped to the east, and gravelly to the west.[278] A river survey profile taken in 2005 shows that the optimal location for the outfall discharge at this location would be in the deep pool on the east bank as shown in Figure 7.4. The discharge pipe would be reduced from a 12-inch HDPE pipe to an eight-inch ductile iron pipe with a diffuser check valve extending approximately 20 feet into the river. The pipeline installation would likely require sheet piling or a temporary dam during in-water construction.

7.2.2 Carnation Farm Road Bridge

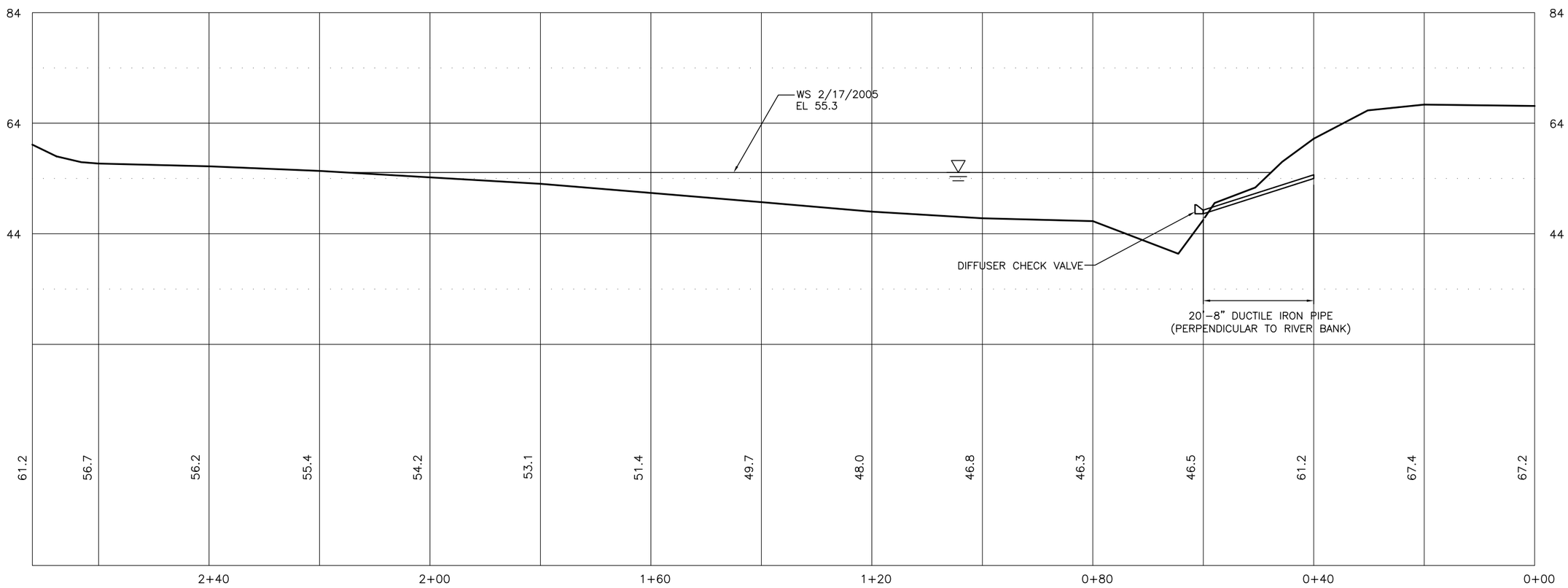
The Bridge location (between RM 22 and RM 23) had also been identified as an area with a wide bed but also has a bridge, footings, and piers. River survey profiles taken in 1950 and 2005 confirm that minimal scouring and sediment deposition have occurred at the west bridge pier over the last 55 years. Overall, the riverbed has been stable at this location. The optimal location for the outfall discharge would be in the deep pool close to the west bank as shown in Figure 7.5. In order to reach the deep pool of the river, several construction methods were evaluated. Laying the discharge pipeline across the width of the Snoqualmie River to reach the deep pool area would cause extensive and prolonged in-water disruptions due to construction. An alternate configuration would be to support the discharge pipeline across the Bridge to the west pier. The bridge pier would continue to provide support as the pipeline enters the water. A diffuser check valve would provide a downspout-type outfall.

The Bridge is a registered historical landmark. Any construction efforts would require a Certificate of Appropriateness from the Landmark Commission, which demonstrates that the alternative will have the least overall impact to the area. Initial discussions with the County's Roads Services Division have indicated that a seismic retrofit of the bridge was completed in 1997. Two three-inch pipelines are already attached to the bridge. A feasible option discussed with the County's Roads Services Division includes using the bridge to structurally support an additional eight- or ten-inch ductile iron discharge pipeline for the CWWTF.

H:\Client\KingCo-DNR_SEA\6620ot10\Div\Dwg\FIGURE_7.4 3-14-05 10:53am sfroker XREFS: D-TTL-KC-CARN

GENERAL NOTES:

1. VERTICAL ELEVATIONS ARE BASED ON NAVD 88 DATUM.
2. RIVER PROFILE TAKEN FACING DOWNSTREAM, 20' SOUTH AT NORTH SIDE OF TOLT MACDONALD PARK.
3. PROFILE TAKEN ON FEBRUARY 17, 2005 BY PENHALLEGON ASSOCIATES CONSULTING ENGINEERS.



RIVER PROFILE

SCALE: 1'= 20'

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

SCALE: 1"=20'

carollo engineers

DESIGNED/DRAWN: SEF	SCALE: NONE
PROJECT ENGINEER: SML	
DESIGN APPROVAL:	
FINAL APPROVAL:	CONTRACT NO: C_____C

KING COUNTY

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.4
SNOQUALMIE RIVER PROFILE NEAR TOLT MACDONALD PARK

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FILE NO: 423528/###
DRAWING NO:
SHEET NO: OF

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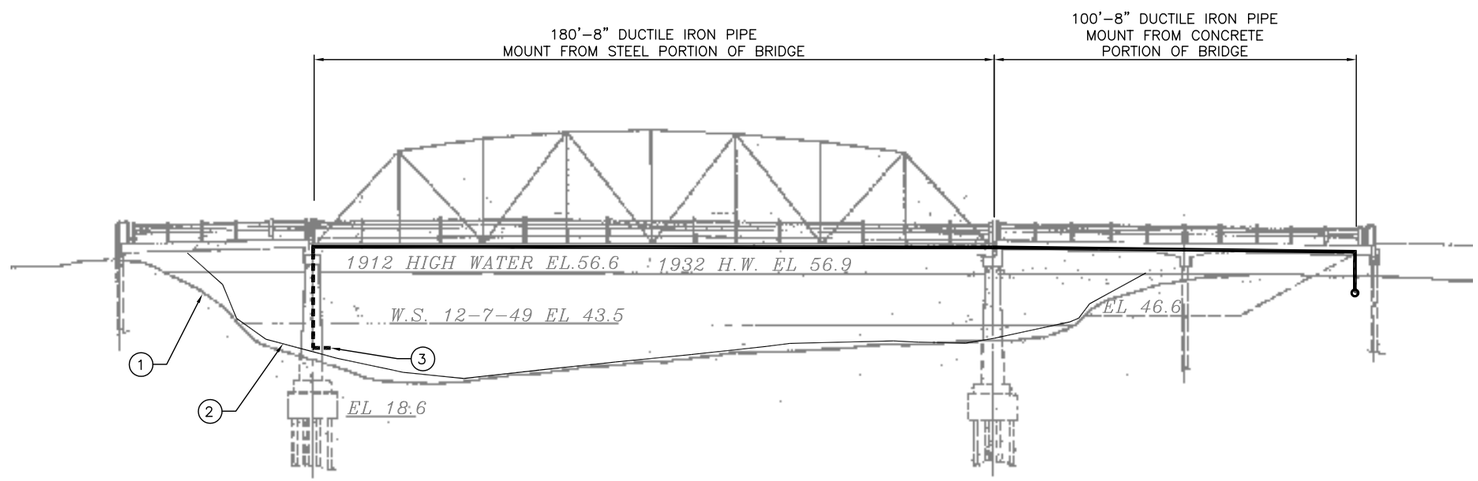
KEY NOTES:

1. CARNATION FARM ROAD BRIDGE AND RIVER PROFILES PREPARED IN APRIL 1950. ELEVATIONS SHOWN ARE BASED ON NAVD 88 DATUM.
2. RIVER PROFILE TAKEN AT 20 FEET NORTH OF NORTH SIDE OF CARNATION FARM ROAD BRIDGE ON FEBRUARY 17, 2005 BY PENHALLEGON ASSOCIATES CONSULTING ENGINEERS.
3. PROTECTED 8" DIFFUSER CHECK VALVE.



BRIDGE ELEVATION
AND RIVER PROFILE

SCALE: 1" = 40'

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED/DRAWN: SEF	SCALE: NONE
PROJECT ENGINEER: SML	
DESIGN APPROVAL:	
FINAL APPROVAL:	CONTRACT NO: C_____C

KING COUNTY

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.5
RIVER PROFILE AND
OUTFALL AT BRIDGE

DATE:
FILE NO: 423528/###
DRAWING NO:
SHEET NO: OF

7.2.3 Cost Comparison

Costs shown in Table 7.2 compare construction and related allied costs. The costs do not account for other tangible and intangible costs related to the difficulty of permitting and construction at the discharge location. Conveyance from the City-owned site to a discharge point near the Park is less than 15 percent of the distance to the Bridge. In addition, conveyance to the Park is not anticipated to require easements or traffic control because the pipeline would be conveyed along the north edge of a park currently owned by the County. As a result, the overall cost of conveyance to the Park will cost approximately $1 million less than conveyance to the Bridge.

Table 7.2 Cost Comparison of Snoqualmie River Discharge Locations
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Description	Carnation Farm Road Bridge ($)	Tolt MacDonald Park ($)
Capital Costs		
Installed trench	748,000	75,000
River outfall structure	184,000	181,000
Mechanical valves and appurtenances	50,000	20,000
Estimating contingency	99,000	28,000
Contractor overhead and profit	162,000	46,000
Sales tax	109,000	31,000
Easement allowance	38,000	0
Subtotal	1,390,000	381,000
Allied Costs		
Consultant services	258,000	217,000
County administration and other allied costs	100,000	100,000
Subtotal	358,000	317,000
Total Cost (February 2005 dollars)	1,748,000	698,000

7.2.4 Conclusion

The combination of technical, scheduling, environmental and permitting parameters evaluated in Table 7.1 affirms that the Bridge discharge location is preferred over the Park discharge location. Although the cost comparison of the two discharge locations shows a $1 million total cost savings for the Park discharge, the comparison does not account for other potential increased project and cost impacts. For example, the conveyance cost and schedule savings associated with the Park alternative may be exceeded by costs related to

the more complex in-water construction, additional environmental review, and more difficult permitting requirements. Conversely, discharging the highly treated water at the Bridge would decrease the exposure risk to areas and densities of documented Chinook and steelhead redds based on 2004 data.[279]

By attaching the discharge pipe directly to the Bridge structure, the amount and duration of in-water construction would be minimized and thus also minimize the impact to sensitive habitat by not disturbing the existing riverbed. With a nominal habitat impact, the United States Army Corps of Engineers (USACE) would not be required to review and issue a CWA Section 404 permit; thereby simplifying the number of regulatory approval processes prepared by the County.

In addition, the County proposes to install a single diffuser valve for discharge of the highly treated water. As compared to traditional multi-port diffusers, a single diffuser valve can provide for a cost-effective means of consistently achieving high initial dilution within the river while generating less headloss at peak flows. The valve design also prevents the intrusion of sand, mud, debris, or river water back into the diffuser pipe, which can accumulate and cause blockage within the pipe. With a variable orifice, the valve optimizes the diffuser hydraulics for the full range of flows by inherently enhancing jet velocities. Figure 7.5 shows that there has been negligible river channel migration at the Bridge in the past 55 years, and the deep river pool has remained stable.

7.3 Recommended Conveyance Route

A review and confirmation of the selected conveyance route to the Snoqualmie River was completed in order to address public comments and to refine project costs. Three alternative conveyance routes to the Bridge were initially identified during preliminary design efforts, as detailed in TM No. 14.[280] Two routes have been selected for review in this chapter. The routes avoid traversing areas that serve as major city thoroughfares, attempt to provide the most direct conveyance route to the discharge location, and minimize construction disruption impacts to the community. Most of either conveyance route from the City-owned site to the river discharge lies within existing public rights-of-way within areas zoned for urban reserve, rural area, agricultural, and open space. Therefore, no zoning changes would be required for the CWWTF location or conveyance or at the river outfall area.

Route A – Route A was the recommended alternative during preliminary evaluation. The route begins at the City-owned site and continues a short distance east on Entwistle Street. The route then heads due north along Stewart Street to the Bagwell Street intersection and continues north along the UGA boundary to NE 60th Street. Heading west on NE 60th Street (which becomes 310th Avenue NE as the route heads northward) the pipeline continues to the outfall located at the Bridge.

Route B – Route B begins at the City-owned site and continues a short distance east on Entwistle Street. The route then heads due north along Stewart Street to the Bagwell Street intersection and continues north along the UGA boundary to NE 60th Street. The route continues to the north to connect with Carnation Farm Road through privately owned property and travels west on Carnation Farm Road to the outfall located at the Bridge. Based on a site visit by the County with the property owner and property tenant of the privately owned property on March 15, 2005, the pipeline would be installed along the remnants of an abandoned railroad line. Three areas along the railroad elevation embankment that had been excavated were visible during the visit. The route passes through a stream along Carnation Farm Road. The pipeline would be required to be supported by a small concrete bridge overhead or tunneling under the stream.

Figure 7.6 illustrates Routes A and B and Table 7.3 provides a detailed comparison.

The discovery of jurisdictional wetland(s) in excavated areas on the privately owned property between NE 60th Street and Carnation Farm Road and a stream crossing on Carnation Farm Road could increase the cost of the alternative Route B as well as delay the SEPA permitting schedule. Therefore, Route A has been confirmed as the proposed route with a lower risk to unforeseen costs and schedule impacts. Crossing the large excavated areas would require construction of costly bridge-type structures as well as approval of regulatory Section 404 and 401 permits.

7.4 Recommended Wastewater Treatment Design

Figure 7.7 provides an overall schematic of the facility process.

7.4.1 Discharge Requirements

Table 7.4 summarizes the main anticipated discharge requirements for the CWWTF. Table 4.2 of this document lists the minute quantities of other toxins, such as metals, which are also regulated by the Surface Water Standards.[281] These anticipated requirements are also anticipated to satisfy the TMDL recommended loading capacity for the Snoqualmie River.

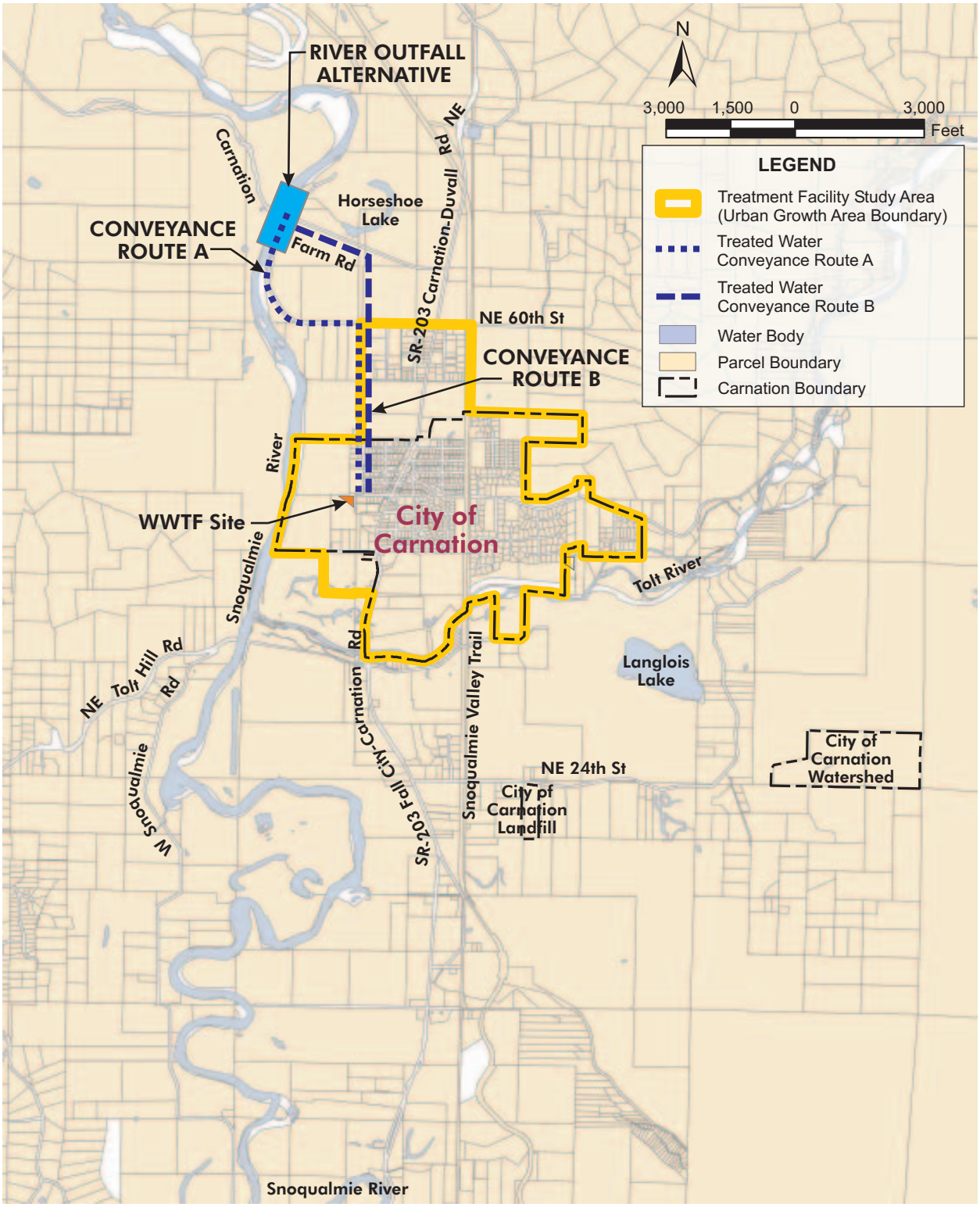


Figure 7.6
SNOQUALMIE RIVER OUTFALL CONVEYANCE COMPARISON
CARNATION WASTEWATER TREATMENT FACILITY
KING COUNTY DEPARTMENT OF
NATURAL RESOURCES AND PARKS

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Table 7.3 Conveyance Route Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

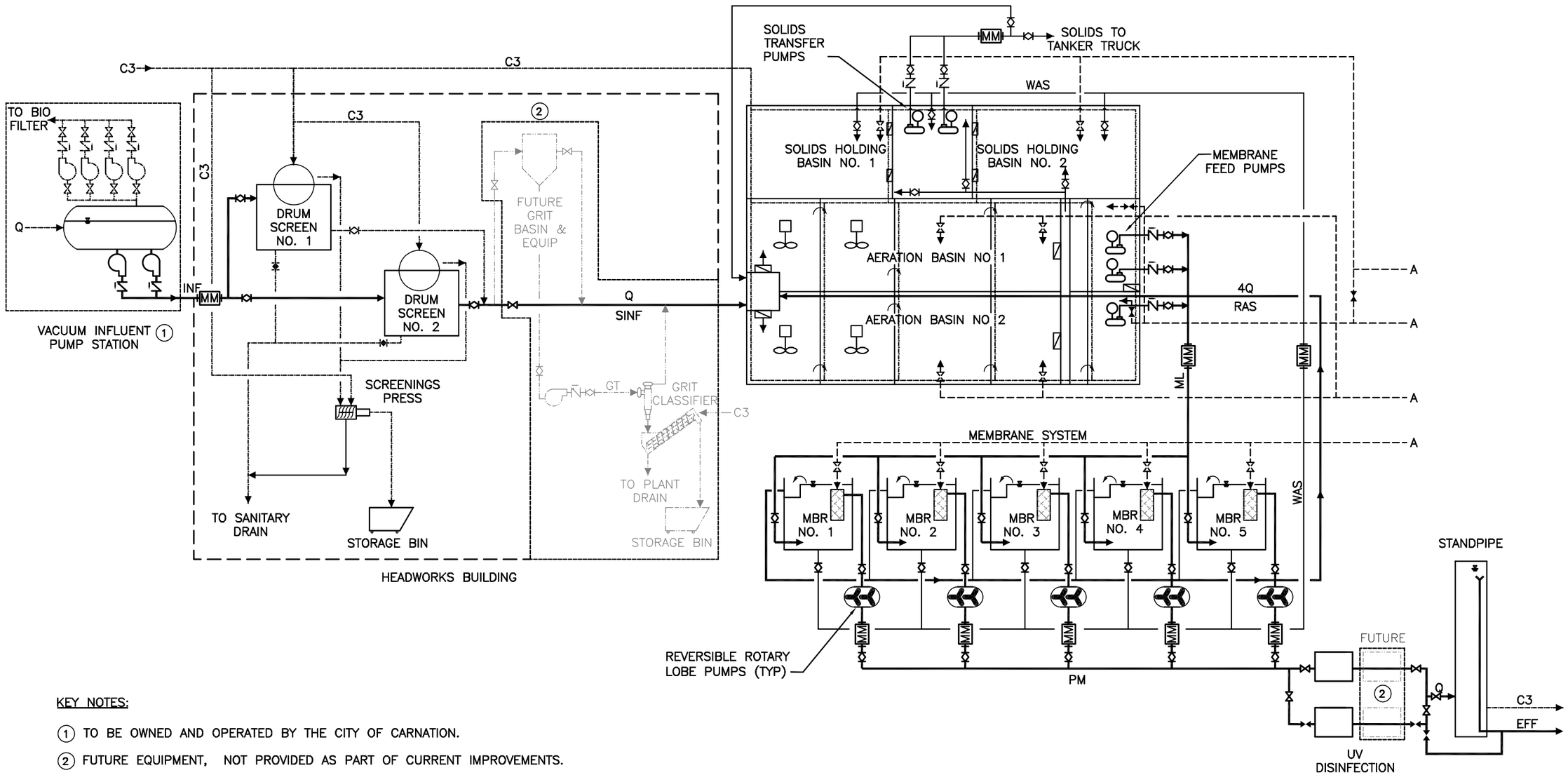
Parameter	Risk	Route A	Risk	Route B
Conveyance distance	**O**	Conveyance distance is 1.7 miles.	**O**	Conveyance distance is 1.6 miles.
Construction and easement costs (conveyance only)	**O**	Cost is approximately $1,100,000 without dewatering or wetland mitigation (in February 2005 dollars). Would require easement from one private entity.	**O**	Cost is approximately $1,000,000 without dewatering or wetland mitigation (in February 2005 dollars). Would require easement from two private entities.
O&M costs	**+**	Could potentially include increased costs. According to historical photos, flooding has submerged portions of 310th Avenue NE along the Snoqualmie River at least once within the past 20 years, severely damaging the roadway.	**-**	Will most likely require increased costs for wetlands mitigation.
Easement requirements	**+**	Easements will be required along the route between Bagwell Street and NE 60th Street. The path has been designated a future City right-of-way.	**-**	Easements will be required along the route between Bagwell Street and Carnation Farm Road. The path between Bagwell Street and 310th Avenue NE has been designated a future City right-of-way.
Potential shoreline impacts	**O**	Increased risk of shoreline impacts along the River on 310th Avenue NE to the Bridge.	**O**	There is a potential shoreline impact at Bridge. In addition, the route would cross a small stream on Carnation Farm Road.
Wetlands impacts	**+**	No wetlands have been identified in the environmental review process.	**-**	Presence of jurisdictional wetlands on the property between NE 60th Street and Carnation Farm Road. Environmental review and mitigation would be required.
Constructability	**O**	Route is not anticipated to require dewatering. There is an increased potential need for dewatering along the river on 310th Avenue NE.	**O**	Dewatering may be required between NE 60th Street and Carnation Farm Road near the jurisdictional wetlands.
Traffic and community disruption	**+**	Minimal impacts to residents expected within the immediate vicinity of pipeline construction.	**-**	Requires construction along 2,400-feet of Carnation Farm Road, one of two routes for crossing the river within the City's vicinity.

Table 7.3 Conveyance Route Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Risk	Route A	Risk	Route B
SEPA review	+	The environmental impacts of locating the outfall at the Bridge have been addressed in the final EIS.[282] There would be no impact on the current SEPA schedule.	-	The route change will likely require an addendum to the EIS.
Public opinion	+	Discussions of the route with adjacent property owners are underway. The SEPA public process requirements have been fulfilled.	-	Additional public outreach would be required due to the change in conveyance route. The redirection would require additional resources and potentially impact the project schedule. Based on a site visit by the County with the property owner and property tenant of the property between NE 60th Street and Carnation Farm Road on March 15, 2005, discussions have indicated that they do not support disturbing the soils or existing fencing. In addition, the railroad grade is used as a high ground shelter for farm animals during flooding events.

+ = more favorable
O = negligible difference in favorability
- = less favorable

SEPA = State Environmental Policy Act
EIS = Environmental Impact Statement



KEY NOTES:

1. TO BE OWNED AND OPERATED BY THE CITY OF CARNATION.
2. FUTURE EQUIPMENT, NOT PROVIDED AS PART OF CURRENT IMPROVEMENTS.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED:
DRAWN:
RECOMMENDED:
APPROVED:
CHECKED: NONE
SCALE:
CONTRACT NO: C_____C

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.7

PRELIMINARY PROCESS SCHEMATIC

DATE: SEPT, 2005
FILE NO: 423557/###
DRAWING NO:
SHEET NO: OF

Table 7.4 Anticipated Discharge Requirements
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Allowable Limit
Year-Round or Non-TMDL Permit Limitations	
Average monthly	
BOD_5[a]	30 mg/L, 155 lb/day
TSS[a]	30 mg/L, 155 lb/day
NH_3-N[b]	38.3 mg/L
Fecal coliform[c]	50 cfu per 100 mL
Residual Cl_2[b]	0.063 mg/L
Average weekly	
BOD_5[a]	45 mg/L, 233 lb/day
TSS[a]	45 mg/L, 233 lb/day
NH_3-N[b]	91.3 mg/L
Fecal coliform	400 cfu per 100 mL
Residual Cl_2[b]	0.165 mg/L
Maximum daily	
Temperature (7-day average)[d]	16 ^oC
pH[e]	6.5 - 8.5
Turbidity[f]	5 ntu + river background
Total dissolved gas[g]	110 percent
Minimum daily	
DO[h]	9.5 mg/L
TMDL Permit Limitations (Aug - Oct)[i]	
Maximum daily	
BOD_5	25 lb/day
NH_3-N	8.4 lb/day
SRP	3 lb/day

BOD = biochemical oxygen demand	ntu = nephelometric turbidity unit
^oC - degrees Celsius	mg/L = milligrams per liter
CFU = colony forming units	mL = milliliter
Cl_2 = chlorine	SRP = soluble reactive phosphorus
DO = dissolved oxygen	TSS = total suspended solids
NH_3-N = ammonia-nitrogen	TKN = total Kjeldahl nitrogen

a. Average monthly concentration shall not exceed 30 mg/L or 15 percent of the respective monthly average influent concentrations, whichever is more stringent.
b. As reported by Cosmopolitan in TM No. 12 for these toxic substances. Table 4.2 of this document lists the other constituents such as metals, which are also regulated by the Surface Water Standards. Using updated potential dilution allowances; the allowable concentration would likely be greater than that reported in this document. See Chapter 4.1 for a discussion of the dilution factor.
c. Based on a geometric mean value, with not more than ten percent of all samples exceeding 100 colonies / 100 mL.
d. No temperature increase can raise the receiving water temperature by greater than 0.3^oC if natural temperature exceeds criteria.
e. Human-caused variation within acceptable range, less than 0.2 unit.
f. Results in less than a ten percent increase when the background turbidity is more than 50 ntu.
g. Criteria does not apply when the stream flow exceeds the seven-day, ten-year frequency flood (7Q10).
h. No DO decrease greater than 0.2 mg/L when the receiving water body is lower than the criteria due to natural conditions.
i. Based on the 1994 TMDL study for mass discharge loading. For the months of August, September, and October, the water quality must meet both the NPDES limits as well as the year-round limitations.

Sources: Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.; *Water quality standards for surface waters of the state of Washington*, *WAC 173-201A* (2003).; Joy, J., *Snoqualmie River Total Maximum Daily Load Study*, Ecology Report #94-71, 1994.

7.4.2 Influent

Forecasted design flows were developed as documented in the 2004 Comprehensive Sewer Plan[283] and TM No. 2[284] and are summarized in Table 7.5. Sizing was performed with Carollo's BioTran 2000™ program and the commercial program BioWin. Minimum flows for facility startup in 2007 represent the minimum condition for blower design. The maximum daily flows for the 2030 design flow condition represent the maximum conditions for compressor design. Design influent concentrations are presented in Table 7.6. It has been assumed that there is no removal of dissolved or suspended pollutants through preliminary treatment. Phosphorus concentrations are based on an analysis of wastewater characteristics within the BioTran 2000™ program.

Table 7.5 Influent Flow
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Influent Flow	Minimum startup flow (mgd)	Average startup flow (mgd)	Maximum month design flow (mgd)	Maximum day design flow (mgd)
Average base flow	0.18	0.22	0.53	0.86
Typical 4-hour diurnal peak	0.33	0.33	0.62	1.29
Peak hourly[a]	---	0.63	---	1.4

mgd = million gallons per day

a. Peak-hour facility capacity satisfied through increased MBR flux rates and MBR feed pump wet well equalization.

Table 7.6 Design Influent Concentrations Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks	
Parameter	**Concentration (mg/L)**
BOD_5	297
Filterable ("soluble") BOD_5	113
COD	683
TSS	297
NH_3-N	29
Organic-N	18
TKN	47
Total P	12
Alkalinity [a]	220
Temperature	
Summer	22°C
Winter (design)	12°C

BOD_5 = 5-day biochemical oxygen demand
C = degrees centigrade (or Celsius)
COD = chemical oxygen demand
TSS = total suspended solids
TKN = total Kjeldahl nitrogen
mg/L = milligrams per liter
N = nitrogen
NH_3-N = ammonia-nitrogen
P = phosphorus

a. Includes supplemental alkalinity addition.

Another key influent parameter assumption involves the design temperature. Certain biological processes, such as nitrification, are very sensitive to temperature. Discharge to wetlands would require the removal of ammonia to 1.5 mg/L and removal of phosphorus to 1.0 mg/L on a year-round basis. The sizing of biological tanks in TM No. 6 had been based on river discharge. River discharge requires ammonia and phosphorus removal during low river flow conditions. In TM No. 6,[285] design calculations assumed a temperature of 15 degrees Celsius. The minimum design temperature of 12 degrees Celsius has since been updated to satisfy both discharge methods. This results in a larger required basin volume than had been developed in TM No. 6.[286]

7.4.3 Headworks

The sewer flow from the community will be conveyed to a centralized wetwell (Vacuum Station No. 1) through a newly constructed vacuum-based sewer collection system. The headworks will consist of a two-story building, with screening and space for future grit removal on the upper level, and screenings handling and storage on the lower level. Upon further evaluation, it was proposed that as part of the recommended preliminary treatment,

the raw sewage pass through two fine screens in parallel to remove inert material that can foul or abrade the membranes. The headworks design parameters are summarized in Table 7.7.

Table 7.7 Headworks Design
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Initial	Ultimate
Mechanical Screen		
Type	Perforated-plate rotary drum screen	Perforated-plate rotary drum screen
Number in service	1	1
Number on standby	1	1
Maximum capacity (mgd/each)	2.2	2.2
Mesh size (mm)	2	2
Screening Washer/Compactor		
Number in service	1	1
Grit Removal		
Type	NA	Induced vortex/cyclonic lamella
Number in service	NA	1
Number on standby	NA	Bypass
Hydraulic capacity (mgd)	NA	1.4
Pumping type	NA	Recessed impeller
Pumping capacity (gpm)	NA	300
Classifier type	NA	Cyclone/washer
Classifier capacity (gpm)	NA	305

gpm = gallons per minute
mgd = million gallons per day
mm = millimeter
NA = not applicable

The cost-effectiveness of installing a grit chamber at the CWWTF was further evaluated. Although the potential for additional abrasion to the mechanical equipment is increased, initial discussions with manufacturers and municipalities regarding vacuum-based sewer collection systems have indicated that only a minimal volume of grit will enter the system. Provisions will be made to permit the retrofitting of grit removal equipment in the future, as necessary.

7.4.4 Biological Treatment and Disinfection

Activated sludge with MBR technology was recommended for the CWWTF. The MBR technology provides the highest water quality while requiring the smallest environmental footprint. Biologically degradable dissolved, colloidal, and suspended organic material and nutrients will be removed with a modified BNR removal configuration (similar to the A^2O process) combined with separate MBR tanks as summarized in Table 7.8. The configuration will provide anoxic, anaerobic, and aerobic zones. The basins will be concrete tanks with outside wall heights of approximately 12 feet above grade and an overall water depth of 17 feet. If phosphorus is identified and/or regulated as problematic beyond the biological removal capabilities of the anaerobic zones, the facility can be retrofitted by adding a chemical precipitation system to the basins in the future.

Table 7.8 Treatment Design Criteria
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Minimum startup flow	Average startup flow	Maximum month design flow	Maximum day design flow
Biological Treatment Basins				
Overall Basin				
Number in service	1	1	2	2
Total number	2	2	2	2
Length, ft (inside)	60.0	60.0	60.0	60.0
Width, ft (inside)	14.0	14.0	14.0	14.0
Side water depth, ft	17.0	17.0	17.0	17.0
Volume, MG				
Zone 1 (anoxic)	0.017	0.017	0.034	0.034
Zone 2 (anaerobic)	0.017	0.017	0.034	0.034
Zone 3 (aerated)	0.029	0.029	0.059	0.059
Zone 4 (aerated)	0.043	0.043	0.087	0.087
Total volume	0.107	0.11	0.214	0.214
Theoretical HRT, hours	14.6	11.7	9.6	6.0
MLSS concentration, mg/L	8,500	8,500	8,500	8,500
Solids residence time, days	29.4	23.0	18.6	10.7
Recycle rate, %	500	500	500	500

Table 7.8 Treatment Design Criteria Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Aeration System				
Diffuser type	Membrane disc			
Air in aerated zones, scfm	110	130	320	620
Anoxic/Anaerobic Zone				
Number of mixers	2	2	4	4
Type	Horizontal submersible			
Waste Activated Sludge				
Waste sludge flow, lb/day	280	360	890	1,540
Concentration, mg/L	10,000	10,000	10,000	10,000
Aeration Blowers (Aeration and Solids-Handing Basins)				
Blower type	Positive displacement			
Number in service	2	2	2	3
Number on standby	1	1	1	0
Total number	3	3	3	3
Capacity required, scfm				
Aeration basins	115	135	390	740
Solids holding basins	95	165	165	250
Membrane feed pump wet well	30	30	30	30
Total capacity required	240	330	585	1,020
Blower capacity required, scfm (each)	340	340	340	340
Pressure differential, psig	10.2	10.2	10.2	10.2
HP (each)	25	25	25	25
Membranes				
Type	Hollow fiber or plate			
Total number of tanks	5	5	5	5
Average in service	3	3	4	4
Peak hour in service	5	5	5	5

Table 7.8 Treatment Design Criteria
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Minimum startup flow	Average startup flow	Maximum month design flow	Maximum day design flow
Maximum available capacity out of service during cleaning or maintenance (%)	25	25	25	25
Installed membrane area (per tank), sf	64,600	64,600	64,600	64,600
Minimum spares per tank (%)	25	25	25	25
Maximum allowable flux rate, gfd				
Average	14	14	14	14
Peak 4-hour diurnal peak	18.2	18.2	18.2	18.2
Peak hour	20	20	20	20
Operating flux rate, gfd				
Maximum monthly flow	4.2	5.2	6.3	10.2
4-hour diurnal peak flow	6.3	7.9	9.5	15.3
TMP, psi				
Average	2 - 5.8	2 - 5.8	2 - 5.8	2 - 5.8
Maximum	10	10	10	10
Approximate side water depth, ft	9	9	9	9
Minimum MLSS, mg/L	8,000	8,000	8,000	8,000
Maximum MLSS, mg/L	12,000	12,000	12,000	12,000
SOTE, %	6-8	6-8	6-8	6-8
Backpulse cycle				
Frequency (minutes between backpulse)	12	12	12	12
Duration (sec)	30	30	30	30
Flow rate (gpm)	179	179	179	179
Pressure (psig)	2 - 8	2 - 8	2 - 8	2 - 8

Table 7.8 Treatment Design Criteria Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Maintenance cleaning per tank				
No. of chlorine cleanings (per year)	90	90	90	90
Chlorine Conc. (mg/L)	250	250	250	250
Chlorine contact time (min/clean)	50	50	50	50
Recovery cleaning per tank				
No. of cleanings (per year per chemical)	2	2	2	2
Chlorine conc. (mg/L)	1000	1000	1000	1000
Chlorine contact time (hours/clean)	4-8	4-8	4-8	4-8
Citric acid conc. (mg/L)	2000	2000	2000	2000
Citric acid contact time (hours/clean)	4-8	4-8	4-8	4-8
Membrane Wet Well				
Number	1	1	1	1
Length, ft (each)	30	30	30	30
Width, ft (each)	10	10	10	10
Maximum depth, ft	17	17	17	17
Minimum depth, ft	4	4	4	4
Equalization volume, MG	0.029	0.029	0.029	0.029
Membrane Air / Agitation Air Blowers				
Blower type	Positive displacement			
Number in service	1	1	1	2
Number on standby	2	2	2	1
Total number	3	3	3	3

Table 7.8 Treatment Design Criteria Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Capacity required, scfm (each)				
Blower capacity, scfm (each)	725	725	725	725
Pressure differential, psig	4.2	4.2	4.2	4.2
HP (each)	30	30	30	30
Membrane Feed Pumps				
Pump type	Positive displacement			
Number in service	1	1	2	2
Number on standby	2	2	1	1
Total number	3	3	3	3
Capacity (each), gpm	2240	2240	2240	2240
TDH, ft	30	30	30	30
HP (each)	25	25	25	25
Membrane Permeate and Backpulse Pumps				
Pump type	Rotary Lobe			
Number in service	3	3	4	4
Number on standby	2	2	1	1
Total number	5	5	5	5
Permeate capacity (each), gpm	224	224	224	224
TDH, ft	55	55	55	55
Backpulse capacity (each), gpm	108 - 227	108 - 227	108 - 227	108 - 227
TDH, ft	25	25	25	25
HP (each)	10	10	10	10
UV Disinfection				
Type	high-output/medium-pressure in-vessel			
UV transmittance, %	65	65	65	65
Number of trains in service	1	1	1	1
Total number of trains	2	2	2	2

Table 7.8 Treatment Design Criteria Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Reactors per train	1	1	1	1
Effective dosage, MJ/sq CM	40	40	40	40
Outfall				
Type	Gravity flow from standpipe			
TDH, ft	28			

ft = feet
gfd = gallons of permeate produced per square foot of membrane per day
HRT = hydraulic retention time
MG = million gallons
mg/L = milligrams per liter
MJ/sq CM = millijoules per square centimeter
MLSS = mixed liquor suspended solids
lb/day = pounds per day
scfm = standard cubic feet per minute
sote = standard oxygen transfer efficiency
sf = square feet
UV = ultraviolet

The MBR pumping equipment and chemical feed equipment will be located in a concrete structure. The membrane tanks will be modular steel tanks that are mounted on the top of this structure. The MBR system will consist of cassette tanks, permeate pumps and backpulse system, blower system, electrical panels, and controls. Blowers for the MBR tanks and aeration basins/solids holding basins will be individually housed in sound enclosures at the southeast end of the MBR area.

The MBR process is considered to be the best available technology (BAT), consistently producing a high water quality that meets or exceeds the “Salmon and Trout Spawning, Core Rearing, and Migration for extraordinary primary contact recreation” surface water standards.[287] The CWWTF will achieve the nearly complete removal of BOD_5, TSS, and nitrogen, and will provide highly polished, high-quality water suitable for the potential unrestricted, cost-effective reuse of non-potable water in the future. The MBRs will be sized to handle peak capacities of 1.29 mgd over a four-hour peak flow period. The storage in the membrane feed pump wet well downstream of the aeration basins will provide the remaining instantaneous peak capacity for the facility from the City’s Vacuum Station No. 1 (1.4 mgd-1.29 mgd = 0.11 mgd), prior to the MBR process.

Membranes in the MBR process provide a physical barrier to remove solids and bacteria, making it the most reliable treatment process capable of filtering water to a final turbidity less than 0.2 ntu. Disinfection will be provided by a closed channel UV disinfection system that is capable of being retrofit to meet the Class A reclaimed water standards.[288] UV disinfection technology has the lowest space requirement and is the most suitable for the design flexibility of the CWWTF. Should the County choose to provide reclaimed water in

the future, the UV dosage design will comply with the reuse standards in effect at the time a reclaimed water permit is requested.

7.4.5 Solids Handling

The collected screenings and grit will be cleaned and dewatered as accumulated to minimize the odor production potential of the residuals. After cleaning and dewatering, the screenings and grit chamber residuals will be transported directly to a local landfill for final disposal.

It is recommended that the wasted solids from the MBR be held at the CWWTF and transported to a regional County treatment facility such as the South Treatment Facility or possibly the Brightwater facility in the future. The additional waste activated sludge is not anticipated to adversely impact the existing process at either the South Treatment Facility or the future Brightwater facility. The solids will be gravity-thickened while held onsite for an average of seven days in covered and aerated solids holding basins, as summarized in Table 7.9. The aerated solids holding basins will also provide emergency storage and limited stabilization. The facility could be designed with the flexibility to use an MBR tank to produce a higher solids concentration in the future, as needed, to reduce the volume of solids transported as the facility approaches design loads.

Table 7.9 Solids Holding Basins
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Minimum startup flow	Average startup flow	Maximum month design flow	Maximum day design flow
Number of units	2	2	2	2
Length, ft	30.0	30.0	30.0	30.0
Width, ft	14.0	14.0	14.0	14.0
Depth, ft				
Maximum	17.0	17.0	17.0	17.0
Minimum	3.0	3.0	3.0	3.0
Total volume, gal				
Maximum	106,800	106,800	106,800	106,800
Storage	88,000	88,000	88,000	88,000
Minimum tank solids concentration with decant, %	1.0	1.0	1.0	1.0
Storage time with decant, days	25	19	8	4
Predicted volatile solids reduction, %	15	22	20	25

Table 7.9 Solids Holding Basins Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Predicted sludge production (WAS), gpd	3,500	4,500	11,300	20,300
Aeration System				
Type of diffuser	Fine	Fine	Fine	Fine
Aeration required, scfm				
For volatile solids destruction	27	50	115	249
For mixing	89	163	163	163
Controlling	89	163	163	249

ft = feet

gal = gallons

gpd = gallons per day

scfm = standard cubic feet per minute

WAS = waste activated sludge

7.4.6 Odor Control

Since as the City-owned site is both directly upwind of and lower in elevation than the majority of City structures, it is critical that the odor control system design must be both sensitive to the community's needs and cost-effective. As a result, the design philosophy for the CWWTF is to incorporate conservative provisions to fully contain and treat nuisance odors that result from those treatment processes with the highest potential of producing detectable odors.[289]

It is recommended that treatment be provided using fiberglass or aluminum covers over identified process areas and connected to a single-stage activated-carbon-scrubbing unit. Both basin covers and separate building enclosures were considered for this project. Basin covers were chosen as the preferred containment method as they can be placed directly over the basins to provide for a more compact and less expensive installation. Preliminary estimates for the basin covers were between $25 and $50 per square foot. A typical estimate for a building to enclose the basins is approximately $150 per square foot and requires a much larger footprint. The volume of air to be treated with the covered basin option is also significantly less, which also affects the capital and operating costs.

Due to the relatively small air flow volumes associated with each process and the close proximity of the processes, a central system is recommended. The unit would remove

hydrogen sulfides as well as other VOCs from the headworks, anaerobic and anoxic zones, membrane feed pump wet well, and solids-handling emission stream areas. Conservatively designed with an 8,000-scfm capacity, the scrubber could sufficiently provide full odor removal capacity during peak events. It is not anticipated that a second-stage or redundant system will be necessary to further protect the surrounding community from nuisance odors. During times when the scrubber is scheduled for maintenance, the County's transportable carbon scrubbers can be mobilized and connected to the ductwork to provide additional treatment.

7.4.7 Support Facilities

The operations building will include an office, conference/lunch room, laboratory, restroom, shop, and electrical room. The electrical room will house motor control centers (MCCs), variable-frequency drives (VFDs), and other electrical equipment. The shop will include a workbench and basic tools for plant maintenance. The chemical feed building will be located at the south end of the MBR building.

7.4.7.1 Laboratory

Employees will conduct limited testing on samples and generate reports in the laboratory. Typically, an oven, refrigerator, sinks, glassware storage, glassware washer, and ample counter space are needed. Cabinetry for glassware storage and a small fume hood will be provided. Limited quantities of point-of-use chemicals will be stored in a ventilated cabinet below. A small workstation, accessible to disabled employees, will provide space for a computer and printer. This laboratory will be similar in size and function to the laboratory currently being constructed for the Vashon Island Wastewater Treatment Plant.

7.4.7.2 Control, Break, and Office Room

The facility control area, break area, and office area will be separated into distinct areas but combined within a single room to facilitate access by a single supervisor. The room will be situated to have visual access to the parking area and entrance gate. Staff working in the control area will need ready access to the restrooms. The control area will have space for a single workstation, including Network access, telephone, closed circuit TV (security), operations manuals, and filing access. This area will be used to monitor plant operations. The break area provides a place for employees to eat meals and gather for meetings. A kitchenette with a refrigerator and microwave will be provided. The office area will require storage for files and manuals and will include a work desk with a separate computer and an office chair. This space should also have network access and phone lines. A centralized space for a copy machine, printer, and plan layout area will be provided.

7.4.7.3 Electrical Room

The electrical room in the operations building will support the entire facility. Based on an initial evaluation, the total connected electrical load for the proposed facility is approximated

to be 500 kilovolt-amperes (kVA). The load includes an additional estimated 100 kVA for building services, including lighting and heating, ventilation, and air conditioning (HVAC) systems. This load can be accommodated by a 600-amp service at 480 volts AC, 3-phase, 60-hertz (Hz) from the local utility, with provisions included in the design for increasing service to 1200-amps in the future. The County and the City are coordinating their discussions on the electrical capacity requirements for both facilities from the local power utility.

Puget Sound Energy (PSE) is the local utility that provides electricity and natural gas service within the City. For service to a wastewater treatment facility, utilities normally furnish and install a padmounted transformer near the location of service. Initial discussions with PSE have indicated that 3-phase power is available at the corner of Highway 203 and Entwistle Street for the City-owned site. PSE may have additional installation requirements to establish the required power at the City-owned site. Additional details are provided in TM No. 10[290] or will be confirmed as design development progresses.

7.4.7.4 Restrooms/Showers

Restrooms and locker facilities are essential to the safety and welfare of employees. During facility operations, it is not uncommon for employees and uniforms to get dirty so showers and lockers for clean and soiled garments will be provided. For facilities between one and ten employees, the code allows for the installation of a single unisex restroom. The design of the single unisex restroom will provide some separation between the area provided specifically for employees and the areas of general use.

7.4.7.5 Chemical Feed

The CWWTF will potentially use liquid sodium hypochlorite for cleaning and periodic odor control. Sodium hypochlorite and citric acid will be required for routine maintenance cleaning and periodic recovery cleaning of the MBR and UV systems. Magnesium or sodium hydroxide will be added to satisfy the nitrification alkalinity requirement as well provide pH adjustments. Chemical feed requirements will be further developed during the design phase.

The chemical area will house chemicals needed for equipment cleaning (sodium hypochlorite and citric acid) and alkalinity adjustment (magnesium or sodium hydroxide). Citric acid will be stored in a tote while the hypochlorite and hydroxide will be stored in chemical tanks. The chemical area will also include future space for aluminum sulfate (alum) or ferric chloride should chemical precipitation be required in the future.

7.4.7.6 Workshop

An overhead-coiling door will be provided to access the workshop, which will include a workbench and work area. Large repair jobs will most likely be done offsite. A workbench and a lockable tool closet are necessary for security.

7.4.7.7 Standby Generator

The critical nature of the CWWTF is such that it will require continuous operation. Standby power must be provided for the entire facility so that the process may continue operation in the event of a loss of power from the utility. By using techniques such as load sequencing and solid-state “soft” starters for motors larger than 25 horsepower (hp), the size of the standby generator can be kept to a minimum. Preliminary calculations indicate that a standby generator rated at approximately 700 kilowatts (kW) would be sufficient.

The standby generator will be a self-contained, enclosed package unit furnished with separately mounted fuel tank(s) above grade. The fuel tank(s) will be sized to supply a minimum of 48 hours of power to the facility in the event of a power loss. There will be a transfer scheme between the main breaker and the generator breaker to transfer power supplied to the switchgear main bus from the utility to the generator whenever there is a loss of utility power and transfer power back to the utility after power is restored.

7.4.7.8 Fire Detection

At a minimum, the facility will include a fire detection system. Fire detection and monitoring will be provided for each building. The status of the fire detection system will be transmitted through the plant supervisory control and data acquisition (SCADA) system.

7.4.7.9 Security System

The facility will include a security system. At a minimum, entrance through the main gate will be controlled and monitored by a card reader system that transmits information through the facility’s SCADA system. The security system will also be monitored remotely at another regional County facility during hours without facility staff. Whether access to other buildings should be monitored and controlled will be investigated and determined during the initial design stage.

7.4.8 Staffing Requirements

It is anticipated that the facility will be staffed with the equivalent of a single full-time employee (FTE). Additional maintenance needs will be scheduled and serviced through the County’s available resources on an as-needed basis. This is based on a 50 percent time allotment for operations duties and 50 percent time allotment for maintenance responsibilities.

7.5 Hydraulic Analysis

The hydraulic profile for maximum, average, and minimum flows at the CWWTF is presented in Figure 7.8. Pipe diameters and gate sizes for the headworks were sized by maintaining a minimum velocity of 2.7 feet per second (fps) and a maximum velocity of 3.9 fps. The ultimate peak flow to the headworks was assumed to be 1.4 mgd as indicated

in the 2004 Sewer Facilities Plan.[291] Pipe sizes for process areas downstream of the headworks were sized to maintain minimum velocities of 0.5 fps and maximum velocities of 8.0 fps. Solids settling in the pipes are not anticipated to be a problem downstream of the MBR process because of: 1) the high water quality, and 2) flushing events to re-suspend any solids that may settle in the return activated sludge (RAS) line.

The resulting profiles indicate that a hydraulic head of 13.6 feet above the ground surface is required at the headworks to drive the treatment process to the aeration basin mixed liquor suspended solids (MLSS) wet well and accommodate the needed equipment in the headworks. MLSS is pumped from the aeration basin wet well to the MBR process. RAS flows by gravity back to the aeration basin flow splitter structure, and permeate is pumped through in-vessel UV disinfection to the effluent standpipe. The highly treated water can either be used for non-potable plant processes within the facility or overflows to a discharge pipe and is sent to the river outfall. Additional assumptions are detailed in TM No. 4.[292]

The standpipe water surface was set at 25 feet above the existing ground surface as a preliminary boundary condition for the hydraulic analysis. The height of the standpipe water surface elevation will be refined as the exact outfall location is established. Preliminary headloss calculations have indicated that the 25 feet of hydraulic head will sufficiently allow the highly treated water to be discharged by gravity. Design will proceed with a 33-foot high tank. Calculations, provided as Appendix H, assume the use of 12-inch HDPE pipe from the standpipe to the east edge of the Bridge. The pipe will be reduced to an 8-inch ductile iron (DI) pipe and supported off the bridge to the discharge location point. The highly treated water will be discharged through a diffuser check valve.

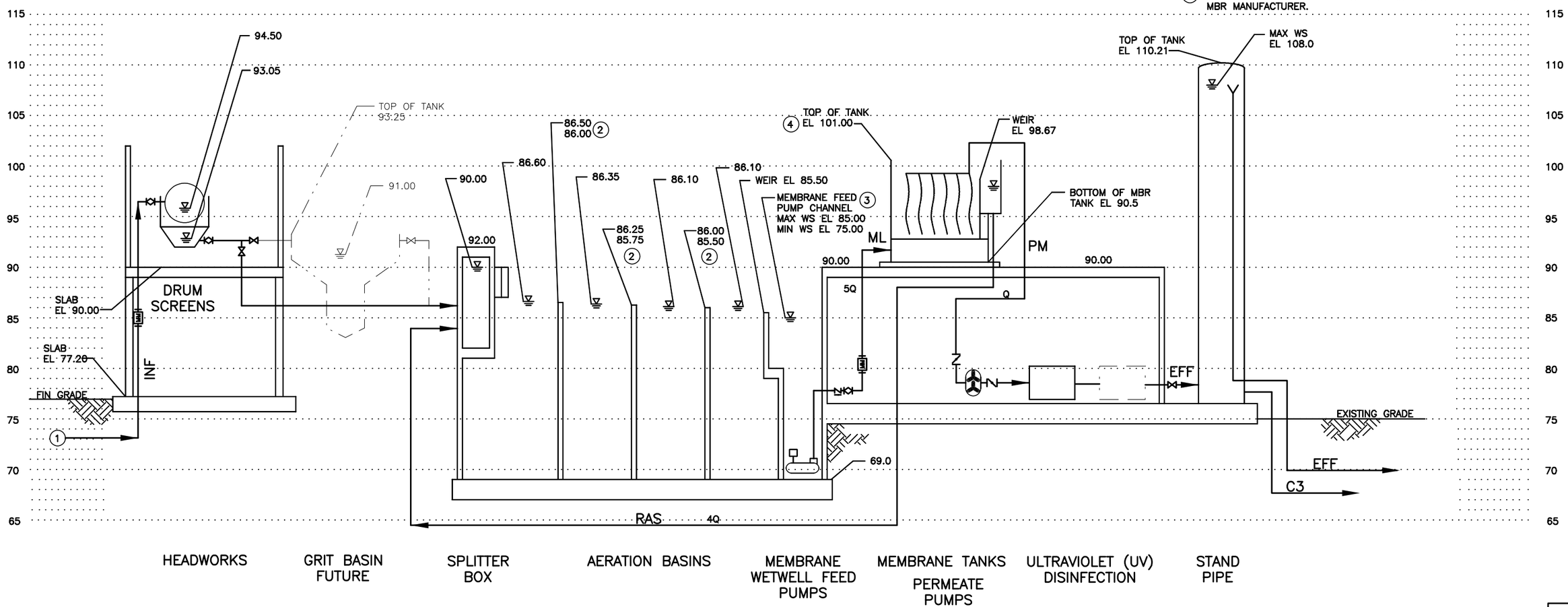
The flexibility of the standpipe design will allow a small booster pump to be installed to increase the available total dynamic head should another discharge alternative be selected in the future. For example, preliminary headloss calculations have indicated that discharging to the SWA will require over 30 feet of hydraulic head. Calculations, provided as Appendix H, assume the use of 12-inch HDPE pipe from the standpipe to the general SWA. The calculations do not account for a wetlands discharge design and should be updated if the alternative is chosen in the future.

GENERAL NOTES:

1. VERTICAL ELEVATIONS ARE BASED ON NAVD 88 DATUM.
2. 100–YEAR FLOOD 74.11 } (DRAFT FEMA MAP, JUNE 2005)
   500–YEAR FLOOD 75.60 }

KEY NOTES:

1. HEADWORKS FLOWS FROM CONSTANT SPEED PUMP STATION (BY OTHERS) WITH 1.4 MGD CAPACITY. FLOW IS INTERMITTENT.
2. TOP OF BAFFLE WALL AND TOP OF NOTCHED END OF WALL.
3. Q = 1.4 MGD PRIOR TO MBR FEED PUMPS.
   Q = 1.29 MGD DOWNSTREAM OF MBR FEED PUMPS.
4. ELEVATION ASSUMES 2 FEET OF FREEBOARD. TANK TO BE PROVIDED BY MBR MANUFACTURER.



HYDRAULIC PROFILE

HORIZONTAL SCALE: NOT TO SCALE
VERTICAL SCALE: 1" = 10'–0"

LEGEND

W.S. ELEVATION AT PEAK CAPACITY

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED: SEF	CHECKED: NONE
DRAWN: KWH	SCALE:
RECOMMENDED:	
APPROVED:	CONTRACT NO: E23020E

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.8

HYDRAULIC PROFILE

DATE: SEPT, 2005
FILE NO: 423557/###
DRAWING NO:
SHEET NO: OF

Last Saved By: TAS 9-23-05 09:25am
H:\Client\KingCo-DNR_SEA\E6020o10\DWG\Dwg\FIGURE_7-8 9-23-05 09:59am JCheesbro XREFS: D-TTL-XC-CARN; x6020-0-00-101

7.6 Conservation by Water Demand Management

It is the County's desire to reduce wastewater production rates in all of its service districts. The City details their water conservation policy in the 2004 Comprehensive Sewer Plan.[293] Furthermore, 90.48.495 RCW requires that sewer plans include an analysis of the potential effects of water conservation programs on wastewater flow. Although the CWWTF will be a new facility, existing housing and commercial establishments in the City will include a variety of older, conventional fixtures. It is possible that replacement of conventional fixtures with water-conserving fixtures could result in a further reduction of unit wastewater flow rates. This would not be expected to affect wastewater pollutant loads, except that concentrations would be increased.

Numerous water demand management studies have shown that significant reductions can be made in response to conservation measures.[294,295,296,297] In accordance with the Countywide Planning Policies presented in King County Comprehensive Plan[298] and to satisfy the requirements of 90.48.495 RCW, a review and cost analysis were commissioned by the County in 2004 to determine the cost implications of employing a water demand management program (retrofits and/or new plumbing codes) in conjunction with the design of the CWWTF. Two independent consultants were chosen to prepare the analysis due to their extensive experience and expertise in water efficiency pilot programs and studies. The financial implications were analyzed in two parts: 1) evaluate the feasibility of using demand management measures to reduce flows to the proposed CWWTF, and 2) evaluate the cost implications of reducing indoor water usage in existing and future homes and businesses within the City.

Impacts of different levels of conservation measures on flow reductions were compared to the current engineering design. Based on the range of resulting flows, four alternatives were selected for cost evaluation.

- **Current Design** – uses the per capita rates derived from historical water usage and agreed upon between the County and the City. The rates do not account for future per capita demand reductions.

- **Code Compliance** – assumes water usage remains similar to historical patterns but accounts for both natural replacement and the fact that new development will meet current plumbing codes (1992 Uniform Plumbing Code) and install "average" efficient fixtures.

- **Best Available Technology (BAT) New Construction** – assumes water usage remains similar to historical patterns but accounts for: 1) natural replacement rate of uprgrade to efficient fixtures, and 2) enhanced water efficiency building standards will require all new development to install BAT fixtures.

- **Mandatory BAT (all)** – assumes all existing fixtures and appliances will be retrofitted with BAT, and 2) enhanced water efficiency building standards will require all new development to install BAT fixtures.

Table 7.10 presents the assumed unit rates for wastewater flow production for each of the four water demand scenarios. Table 7.11 presents the resulting water demand impacts of conservation over the design life of the CWWTF.

Table 7.10 Unit Water Consumption Rates for Water Conservation Scenarios Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks

Parameter	Current Design	Code Compliance	BAT New Construction	Mandatory BAT
Residential (gpcd)[a]	65/NA/65	60/48/47	60/48/32	32/NA/32
Commercial (gpcd)[b]	30/30	24/20.4	24/18	18/18
Agricultural (gal/account/day)[b]	100/100	210/210	210/147	210/147
Elementary school (gal/student/day)[b]	10/10	2.7/2.7	2.7/2.2	2.2
Middle school (gal/student/day)[b]	16/16	2.7/2.7	2.7/2.2	2.2
High school (gal/student/day)[b]	NA/10	NA/3.3	NA/3.0	NA/3.0
Unclassified accounts (gal/account/day)[b]	NA/NA	419/NA	419/NA	293/NA
Unmetered/ unaccounted use (%)[b]	NA/NA	6/NA	6/NA	4/NA
Remlinger Farms (gpd)[b]	7661/NA	7661/NA	7661/NA	5363/NA

gal = gallons

gpcd = gallons per capita per day

gpd = gallons per day

NA = not applicable

a. Existing establishment / retrofitted establishment / new development

b. Existing establishment / new development

Source: Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.

Table 7.11 Projected Average Annual Flow Rates for Water Conservation Scenarios Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
	Average Annual Flow Rate (mgd)			
Year	Current Design	Code Compliance	BAT New Construction	Mandatory BAT
2007	0.21	0.21	0.15	0.12
2012	0.32	0.27	0.22	0.18
2022	0.35	0.29	0.24	0.20
2030	0.37	0.30	0.25	0.21

mgd = million gallons per day

Source: Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.

The conservation study concluded that by accounting for current plumbing codes and natural replacement rates for household appliances, the flow to the CWWTF could potentially be reduced by almost 20 percent at design year. Conservation by stricter mandated plumbing codes may result in a 27 to 30 percent reduction of flow. Mandated conservation (retrofits and new construction plumbing codes) is estimated to provide a 32 to 43 percent flow reduction at design year.

The demand reductions determined within the study were comparable to those experienced through conservation and retrofit projects undertaken by other municipalities. Heatherwood, Colorado, studied a scientifically selected sample of residential water customers to determine baseline conservation data and behavioral changes.[299] Although toilet flushing and shower duration increased after conservation measures were implemented, neither was found to be statistically significant at the 90 percent confidence interval. Based on a three-year study that evaluated water use in 1,188 study homes across 12 cities in the United States and Canada, the average daily per capita use was found to be 69.3 gallons.[300] After the national study, Seattle,[301] East Bay Municipal Utility District (EBMUD),[302] and Tampa[303] participated in follow-up studies to provide further insight into the savings that could be achieved from the installation of high-efficiency toilets, clothes washers, showerheads, and faucets. Table 7.12 presents the conservation retrofit study findings.

Table 7.12 Conservation Retrofit Project Study Findings Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Year	**Location**	**No. of Homes in Study**	**Baseline Water Usage (gpcd)**	**Retrofit Water Usage (gpcd)**
2004[a]	Carnation	733	60.0	31.6
1995[b]	Heatherwood	14	58.8	46.1
2000[b]	Seattle	37	63.6	39.9
2003[b]	EBMUD	33	86.2	52.6
2004[b]	Tampa	26	77.2	38.5

gpcd = gallons per capita per day

EBMUD = East Bay Municipal Utility District

a. Projected values. Assumes the Mandatory BAT conservation alternative.

b. Measured.

Source: Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.

To explore the financial impacts of conservation, a study[304] was completed to provide a cost overview of the three conservation scenarios. The Current Design alternative was not analyzed for financial impacts. Costs were developed for the implementation of conservation programs, total project and operation costs of the new collection and treatment facilities, and energy savings. Program costs for Mandatory BAT included: 1) full retrofits for homes and businesses, 2) residential toilet flapper replacement program and public information budget, 3) non-residential audit/leak repairs and air-cooled equipment rebate program, and 4) County start-up program staff. Implementation costs for BAT New Construction are based on the Mandatory BAT program but do not include a retrofit program and only support conservation maintenance for new structures. Flow-dependent impacts and costs were identified for the sewer system, CWWTF, and potable water system. The findings are based in significant measure on the capital and O&M cost inputs for the collection system and CWWTF. A sensitivity analysis indicated that other selected input assumptions have no significant effect on the cost-effectiveness comparison to the Current Design. No program costs were assumed for the Current Design and Code Compliance scenarios.

The cost analysis also evaluated the cost-effectiveness from separate cost allocation perspectives. Costs allocated to the County included conservation implementation, capital, and O&M costs for the CWWTF. Costs allocated to the City included 1) the capital and O&M costs for the sewer collection system, and 2) energy cost savings and reduced chlorine usage in potable water distribution. Costs credited to the customer included

avoided energy costs. Table 7.13 compares the net present value of combined and individual perspective costs for each alternative in 2004 dollars for the design life of the facility (2007 to 2030), with an assumed annual cost of capital of 5.25 percent and an inflation rate of 2.25 percent per year. The combined perspective accounts for the sum of all the flow-dependent costs for the County, City, and customer.

Table 7.13 Cost Impacts of Conservation Alternatives
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Alternative	Net Present Value ($ in millions)			
	Combined	County	City	Customer[a]
Code Compliance	31.00	15.07	15.93	0.0
BAT New Construction	30.74	15.10	15.80	-0.15[b]
Mandatory BAT (all)	30.65	15.92	15.67	-0.94

a. A negative cost is a benefit.

b. Customer benefits accrue only for owners of new structures.

Source: Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.

The economic analysis showed that the distribution of costs may require a higher initial cost by as much as $850,000, to implement the conservation program upfront.[305] Aggressive conservation is unlikely to cost more than a design approach (which does not account for conservation) over the entire design life of the facility. A 25 percent wastewater flow reduction corresponds to a two percent reduction of wastewater facility costs.

Conservation-based demand reductions only affect flow-dependent unit processes, which result in material reductions. That is, capital and O&M costs for the sewer collection system and CWWTF are only reduced if the flow savings causes a decrease in equipment rating or material usage. Due to the relatively small flow to the CWWTF, some equipment and support facilities are negligibly impacted because the current design already reflects the smallest-capacity range. Other aspects of the facility are either size-constrained by the pollutant load (not reduced on a lb/day basis) or serve on a support basis independent of the flows.

The conservation scenarios evaluated represent an initial estimate of the impacts of conservation. Both the City and the County have an obligation to maximize the overall environmental and intangible benefits in a cost-conscious manner. The County will discuss possible financially sound conservation programs with the City. Conservation practices will have little to no effect on the design of the CWWTF or the collection system but may impact the associated O&M costs.

7.7 Reliability and Redundancy

For the river outfall discharge alternative, the CWWTF is required to meet a minimum Class II level of reliability and redundancy. Reliability Class II is for "works whose discharge, or potential discharge, as a result of its volume and/or character, would not permanently or unacceptably damage or affect the receiving waters or public health during periods of short-term operations interruptions, but could be damaging if continued interruption of normal operations were to occur."[306] The County has committed to designing the CWWTF to have the flexibility to meet the strict *Washington Reclamation and Reuse Standards*[307] reliability and redundancy standards in the future. Reclamation facility standards are also generally more stringent than tertiary treatment standards for disinfection, reliability, and solids removal and are summarized in Table 7.14 as they apply to the CWWTF design.

Table 7.14 EPA Unit Process Component Reliability Requirements
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Component Installed	Class II Reliability Standard	Reclamation Standard
Mechanically cleaned bar screens	Backup unit required (may be manual).	Backup unit required.
Pumps	Backup unit provided for each set of pumps.	Backup unit provided for each set of pumps.
Aeration basin	At least two equal volumes must be provided.	Multiple units capable of providing oxidized wastewater with one unit out of service.
Aeration blowers or aerators	Provide capacity sufficient to meet peak oxygen demand with largest unit out of service.	Multiple units capable of providing oxidized wastewater with one unit out of service.
UV disinfection system	No requirement listed. Common design practice is to provide redundant capacity.	Standby unit / equipment required.
Emergency effluent storage	No requirement.	24-hour maximum daily flow or alternative disposal method.

Sources: Washington State Department of Ecology, *Criteria for Sewage Works Design*, 1998. G2-64.
Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.

In the State of Washington, reclaimed water is categorized into four classes of water quality. The classification dictates their approved usages. Class A is classified as the highest quality of reclaimed water, requiring the wastewater to be oxidized, coagulated, filtered, and disinfected. Classes B, C, and D require varying levels of oxidation and disinfection. Unrestricted urban reuse or beneficial use to wetlands such as the SWA would require the water to meet Class A standards.

In general, the facility will be designed to provide constant, reliable treatment; have on-line automated alarms; and possess redundancy or standby equipment for each unit treatment process. Mechanical treatment devices such as screens, pumps, and blowers are provided with one unit as standby. The facility processes will be designed to continue to fully treat the flow while any single process unit is removed from service for maintenance or repair. A more detailed explanation of the redundancy cost basis is given in TM No. 6.[308]

In the event that the County or the City would be interested in beneficial reuse in the future (wetlands restoration or urban use), the CWWTF design has the flexibility to meet the Class A reclaimed water standards and the reclaimed water standards for discharging to wetlands.[309] Ecology would require an engineering report that contains a description of the design of the proposed reclamation system and the means of achieving compliance with the standards. Appendix I provides a reliability checklist and water quality compliance comparison for the facility. The appendix is designed to provide an indication of the general facility design requirements as set forth by the reclamation standards[310] in terms of reliability and water quality. The appendix is not intended to provide an all-inclusive list of criteria that must be met to use reclaimed water. For example, discharge to beneficial use wetlands requires background studies, the performance of periodic biological monitoring, a demonstration of a net environmental benefit, compliance with the allowable hydraulic loadings, and area impairment analysis for the Snoqualmie River. Areas containing or using reclaimed water must notify all persons who would have probable reason to make use of the area. Pipelines containing reclaimed water must be purple, clearly labeled, and located so that no cross-contamination with potable lines may occur. All valves, storage facilities, and outlets should be tagged or labeled that the water is not intended for potable purposes. Permitting, distribution design and monitoring requirements will be reviewed if the highly treated water will be used for reclamation purposes in the future.

7.8 Final Planning Cost Estimate

The costs for the CWWTF were revisited to provide an updated estimate of the total project costs. Treatment facility estimated quantities and costs were updated based on the preliminary site plan layout identified in Figure 7.1. Conveyance and discharge costs are based on the recommended discharge conveyance route as illustrated in Figure 7.2 and assume the discharge pipeline is supported on the Bridge to the west pier. Table 7.15 summarizes the total project cost of the CWWTF, conveyance, and discharge to the Snoqualmie River. The discharge route proceeds north to NE 60th Street and heads northwest to the Bridge along 310th Avenue NE. Appendix J provides the detailed estimates used to develop unit prices for installed pipe for each of the routes discussed in this chapter. Appendix K provides the updated estimate comparison of the project if the highly treated water was discharged to the SWA for beneficial use. Table 7.15 does not include any potential costs associated with purchase or lease of land for the CWWTF. The City and County will be involved in discussions to come to an agreement for long-term use

of the CWWTF site area. The County currently estimates a purchase price of approximately $200,000 for as much as two acres of the property.

Table 7.15 Conceptual Level Cost Estimate
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Description	Quantity of units	Unit	Unit Price ($/unit)	Installation Price ($)	Total Price ($)
Wastewater Treatment Facility					
Capital costs					
Mobilization	1	LS	500,000		500,000
Sitework[a]					
Excavation	4,200	CY	30		126,000
Backfill	2,100	CY	30		63,000
Yard piping	1	LS	150,000		150,000
Paving	20,400	SF	4		81,600
Miscellaneous utilities	1	LS	200,000		200,000
Landscaping	1	LS	100,000		100,000
Fencing	1,000	LF	15		15,000
Lab/admin building					
Concrete masonry unit (CMU) structure	3,500	SF	150		525,000
Lab equipment	1	LS	100,000		100,000
Finish lab/admin area	1,500	SF	50		75,000
Chemical storage	1	LS	100,000		100,000
HVAC	1	LS	100,000		100,000
Headworks/treatment basins					
Base slab concrete	260	CY	250		65,000
Wall concrete	530	CY	750		397,500
Elevated concrete	60	CY	500		30,000
Headworks building	1,900	SF	100		190,000
Screening equipment	1	LS	250,000	30,000	280,000
Aeration system	1	LS	150,000	50,000	200,000
Solids-handling/wet well covers	1	LS	100,000		100,000
Odor control scrubber/ductwork	1	LS	500,000		500,000

Table 7.15 Conceptual Level Cost Estimate
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Description	Quantity of units	Unit	Unit Price ($/unit)	Installation Price ($)	Total Price ($)
MBR/UV area					
Base slab concrete	140	CY	250		65,000
Wall concrete	50	CY	750		37,500
Metal roof structure over MBR area	2,450	SF	30		73,500
MBR treatment equipment	1	LS	900,000	300,000	1,200,000
UV disinfection equipment	1	LS	500,000	50,000	550,000
Standpipe equipment	1	LS	100,000		100,000
Electrical and controls (15% of total)	1	LS	888,600		888,600
Estimating contingency	10	%		+	681,300
Capital costs subtotal					7,494,000
Contractor overhead and profit	15	%			1,124,100
Sales tax	8.8	%		+	758,400
Direct construction cost subtotal					**9,377,000**
Allied costs					
Consultant services					
30% design					827,000
Final design					990,000
CM support services	4	%			375,000
KC admin and other allied costs				+	900,000
Allied costs subtotal					**3,092,000**
Total CWWTF Project Costs (Feb 2005)					**12,469,000**
Conveyance and Discharge to River at the Carnation Farm Road Bridge					
Capital costs					
Conveyance					
12' HDPE - CWWTF to Bagwell St.[b]	1500	LF	95		143,000
12" HDPE - Bagwell St. to NE 60th[c]	2700	LF	62		168,000
12" HDPE - NE 60th to Bridge[b]	4600	LF	95		437,000

Table 7.15 Conceptual Level Cost Estimate
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Description	Quantity of units	Unit	Unit Price ($/unit)	Installation Price ($)	Total Price ($)
River outfall structure[d]	1	LS	184,000		184,000
Mechanical valves and appurtenances	1	LS	50,000		50,000
Estimating contingency	10	%		+	99,000
Capital costs subtotal					1,081,000
Contractor overhead and profit	15	%			162,000
Sales tax	8.8	%		+	109,000
Direct construction cost subtotal					**1,352,000**
Easement allowance[e]	2700	LF	14		**38,000**
Allied Costs					
Consultant services					
30% design					92,000
Final design					110,000
CM support services	4	%			56,000
KC admin and other allied costs				+	100,000
Allied costs subtotal					**358,000**
Total Conveyance/Discharge Project Costs (Feb 2005)					**1,748,000**
Total Project Cost					**14,217,000**

General Notes:

(1) The cost estimate herein is based on our perception of current conditions. The estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures.

(2) Carollo Engineers has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies.

(3) Carollo Engineers cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the costs presented herein.

(4) General Exclusions: All costs associated with the identification/mitigation of hazardous materials. All costs associated with historical/cultural discoveries on site. All costs associated with dewatering.

Table 7.15 Conceptual Level Cost Estimate
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Description	Quantity of units	Unit	Unit Price ($/unit)	Installation Price ($)	Total Price ($)

Footnotes:

a. Foundation pilings are not anticipated to be required for the project based on recent soil borings on the site.

b. Asphalt-paved roads with no curbs or gutters. Open-cut trenching costs include 10-ft-wide pavement demolition, earthwork, and pavement restoration. Assumes excavation to an average of 5 ft below ground surface, traffic control, and 50% native backfill above pipe zone. Does not assume costs for shoring.

c. Open-cut trenching costs include earthwork and gravel surface restoration. Assumes excavation to an average of 5 ft below ground surface and use of 75% native backfill above pipe zone. Does not assume costs related to shoring. Easement allowance for conveyance right-of-way listed separately.

d. Assumes installation of 280 ft of 8-inch-diameter horizontal ductile iron pipe, vertical pipe with a diffuser check valve, and in-water work.

e. Allows for 30-foot temporary easement in addition to 10-foot permanent easement from Bagwell Street to NE 60th Street.

Date: **3/8/2005**
Calculations By: **S. Leung**
Checked: **B. Einfeld**

CY = cubic yard
DI = ductile iron
LF = linear feet
LS = lump sum
SF = square foot

7.9 Future Expansion

The north and east physical boundaries of the recommended CWWTF site are constrained by the setback requirements from the property lines. The City's vacuum pump station bounds the facility to the south. By 2017, the City will have reached residential saturation within its UGA, with only additional employment-related flows anticipated. These additional employment-related flows and loads will likely represent only a small increase in flow to the CWWTF.

The CWWTF can be expanded to accommodate potential future treatment processes that may be required due to additional loads or new regulations. The current facility layout identifies potential locations for an additional aeration basin and equipment for mechanical solids dewatering and chemical addition for phosphate removal. If the City chooses to implement non-potable reuse either within the City and/or to enhance the SWA in the future, the river outfall can serve as the alternative discharge method to meet the *Washington Reclamation and Reuse Standards*.[311]

Notes

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[304] Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.
[305] Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.
[306] Washington State Department of Ecology, *Criteria for Sewage Works Design*, 1998. G2-64.
[307] Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.
[308] Carollo Engineers, *Technical Memorandum No. 6 - Treatment Process Configuration*, 2004.
[309] Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.
[310] Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.
[311] Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.

8.0 FINANCIAL ANALYSIS

8.1 Capital Cost Allocation

Table 8.1 provides a summary of the CWWTF costs from Chapter 7 in 2005 dollars. Estimated quantities and costs for the CWWTF were updated based on the preliminary site plan layout identified in Figure 7.1. Conveyance and discharge costs are based on the recommended discharge route as illustrated in Figure 7.2 and is based on conveyance to a river outfall at the Bridge.

Table 8.1 Total Capital Cost
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Cost Parameter	Total Cost ($)
CWWTF	
Construction cost	9,377,000
Allied cost	3,092,000
Conveyance and discharge	
Construction cost	1,352,000
Easement allowance	38,000
Allied cost	358,000
Total Capital Cost[a]	**14,217,000**

a. Cost does not include purchase or leasing of land for the CWWTF.

8.2 Operations and Maintenance Cost Allocation

Annual O&M costs include labor, power, equipment replacement, and chemical usage. Table 8.2 presents the annual and present worth costs anticipated for the CWWTF. The total annualized capital, operations, and maintenance cost is approximately $1,610,000, assuming a 5.875 percent discount rate over 22 years.

Table 8.2 Operations and Maintenance Costs Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks			
Parameter	**Quantity of Units**	**Unit Price ($/unit)**	**Total ($)**
Annual Costs			
Labor[a]	2,080 hr	43	90,000
Energy	690,000 kWh	0.065	45,000
Maintenance	1 LS	93,000	93,000
Chemicals	1 LS	72,000	72,000
Solids Transportation[b]	1 LS	122,000	122,000
Miscellaneous	1 LS	20,000	20,000
Total O&M Cost			*442,000*
Total Present Worth[c]			5,380,000
LS = lump sum			

a. Assumes one full-time employee equivalent during normal operation (50 percent maintenance duties, 50 percent operations duties).

b. Annual estimated transportation cost based on thickening to two percent solids.

c. In 2005 dollars (22 years, 5.875 percent discount rate).

8.2.1 Period of Analysis

A planning period is selected to approximate the life of the capital facilities to be compared in the economic analysis, as well as to capture the influence of significant factors on economic decisions. A planning period of 22 years was selected for this project, encompassing the design period from December 2007 through 2030. This represents the typical period for facilities planning and approximates the life of major equipment in wastewater treatment facilities. In addition, 20 years is the planning period required in EPA Facilities Planning.[312]

8.2.2 Operations Labor Rate

The operations labor rate is estimated to be $43 per hour, including fringe benefit costs, based on the 2004 fiscal year average rates for the County's operations and maintenance personnel. An employee crew equaling one full-time employee equivalent will be tasked with routine preventive maintenance procedures as well as normal operation of the facility. To minimize operations costs, the facility will be designed to an automation level to be routinely operated from a remote location. This will include such activities as the review of process parameters and the daily wasting of solids from the activated sludge process. Routine maintenance tasks include inspection of pumps and valves, review of recorded information, testing of alarm systems, and water quality sampling and testing. O&M duties

will be performed in conjunction with maintenance personnel from the County's other facilities. Such utilization of the County's staffing resources will allow any planned or emergency procedures to be completed in a timely manner.

8.2.3 Power Cost

The power cost rate is estimated to be approximately $0.065 per kilowatt-hour based on information from PSE and the County's power consumption costs for existing pump stations from previous years. Power usage at the CWWTF is anticipated to be more in line with the power usage at the County's Hollywood and York Pump Stations than with the County's larger wastewater treatment facilities. Therefore, the $0.065 per kilowatt-hour rate will be used for the facility power cost.

8.2.4 Chemical Cost

Estimated costs for commonly used chemicals at the CWWTF are based on costs for sodium hypochlorite, sodium hydroxide, and citric acid. Individual chemical costs are based on previous and anticipated costs provided by process equipment manufacturers and budgetary quotes from local vendors.

8.2.5 Maintenance Cost

To estimate the cost of maintaining new facilities, an allowance is made based on the original construction cost of the facility. For this analysis, an allowance for mechanical equipment maintenance was selected to be three percent, based on previous engineering experience.

8.2.6 Solids Transportation Cost

Transportation costs were based on the County purchasing a new 6,000-gallon septic tanker trailer. The trailer would be transported to the South Plant as required. Each sludge load haul would cost approximately $300.[313]

8.3 Project Financing

8.3.1 Project Financing

The County's Wastewater Treatment Division (WTD) capital improvement program (CIP) is funded primarily through proceeds from sewer revenue bond sales, short-term borrowing, capacity charge revenues, and transfers from the operating fund. Additionally, some low-interest loan programs such as the State Revolving Fund and the Public Works Trust Fund may be available. The operating fund derives the majority of its revenue from monthly charges to sewer customers that are collected by WTD's component agencies. Transfers from the operating fund to the capital program are the result of additional cash generated to meet the financial policy requirement of maintaining a debt service coverage ratio of no less

than 1.15 of all debt service payments. WTD uses these transfers to reduce the amount of borrowing necessary to finance the capital program.

The County's Sewer Rate and capacity charge are set annually by the County Executive and Council to reflect the current monetary requirements forecast. In June 2004, the County Council adopted a monthly wholesale sewer rate of $25.60 and a capacity charge of $34.05 for 2005. Revenues generated by this rate and capacity charge are sufficient to fund the 2005-2010 WTD financial plan that includes construction of the CWWTF, while fully complying with WTD's financial policies.

Prior to facility operation, the capital costs associated with the CWWTF will be financed through the resources available for costs associated with any new facilities and in accordance with the financial policies of the County and the WTD. The actual mix and cost of these instruments will reflect economic and financial conditions, WTD's financial position, and the appropriateness of the project for securing below-market rate resources.

8.3.2 Customer Charges

Once facility operations commence, the costs associated with construction plus operation and maintenance of the facility will be reimbursed or supported through a combination of user charges. These include the regular monthly sewer rate, the capacity charge and a special surcharge applied to the City's customers. The monthly rate is an amount uniformly levied on all system customers or customer equivalents. The capacity charge is levied on new connections to the system for a period of 15 years, with the option of payoff at a discount. The special surcharge, specified as a percentage of the regular monthly sewer rate, is designed to recover the additional capital-related costs incurred in the construction of facilities for the City.

The rate surcharge to the City's customers is based on the present value of the principal and interest payments incurred in constructing the facilities, over a 35-year period at a discount rate of 5.5 percent. These costs are then compared to the present value of the monthly sewer rate and capacity charge revenues from the City's customers during the same period. The surcharge, specified as a percentage of the monthly rate revenue, is set such that the sum of the resulting revenues equal the costs within the time frame. The O&M costs of the County-constructed facilities are anticipated to be recovered through the revenue from the regular monthly rate payment of the City's customers.

Assuming that the City is unable to secure grant funding, the City's initial estimate of a typical monthly sewer bull for a single-family residence would be $155. This includes local service charges in addition to County charges indicated above.

Notes

[312] EPA *State and Local Assistance*, 40CFR35.2030, (2004)
[313] Mark Lucas, King County Department of Natural Resources and Parks, e-mail message to John Komorita, September 29, 2003.

9.0 PROJECT IMPLEMENTATION

9.1 Schedule

Table 9.1 outlines the current timeline for completing the WWTF.

Table 9.1 Project Schedule
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Task	Anticipated Dates
Facility Plan	November 1, 2004 - May 15, 2005
Permitting (non-NPDES)	January 1, 2005 - February 28, 2006
Final design	January 1, 2005 - December 30, 2005
Advertise / award	January 1, 2006 - May 30, 2006
Construction	June 1, 2006 - October 31, 2007
WWTF	July 1, 2006 - October 31, 2007
Conveyance	Feb 1, 2007 - April 31, 2007
River Outfall	March 2007
Startup	November 1, 2007 - December 31, 2007

9.1.1 Construction Sequence

The total construction and startup period for the treatment facility is anticipated to require approximately 18 months. The anticipated construction sequence is as follows:

1. Site preparation
2. Excavate headworks/basins/MBR/UV/chemical areas
3. Construct concrete headworks/aeration basins
4. Construct foundation and base slab for chemical/MBR/UV disinfection facility
5. Install yard piping and electrical ductwork
6. Construct foundation and base slab for operations building
7. Complete structural work for operations building
8. Install mechanical equipment
9. Complete electrical work

10. Complete site paving
11. Install roof system for chemical feed facility
12. Complete installation of instrumentation and controls
13. Complete startup of facility
14. Complete landscaping

The total conveyance construction period is anticipated to require approximately three months. The anticipated construction sequence is as follows:

1. Begin trenching and installing pipe
2. Pressure test pipe after installation
3. Complete road restoration

The total river outfall construction period is anticipated to require approximately three weeks. The anticipated construction sequence is as follows:

1. Extend pipe from open-cut conveyance route vertically to Bridge above
2. Support pipe across Bridge to western pier above the water
3. Perform in-water work for discharge point

9.1.2 Public Involvement

Public concern is an important factor in the development of the CWWTF design. The City lies in an environmentally sensitive area and is committed to preserving wildlife habitats, maintaining current property values, ensuring public health, and addressing aesthetics issues. Both residents and environmental interest groups have been very active in all aspects of the alternatives selection process. As a result, every effort was made by the City and County to consider each decision from multiple perspectives, such as technical merit, economic limitations, comments from individuals and agencies, and environmental impact to the surroundings. Appendix L details the public involvement chronology for the project.

Beginning in January 2003, the County conducted extensive public involvement activities for the project. Some of these activities, conducted through April 2005, are as follows:

- Twenty-five interviews with community and interest group representatives to gather input regarding concerns, issues and opinions about the treatment facility and ways to involve the public
- Four CAC meetings on facility siting, to obtain input on the development and application of siting criteria, and on the results of the siting process

- Eight community meetings to provide information about the project, obtain feedback on the siting process and criteria, and discuss the treatment process and discharge options and explain the decision process and factors. Input on design of the treatment plant and discharge options was also requested.
- A site tour at SWA in conjunction with the WDFW, to discuss the wetlands enhancement discharge options
- Numerous meetings with property owners near the treatment facility sites and discharge locations
- Attendance and participation at the City's open houses and City Council meetings
- Frequent briefings to tribes, political leaders and community and interest groups
- A charrette to identify wetland discharge alternatives attended by stakeholder groups, permitting agencies, and resource agencies
- Four fact sheets to provide information about the project
- An ongoing project Web site,[314] to provide updated project information
- Staffing of an information booth at City's Fourth of July Festival each year
- A toll-free telephone number and e-mail address to receive public input and questions
- Five newsletters and several updates mailed to area citizens and project update mailings to a distribution list developed during activities listed above
- Responses to requests for information and questions from individuals and groups

In summer 2003, the County conducted an expanded SEPA scoping process for the draft EIS[315] under WAC 197-11-410.[316] As lead agency for SEPA review, the County issued a Determination of Significance and scoping notice on July 28, 2003. The scoping notice described the alternatives being considered and requested comments on issues and alternatives to be addressed in the EIS.

About 4,000 scoping notices were distributed to potentially affected parties. A public hearing/open house was held at the Carnation Elementary School on August 6, 2003. A separate meeting for regulatory agency representatives was also held on that day. A notice was provided on the project Web site,[317] legal notices were placed in local newspapers, and other legal notification requirements were met. The County allowed more than 45 days for scoping comments to be prepared and submitted. The comment period ended on September 12, 2003.

The County received a total of 76 individual scoping comment submittals (letters, e-mails, mail-back comment forms from the scoping notices, and/or testimony to a court reporter)

from 66 parties. Many submittals contained multiple comments. Of the 66 responders, 53 were individual citizens, nine were public agencies and four were interest groups or other organizations.

The County issued a draft EIS[318] on June 28, 2004 to provide environmental information to the public and agencies and to solicit comments on the proposals and issues discussed in the EIS. King County provided a 30-day public comment period for interested citizens, groups, agencies and governments to review the EIS and provide comments. A public hearing was held on July 14, 2004 to receive public testimony on the draft EIS. The public comment period closed on July 27, 2004.

The County received comments from a total of 28 individuals, groups and government agencies. Of these, 19 were individuals, eight were government agencies, and one was a private group. The comments and County's responses are provided in the final EIS.[319]

The final EIS[320] was one of the tools used by the Executive, in consultation with the City, in making a decision on the CWWTF. The final EIS provides information on the potential environmental impacts of the proposal. The Executive and the City considered these and other factors, including cost, engineering, community, and policy issues, into account in reaching a final decision.

9.2 Permitting and Regulatory Approvals

9.2.1 Water Quality Plan Compliance

The CWWTF has been envisioned by the City for a number of years, as documented in the City of Carnation 1996 Comprehensive Plan,[321] and the need for the CWWTF continues to be adopted in the subsequent revisions.

9.2.2 Biological Assessment

A biological assessment (BA) is being prepared for the CWWTF to comply with Section 7 of the Endangered Species Act (ESA). The BA was submitted to the EPA for review in June 2005 and forwarded to the services (USFWS and NOAA Fisheries) for their concurrence shortly thereafter. A biological opinion was issued in September 2005.

9.2.3 Joint Aquatic Resources Permit Application

A Joint Aquatic Resources Permit Application (JARPA) is a combined application package that will be submitted to the appropriate agencies for the required project permits. It is anticipated that the project will require the following aquatic resource permits:

- Hydraulic Project Approval (WDFW)
- Shoreline Substantial Development permit (King County)

It is anticipated that the JARPA package will be submitted to the appropriate permitting agencies in April 2005.

9.2.4 Environmental Impact Statement

The draft EIS for the CWWTF was issued on June 28, 2004 to comply with the SEPA requirements.[322] The draft EIS analyzed the characteristics, probable impacts, and mitigation measures for the CWWTF alternatives. The draft EIS underwent a 30-day public comment period, including a public hearing. The final EIS was issued October 15, 2004, and addressed all comments submitted (eight government agencies and 20 individuals or groups).[323] Changes made to specific sections in the draft EIS in direct response to the comments are reflected in the final EIS.

9.2.5 Environmental Assessment

As a recipient of federal grant funds, the overall CWWTF is subject to National Environmental Policy Act (NEPA) review. The EPA has prepared an environmental assessment (EA), evaluating the impacts of the project on the environment. In their analysis, the EPA issued a Finding of No Significant Impact (FONSI) and EA for the project in September 2005. The FONSI and EA 30-day comment period will end on October 22, 2005.

9.2.6 Other Construction and Discharge Permits

The County will treat and discharge wastewater in accordance with the applicable permit standards. Permits related to construction of the facility and discharge from the CWWTF to a Snoqualmie River outfall are expected to include a NPDES municipal discharge and storm water construction permit(s), Washington Department of Natural Resources Aquatic Lands Lease permit, and local clearing and grading, right-of-way, and building/construction permits. The CWWTF will meet all permit requirements, and these requirements will ensure that water quality standards in effect at the time of permit issuance are met. The potential NPDES permit limitations for discharge to the Snoqualmie River are summarized in Table 4.2.

The CWWTF will be designed in a manner that will facilitate upgrades to accommodate potential regulatory changes. NPDES permits typically place limits on the quantity and concentration of pollutants that may be discharged into state surface waters. A NPDES municipal discharge permit would be required for the river discharge and wetland discharge alternatives. NPDES is part of the federal CWA. EPA administers the CWA and has delegated NPDES permitting authority for Ecology. EPA has established federal water quality criteria under the CWA; Ecology has developed state water quality standards[324], which must be at least as stringent as the federal criteria. The purpose of the water quality standards for surface waters is to preserve the beneficial uses of state water bodies for humans and wildlife.

These standards are periodically reviewed and updated through a public process. The NPDES permits for the CWWTF are subject to the water quality standards that are in effect and applicable at the time of permit application. In addition, NPDES permits are issued for a period of five years, after which permits are reviewed and revised as necessary to protect water quality. Thus, the CWWTF would be subject to any new regulations that came into effect between the time the initial permits were issued and every five years thereafter when permits were renewed. Planning for the CWWTF will take into account the need to meet more stringent treatment requirements in the future.

Notes

[314] King County Department of Natural Resources and Parks, Wastewater Treatment Division, http://dnr.metrokc.gov/wtd/carnation/ (accessed April 7, 2005).
[315] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Draft Environmental Impact Statement for the Carnation Treatment Facility,* June 2004.
[316] *SEPA Rules: Environmental Impact Statement; Expanded Scoping*, *WAC 197-11-410* (1984).
[317] King County Department of Natural Resources and Parks, Wastewater Treatment Division, http://dnr.metrokc.gov/wtd/carnation/ (accessed April 7, 2005).
[318] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Draft Environmental Impact Statement for the Carnation Treatment Facility,* June 2004.
[319] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004
[320] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004
[321] City of Carnation, *Carnation Comprehensive Plan - 1996*, City of Carnation, Washington, http://www.ci.carnation.wa.us/library/COMPLAN.PDF (accessed June 1, 2003).
[322] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Draft Environmental Impact Statement for the Carnation Treatment Facility,* June 2004.
[323] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[324] *Water quality standards for surface waters of the state of Washington*, *WAC 173-201A* (2003).

APPENDIX A

City of Carnation 2004 Comprehensive Sewer Plan, Executive Summary

CITY OF CARNATION

2004 COMPREHENSIVE SEWER PLAN

OCTOBER 2004

Carnation City Hall
4621 Tolt Avenue / SR-203
Carnation, WA 98014-1238

City Council

Position 1 – Bill Paulsen
Position 2 – Laurie Clinton
Position 3 – Yvonne Funderburg, Mayor
Position 4 – Joan Sharp, Deputy Mayor
Position 5 – Stuart Lisk

PREPARED BY

Roth Hill Engineering Partners, LLC
2600 – 116th Avenue NE, #100
Bellevue, Washington 98004
Telephone 800.835.0292
Fax Phone 425.869.1190

EXECUTIVE SUMMARY

PURPOSE AND NEED OF THE PLAN

Besides meeting the requirements of WAC 173-240-050, the primary purpose of this City of Carnation 2004 Comprehensive Sewer Plan (henceforth, this Plan) is to provide a guidance document for the design, construction, and operation of a new sanitary sewer system to serve the City and, eventually, its entire Potential Annexation Area. A major element of this guidance is the recommendation for a collection system based on vacuum sewer technology, as derived from a cost-effective evaluation of collection system alternatives.

The collected wastewater is proposed to be treated and disposed at a new wastewater treatment facility being designed and constructed by King County.

The primary need for the sewer system (and consequently this Plan) is due to the inadequacy of the existing septic tank and drainfield systems that are currently in use throughout the planning area.

More detailed information concerning the development of the collection system alternatives, analysis of their costs, and the selection of the vacuum sewer alternative may be found in Chapters 5, 6, and 8. Chapter 7 provides details about the King County treatment and disposal facility. Further information specifically relating to the existing wastewater disposal systems may be found in Chapter 3, Section 3.6.

PLAN BACKGROUND

This Plan provides the background information, the development of sanitary sewer collection system alternatives, the selection of a recommended alternative, and an analysis of the financial impacts to the City's future sewer service customers.

Major factors forming the context of this Plan's development are described below:

- The City does not presently have a centralized sewer collection system. All wastewater treatment is provided by on-site septic tank/drainfield systems, many of which are old and, being located on small properties, are not compliant with today's standards for such systems. For example, in 1987 Seattle-King County Public Health changed their code to emphasize not only disposal but also treatment in the design and construction of on-site disposal systems (see Chapter 3).

  Replacing individual septic tanks with a centralized wastewater collection system and treatment plant is an important step toward the long-term viability of Carnation. The inadequacy of the existing on-site sewage disposal systems has been recognized for many years as evidenced by a letter dated April 19, 1988 to the City from the Seattle-King County Public Health (see Appendix E). The letter states that the most

important fact concerning the Carnation-area soils is that there is no restrictive layer of soil protecting the ground water resource from sewage (bacterial contamination). The letter cites a recent survey (at that time) of some of the businesses in the City and finding that every one of them had an inadequate on-site disposal system. Amongst the outlined problems it states that residential failures are common and points out that the existing systems are nearing the end of their useful lives. Some 'sump' types of systems are used by businesses and residences close to the City's well. These sump systems discharge sewage directly to the coarse gravels without any treatment. Many residences and businesses have been prevented from expanding or remodeling and the school district would likely be prevented from locating a new high school in Carnation. All of the outlined problems are described as only getting worse. This letter further noted that the Director of the Environmental Health Division had declared a public health hazard in the City on December 2, 1987.

On September 9th, 2003 Seattle-King County Public Health wrote a letter to the City in support of the proposed sewer system and in general reiterating the public health concerns raised in the 1988 letter. The September 9th letter is also in Appendix E.

With this background and as a result of this and of previous planning activities, some of which are described below, the City had already moved beyond the "do-nothing" alternative by the time this Plan was initiated. The major implication of all of this for this Plan is that that its primary theme is concerned with the creation of an entire new sewer system and utility rather than an existing infrastructure system as would be typical of most comprehensive sewer plans.

- The City is not located in close proximity to another sewer system purveyor and previous studies determined it was not cost effective to convey the sewer that distance. Therefore, a wastewater treatment and disposal system to serve the City directly is required (see below). The new treatment system will help Carnation meet the needs of its residents, schools, and businesses while protecting public health and the environment.

- A draft comprehensive sewer plan was previously prepared by American Engineering Corporation (dated November 2000). This plan was never adopted but every effort has been made herein to make use of and reference the information developed in this earlier plan. Therefore, the chapter organization of the AEC plan has been followed in this Plan and much of the background information has been incorporated by reference. The findings and recommendations of this Plan, however, are significantly different. The AEC plan is included as Appendix A in this Plan. (This Plan should be read section by section and then if a section of AEC 2000 is specifically incorporated by reference, that section of AEC 2000, along with any related figures and tables, should be read sequentially as a part of this Plan. If a section of AEC 2000 is not referenced in this Plan, then that section of AEC 2000 is not a part of the official 2004 Comprehensive Sewer Plan, even though it still appears in Appendix A.)

- In 2002, Roth Hill Engineering Partners, LLC prepared an engineering report. The report analyzed the alternative collection system options available to the City and recommended the use of a vacuum sewer system as the core conveyance methodology for the City. In May 2002 the Carnation City Council accepted this recommendation. The analysis of alternatives (see Chapters 5 & 6) and the recommendations of the 2002 engineering report (see Chapter 8) have been incorporated directly into this Plan.

- In June 2002, the City approved the entering into an interlocal agreement with King County for the County to provide the design, construction, and operation of a local treatment plant. King County Ordinance (No. 14582) authorizing the agreement was signed by the King County Executive on March 13, 2003, and the agreement was signed by the County on June 16, 2003. This subject is discussed in more detail in Chapter 7 but otherwise the wastewater treatment plant and disposal system are not a subject of technical analysis in this Plan. The treatment plant has a target completion date of 2007.

- King County recently completed a siting study for the treatment plant in July 2003. Two alternative treatment plant sites were selected for further study in an Environmental Impact Statement (EIS). The siting study was conducted under an extensive public involvement process with the convening of a citizens advisory committee and with several public meetings. Three discharge options were also selected to undergo further study in the EIS including a river outfall, wetlands enhancement and upland infiltration. The siting process will be documented in the draft EIS and draft Facilities Plan for the treatment plant, both scheduled for completion in February 2004.

- The treatment plant will include fine screenings, grit removal, biological nutrient removal, a membrane bioreactor, sludge thickening and ultra-violet disinfection. Solids will be hauled to the King County South Treatment Plant in Renton and incorporated in the County's biosolids program (silvicultural and land application). Specifics on the treatment plant, and the selection of individual treatment processes, will be included in the draft Facilities Plan for the treatment plant.

PLAN DEVELOPMENT

Under the Growth Management Act (GMA), urban levels of service are to be provided in urban areas. Sewer service is generally considered an urban level of service for addressing wastewater needs, while onsite systems are generally considered a rural level of service. The City made a decision to become an urban area, accepting urban levels of responsibility for accommodating growth in the region under the Countywide Planning Policies. The City also requested the ability to expand its City limits by pursuing an annexation area defined by the Urban Growth Boundary (UGB). The Urban Growth Boundary is shown on Figure 3-1. This Plan shows a recommended concept for providing sewer service within this area based on a centralized vacuum sewer system but also to include grinder pump stations and force

mains to serve some of the peripheral areas. The City initially intends to make sewer service available to all developed properties within the City limits with extensions to the other areas inside the UGB to follow in the future.

The service area has been divided into 19 (sewer drainage) Basins designated by the letters A through S. These are described in Section 4.3 of Chapter 4 and shown on Figure 4-1. Included in Chapter 4 are population and employment projections at intermediate years up to the year 2030. Table 4.5 shows the total ultimate population and employment for all Basins inside the Urban Growth Boundary as 3,871 and 2,825 respectively. The ultimate population is predicted to be reached in the year 2022 (+/-) but ultimate employment level will likely occur after 2030. These projections are for the areas within the City limits and the Urban Growth Area only.

Also described in Chapter 4 is the development of flow criteria for residential and commercial areas. Separate flow criteria are further developed for the Tolt MacDonald Park and Campground, the Tolt Middle School, the Carnation Elementary School, and Remlinger Farms. The possibility of a new high school to begin operation in the 2007-2008 school-year has also been taken into account. Using the flow criteria and the population and employment projections, the peak flow rate is predicted to be 819 gallons per minute (gpm) inside the City limits and 318 gpm outside for 2023. Ultimate peak flow inside the City limits is predicted to be 852 gpm and 318 gpm outside. See Table 4.6.

In Chapter 6, the three basic alternative collection systems are presented: a gravity system (Figure 6-1), a vacuum system (Figure 6-2), and a grinder pump system (Figure 6-3). It should be noted that both the gravity and vacuum system alternatives require the use of grinder pumps and force mains for some areas. Table 6.1 summarizes the total project cost projections for the three alternatives as follows:

Gravity system	$16,375,000
Vacuum system	$13,973,000
Grinder pump system	$14,764,000

Tables 6.2, 6.3, and 6.4 present these costs in detail. The above cost projections apply to the entire service area including those areas outside of the City limits that will not be constructed initially.

The interlocal agreement with the County includes a cost recovery plan for the City to pay for the capital and operations and maintenance for the treatment plant. This agreement limits the maximum cost to the City for the treatment plant of $10,600,000. The treatment plant will be designed to accommodate the flows as stipulated in this Plan.

PLAN RECOMMENDATIONS AND FINANCIAL PROGRAM

In Chapter 8, the selection of the vacuum sewer system alternative is described. As noted previously, the City Council adopted this alternative in May 2002. The initial portion of the sewer system to be constructed will be for the Basins inside the City limits.

The Capital Improvement Program is presented in Table 8.1. The table lists by project the estimated costs, the expected year of completion, and the funding sources. The two major projects are the wastewater treatment plant with an estimated cost of $10 million to be completed in 2007 and the collection facilities inside the City limits for $8.9 million to be completed in 2006.

Funding the proposed Capital Improvement Program will be a mixture of grants, PWTF loans, monthly sewer rates, and a surcharge on water rates. These and other possible sources of funding are discussed in Chapter 9. At this time (October 2003), the City has retained FSC Group of Redmond to assist with the development of a financial plan. A formal rate study is scheduled to be completed in 2004.

Subject to the future completion of the rate study, and assuming no grant funding is obtained, the total monthly payments for a typical single family residence are presently estimated to be $155 as shown in Table 9.2 and which is reproduced below. This includes an estimated Monthly Sewer Rate of $66 for the capital costs of the treatment plant and the operating costs for the plant and conveyance system. Also included, is the Local Facilities charge of $70 for the capital costs associated with collection and conveyance facilities. The remaining $19 of the monthly rate is the mandatory King County Connection Charge and is the only element of the estimated rate that is a known fixed cost at this time.

Included in the $155 per month estimate (as part of the $70 Local Facilities charge) are the costs for the individual side sewer connections, which are assumed to be privately financed. Although this cost will vary from connection to connection it is expected to average approximately $3,162.

SFR Sewer Rate – With No Grant Funding for Local Facilities

Monthly Sewer Rate	Property Tax (est.)	Assessment (Average Cost)		King County Connection Charge	Total Monthly Payments
		Local Facilities	Side Sewer		
$ 66	$ -	$ 50	$ 20	$ 19	$ 155

The Side Sewer charge, as explained below, will likely be privately financed. $20 represents the estimated typical monthly equivalent charge if financed over 20 years.

The single-family residential rate schedule shown in the table further assumes the City will receive no grant money to help finance the new system. Tables 9.3 and 9.4 present the impacts of receiving 25% and 50% grant funding on the Local Facilities' portion of the monthly rate and thereby lowering it from $70 to $59 and $46 respectively. Rates for non-residential customers will be partially based on sewage volume generated and partially based on the Local Facilities required.

On page 9-9 a number of policy objectives is recommended to be included as part of or in conjunction with the rate study scheduled in 2004. The foremost recommendation, however, is to aggressively pursue grant funding opportunities to offset the unavoidably high costs of the sewer system. At this time, the City is aggressively pursuing this objective.

APPENDIX B

City of Carnation 2004 Draft Sewer Facilities Plan, Executive Summary

CITY OF CARNATION

2004 SEWER FACILITIES PLAN

CITY REVIEW DRAFT – SEPTEMBER 2004

Carnation City Hall
4621 Tolt Avenue / SR-203
PO Box 1238
Carnation, WA 98014-1238

City Council

Position 1 – Bill Paulsen
Position 2 – Laurie Clinton
Position 3 – Yvonne Funderburg, Mayor
Position 4 – Joan Sharp, Deputy Mayor
Position 5 – Stuart Lisk

PREPARED BY

Roth Hill Engineering Partners, LLC
2600 – 116th Avenue NE, #100
Bellevue, Washington 98004
Telephone 800.835.0292
Fax Phone 425.869.1190

EXECUTIVE SUMMARY

PURPOSE OF PLAN

The primary purpose of this Facilities Plan (henceforth, "Plan") is to fulfill the requirements of WAC 173-240-060 as it relates to the design and construction of the new vacuum-based sanitary sewer collection system for the City of Carnation. The Plan is an engineering report and represents the next step in implementing the City's 2004 Comprehensive Sewer Plan. The Plan provides design information sufficiently complete so that plans and specifications can be developed without substantial changes. Ultimately, this Plan must be approved by the Department of Ecology (DOE).

SCOPE AND ORGANIZATION OF PLAN

This Plan is organized into the following Sections plus Appendices:

- Section 1 – Introduction
- Section 2 – Planning Considerations
- Section 3 – Alternatives Analysis
- Section 4 – Sewer Collection System
- Section 5 – System Operation and Maintenance
- Section 6 – Project Cost and Timeline
- Appendices

A brief summary of each follows below. These summaries describe the contents of each Section and present the most significant data or information found therein. For more complete descriptions and information, direct reference to the appropriate Section is required.

Section 1 – Introduction

The Introduction delineates in more detail the Purpose of the Plan which has been summarized above. Also presented is a listing of the Plan Sections and their contents.

The City is located at the confluence of the Tolt and Snoqualmie Rivers in King County, Washington as shown on Figure 1-1, Vicinity Map. The City encompasses approximately 608 acres with an additional approximately 164 acres in its Potential Annexation Area.

The City has entered into an interlocal agreement with King County to have the County design, construct, operate, and maintain the wastewater treatment plant and disposal system for the City. A plan for the King County facilities is not included in this Plan, but is the subject of a separate facilities plan being prepared by the County.

A brief project description is presented wherein it is noted that the subject project for this Plan is the vacuum sewer system to serve the entire Urban Growth Area, i.e. the City limits

plus Potential Annexation Area. The City is presently proceeding with the design and construction of only that portion of the new sewer system which will serve those properties within the City limits.

Section 2 – Planning Considerations

The planning considerations have been adapted and abridged from the 2004 City of Carnation Comprehensive Sewer Plan.

The planning area, Urban Growth Boundary, and the planned sewer service Basins are shown on Figure 2-1, Planned Service Area Basins, wherein the 19 Sewer Basins are designated by the letters A – S. Land use and zoning are described and shown on Figures 2-2, Existing Land Use, and 2-3, Current Zoning.

Population and employment projections, by Sewer Basin, are presented in Tables 2.1 and 2.2 respectively for the years 2000, 2007, 2012, 2022, and 2030. In Table 2.3, the ultimate population and employment capacity by Sewer Basin is presented. The ultimate residential population for the Urban Growth Area is predicted as 3,871 residents and is expected to be attained by the year 2022. The ultimate employment level in the Urban Growth Area is predicted to be 2,825 employees but is not anticipated until after the year 2030.

Development of the criteria for projecting wastewater flows begins in Subsection 2.4. Flow criteria are developed for residential, commercial, Tolt MacDonald Park, school, and Remlinger Farms flows. Peak flow factors are also developed. The most significant flow factors are:

- Residential: 65 gpcd (gallons per capita per day)
- Commercial: 30 gped (gallons per employee per day)
- Carnation Middle School: 16 gpsd (gallons per student/staff per day)
- Future High School and Carnation Elementary School: 10 gpsd (gallons per student/staff per day)
- Remlinger Farms: 55 gpm (peak flow) (gallons per minute)
- Peaking Flow Factors: 3.0 for residential and commercial, 2.0 for schools based on an 8-hour day.

Applying the criteria for projecting wastewater flows with the population and employment forecasts results in the projected wastewater flow estimates presented in Table 2.4. As shown in the Table, the ultimate peak flow for the Urban Growth Area is predicted to be 975 gpm.

Conservation/Demand reduction is a goal of the City. The City encourages low flow plumbing devices. The estimated cost and benefit to the overall sewer project for major retrofit projects were evaluated and City specific benefit was found to be very small or nonexistent. The Council will take demand reduction measures when it is deemed to be beneficial to the City.

Both King County and the City are looking at potential applications for water reuse. At this point, the City is not installing a parallel "purple pipe" system along with vacuum system due to additional costs and complexity to the project. However, the City wants to retain the right to the reuse-grade reclaimed wastewater produced by the treatment plant.

Section 3 – Alternative Analysis

Section 3 presents a cost-effective analysis of two alternative sewer collection systems for the City, one based on a conventional gravity sewer system and the other based on a vacuum sewer system.

The advantages and disadvantages of both conventional gravity sewers and vacuum sewer systems are described. A gravity system will likely have higher capital costs but lower operations and maintenance costs versus a vacuum sewer system. A significant disadvantage of a gravity system is its potential vulnerability to infiltration/inflow relative to a vacuum sewer system, especially in an area with a high ground water table, such as Carnation.

The layout for a gravity sewer system alternative is presented in Figure 3-1, Gravity System Alternative, while the vacuum system alternative is shown on Figure 3-2, Vacuum System Alternative. These alternatives are described in Subsection 3.4 and are followed by the cost-effective analysis itself in Subsection 3.5.

In 2002, the Carnation City Council unanimously approved Agenda Bill AB02-21 determining that a vacuum sewer system is the preferred method of wastewater collection for the City. This analysis fulfills a requirement of the Facilities Plan by considering both the project (capital) costs and the operations and maintenance (O&M) costs using the federally mandated interest rate for the year 2004 of 4.875% to convert the capital costs to an equivalent annual cost.

The project (capital) cost and O&M estimates for the gravity sewer system are presented in Table 3.1 while similar costs for the vacuum sewer alternative are given in Table 3.2. The cost-effective analysis comparison of the two systems is presented in Table 3.3. The results in Table 3.3 are summarized below:

	Gravity System	Vacuum System
Equivalent annual project cost	$857,785	$787,875
Annual O&M cost	$105,382	$132,633
	---	---
Total Annual Cost	$963,167	$920,508

As shown, the vacuum sewer system, due to its lower initial capital cost, is the most cost effective alternative. This validates the decision that was made in 2002 that the vacuum sewer system was the most cost effective collection system for the City.

Section 4 – Sewer Collection System

Section 4 presents a detailed description of the selected vacuum sewer system alternative presented in Section 3. (Refer to Subsection 4.3). The description is based on the most recent preliminary design available at the time of this Plan's preparation. It can be anticipated that small modifications to the proposed layout will be required before the design is finalized due to, for example, the ease or difficulty of obtaining specific easements on private property.

Major features of the proposed system are that the entire City, including the PAA, will be served by a single vacuum pump station which will be housed in a building and provided with an emergency backup generator to keep the station operational during an electrical power outage. Influent to the vacuum pump station will be from five separate service areas. Each of the five service areas will be served by its own 10-inch diameter pipe entering the station. The vacuum pump station site will be located on City-owned property in the western part of the City (see Figure 3-2). A few grinder pump stations, either temporary or permanent, may be required to serve a few outlying services including Remlinger Farms.

The most important element in Section 4 is the design criteria presented in Subsection 4.2. These are the criteria to be used to design the City's sewer collection system. The wastewater flow criteria from Section 2 are presented in Subsection 4.2.1 in a summary format. In Subsection 4.2.3, the following design criteria are presented for the collection system piping:

Vacuum Valve	3-inch opening for solids passing
Vacuum Loss Limits	13 feet due to vertical lift 5 feet due to friction
Friction Loss Determination	Using modified Hazen-William equation as derived by AIRVAC®
Pipe Diameters	3-inches for valve pit connections 4 – 10-inches for collection mains
Pipe Layout Parameters	
Profile	"Sawtooth" pattern
Minimum slope between lifts	0.2% (downhill)
Pipe Length Restrictions	300 feet maximum for 3-inch service laterals 2,000 feet maximum for 4-inch diameter Determined by vacuum loss limits for > 4-inch
Access/Cleanout Locations	On 6-inch or larger mains only Where a change in pipe size is made At a minimum of every 1,500 feet

In Subsection 4.2.3 the design criteria for the vacuum pump station and force main to the King County treatment plant are given as shown below:

Peak Station Flow	975 gpm
Number of Vacuum Pumps	4, each rated 25 hp, 150 cfm minimum 1 space provided for future vacuum pump
Sewage Discharge Pumps	
Number	2, each rated for 25 hp, 975 gpm
Total Dynamic Head	50 feet (+/-)
Collection Tank	
Total System Volume	7000 gallons
Operating Volume	2300 gallons
System Pump Down Time (lower vacuum from 16 to 20 in Hg)	3 minutes maximum
Collection Tank Level Controls (from lowest to highest)	Ground probe Both discharge pumps stop Lead discharge pump start Lag discharge pump start High level alarm Reset for high level cutoff probe High level cutoff
Force Main	
Minimum velocity	2.5 fps
Maximum velocity	7 fps
Length	300 feet (+/-)
Diameter	10-inch

Some of the design criteria are derived from information made available from AIRVAC®. It should also be noted that information regarding the sewage pumps in the station is based on the assumption that King County's treatment plant will be located adjacent to the City's vacuum pump station. There is a possibility the County's treatment plant will be located in the southern part of the City and, if this happens, it would impact the design of the sewage pumps and force main. This is discussed more fully in the Section 4.

In Subsection 4.3.5 a brief statement explaining that infiltration/inflow is minimal in a vacuum sewer system is presented and explained.

Reproduced below (from Subsection 4.3.6) is Table 4.1, Design Flow Summary, which presents a summary of the planning year (2024) and ultimate design flows for the 5 main collection pipes (designated A through E on Figure 3.2), the vacuum station, and the County's treatment plant.

Table 4.1, Design Flow Summary				
	2024		Ultimate	
Location	Peak (gpm)	Max Month (mgd)	Peak (gpm)	Max Month (mgd)
Pipe A	196	---	196	---
Pipe B	222	---	237	---
Pipe C	177	---	177	---
Pipe D	187	---	200	---
Pipe E	165	---	165	---
Vacuum Station	947	0.49	975	0.53
Treatment Plant	975	0.49	975	053

Notes: (1) gpm = gallons per minute; mgd = million gallons per day

(2) Maximum month flows are derived from "Technical Memorandum No. 2, Population, Flow, and Loads"; September 2004; prepared for King County by Carollo Engineers, P.C.

The system is being designed based on the AirVac® design criteria and equipment. As described in Subsection 4.4, the City intends to acquire the AirVac® equipment through a 'sole source procurement' process whereby the City will negotiate the pricing in advance of the public bidding for the conveyance system construction contracts. The sole source procurement process is subject to the review and approval of regulatory agencies such as the DOE and EPA. The details of this process are being developed as of the time of this Plan preparation.

Section 5 – System Operations and Maintenance

In this Section, the existing operations and maintenance responsibilities are reviewed and recommendations on proposed staffing requirements and other related components that will be required of the City in order to operate and maintain its new sewer collection system are presented. Major recommendations are:

- Hire a new fulltime Public Works Maintenance Worker.
- Hire one new half-time office employee.
- Acquire new accounting software and appropriate computer hardware.
- Purchase a trailer mounted vacuum field test pump and general purpose backhoe.

Also presented in Section 5 is a recommended list of spare parts and preliminary recommendations for routine maintenance of the both the vacuum valves (at the service connections) and the equipment at the vacuum pump station.

Section 6 – Project Cost and Timeline

This Section presents the estimated cost impacts of the sewer collection system presently being designed on the City's citizens, a review of the necessary regulatory agency permits required for the project, and the anticipated schedule for completing the design and construction phases of the project. The project, as discussed in this Section, is limited to providing sewer service inside the City limits.

The most recent project cost estimate for the sewer system presently being designed is $11,582,806. (Because the current project is limited to City-only service, this estimate is lower than the vacuum sewer estimate presented in Section 3 which was based on providing service throughout the Urban Growth Area.) Also not included in this estimate is King County's treatment and disposal facility which is budgeted at $10.6 million.

The City has received PWTF loans and STAG grants to assist with the funding of the project. At the present time, the average monthly rate for a single family residence is predicted to be $155, which includes costs for operating and maintaining the County's treatment facility. The City is actively seeking additional grant funding in order to lower the monthly customer costs. The City will apply for a DOE loan/grant of $10 million in 2005.

The City is in the process of conducting a rate study to establish a rate structure for various types and sizes of properties. Most likely, the costs will be apportioned between General Facilities charges (the vacuum station and oversized lines) and Local Facilities charges (the lines providing service to properties) based on either land area or Residential Customer Equivalents or some combination thereof. Residential Customer Equivalents will be in accordance with the equivalents established by King County DNR. Residential Customer Equivalents for non-residential facilities will be based on a fixture count survey.

In general, the permits required for the project are a function of their location. Many of the required permits are under the jurisdictional authority of the City itself. These include: Zoning, Building, Street Use, Special Use, Grading, and Shoreline Substantial Development Permits.

Permit requirements from agencies other than the City include: Washington State Department of Fish and Wildlife Hydraulic Project Approval, King County Property Services Special Use Permit, King County DDES Shoreline Substantial Development Permit, King County DDES Public Agency Use Permit, and King County Wastewater Treatment Division Project Approval.

At this time, design of the Sewer Collection System is in progress with Final Plans and Specifications anticipated to be submitted to Department of Ecology for approval in December 2004. Contingent upon approval of this Facilities Plan and the Sewer Collection System Final Plans and Specifications, and successful acquisition of easements, advertisement of the project currently is planned for April 2005 with construction to start in June 2005.

Appendices

The following Appendices are included in this Plan:

- Appendix A – Interlocal Agreement between the City of Carnation and King County
- Appendix B – NEPA Environmental Assessment
- Appendix C – DOE Comments and Approval
- Appendix D – Adopting Resolution and Ordinance

The findings of the NEPA process, given in Appendix B, constitute an important element in the required content of the Plan.

APPENDIX C

King County - City of Carnation Agreement for Sewage Disposal

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KING COUNTY

CITY OF CARNATION

AGREEMENT FOR SEWAGE DISPOSAL

THIS AGREEMENT, made as of this 16th day of June 2003, between the CITY OF CARNATION, a municipal corporation of the State of Washington, hereinafter referred to as the "City", and KING COUNTY, a political subdivision of the State of Washington, hereinafter referred to as "the County";

W I T N E S S E T H:

WHEREAS, the public health, welfare and safety of the residents of the City and the residents of the County require the development of adequate systems of sewage collection and disposal, the elimination of water pollution and the preservation of the fresh and salt water resources of the area; and

WHEREAS, growth of population, topographic conditions and preservation of water resources require that certain sewage disposal works be constructed and operated and that the cities and special districts within the Metropolitan Area dispose of their sewage in accordance with a comprehensive plan for the Metropolitan Area; and

WHEREAS, the County is engaged in developing and operating a Metropolitan Sewage Disposal System and the City is engaged in developing a sewage collection system for the City; and

WHEREAS, the City desires to deliver certain sewage collected by the City to the County for disposal as soon as facilities necessary for such delivery are available; and,

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WHEREAS, preliminary planning and engineering information indicates that construction of a wastewater treatment plant in the City would be the preferable alternative for the County's treatment and disposal of sewage delivered by the City; and

WHEREAS, the parties are interested in evaluating any possibilities for the reuse of wastewater that may be associated with locating said plant in the City; and

WHEREAS, to provide for the disposal by the County of sewage collected by the City it is necessary that an agreement be now entered into establishing certain rights and duties of the parties incident thereto;

NOW, THEREFORE, in consideration of the mutual covenants contained herein, it is hereby agreed as follows:

Section 1. Definition of Terms: The following words and phrases used in this agreement shall have the meanings hereinafter set fourth in this section.

(a) The words "Comprehensive Plan" shall mean the Comprehensive Sewage Disposal Plan adopted in Resolution No. 23 of the Municipality of Metropolitan Seattle and all amendments thereof or hereafter adopted.

(b) The words "Metropolitan Sewerage System" shall mean all of the facilities to be constructed, acquired or used by the County as a part of the Comprehensive Plan. The Metropolitan Sewerage System shall generally include sewage disposal facilities with capacity to receive sewage from natural drainage areas of approximately one thousand acres or more. The Metropolitan Sewerage System shall thus include trunk or interceptor sewers extending to a point within each tributary and natural drainage area where not more than one thousand acres remain to be served beyond the upper terminus of such trunk and interceptor sewer.

(c) The words "Local Sewerage Facilities" shall mean all facilities owned or operated by a Participant for the local collection of sewage to be delivered to the Metropolitan Sewerage

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System and all side sewers and connection fittings connected directly to such System which serve customers of such Participant.

(d) The words "Metropolitan Area" shall mean the area contained within the boundaries of King County as now or hereafter constituted.

(e) The word "Participant" shall mean each city, town, county, sewer district, municipal corporation, person, firm or private corporation which shall dispose of any portion of its sanitary sewage into the Metropolitan Sewerage System and shall have entered into an agreement with the County providing for such disposal.

(f) The word "Residential Customer" shall mean a single family residence billed by a Participant for sewerage charges.

Section 2. Delivery and Acceptance of Sewage. The City shall deliver to the County all of the sewage and industrial waste collected by the City and the County shall accept the sewage and waste delivered for treatment and disposal as hereinafter provided subject to such reasonable rules and regulations as may be adopted from time to time by the King County Council. The County shall not directly accept sewage or wastes from any person, firm or corporation which is located within the boundaries of or is delivering its sewage into the Local Sewerage Facilities of the City without the written consent of the City. The City shall not deliver sewage to any other agency for disposal without the written consent of the County.

Section 3. Construction of County Facilities. The County shall construct, acquire or otherwise secure the right to use all facilities required for the disposal of sewage delivered to the County pursuant to this Agreement and shall perform all services required for the maintenance, operation, repair, replacement or improvement of the Metropolitan Sewerage System, including any additions or betterments thereto. The County shall in its sole discretion determine the nature, location and time of construction of facilities of the Metropolitan Sewerage System. *The*

County shall, however, make every reasonable effort to construct and place in operation facilities necessary to treat sewage delivered by the City within five years from the date of this agreement and shall make every reasonable effort to achieve the following milestones:

1) Completion of final facility plan by March, 2004.

2) Completion of 90% design by December, 2004.

3) Execution of construction contract by October, 2005.

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If opportunities arise during the course of this project that allow the county to compress the schedule described in this section the county will compress it accordingly. The city and the county will meet periodically to review the progress that each party is making towards construction of the facilities described in this Section 3 and Section 4. Through these meetings the county will also keep the city updated as to costs and financing of the county's project.

In the event the county elects to construct the sewage treatment facilities contemplated by this section outside the Carnation city limits or elects to convey Carnation sewage to a treatment facility outside the city it will provide a written explanation to the city for such election.

The parties acknowledge that construction of these facilities may proceed only upon compliance with applicable environmental and permit requirements.

The city may terminate this agreement at any time prior to execution of a contract for construction of sewage treatment facilities upon sixty days notice and reimbursement of all costs incurred by the county to plan, design and prepare for construction of sewage treatment facilities to serve the city. The city shall not, however, be obligated to reimburse the county for any costs it incurs prior to the date of this agreement. In the event the city terminates the agreement and reimburses the county as provided in this paragraph, the county shall release to the city all relevant planning, engineering and bid documents (including those in electronic form) prepared from the date of this agreement to the date of termination including any

environmental documents, surveys, drawings, permit applications and permits; it being the intent of the parties that the city shall then receive the work products for which it will have paid.

Section 4. Connection of Local Sewerage Facilities to the Metropolitan Sewerage System. Local Sewerage Facilities of the City which may be required for the delivery of sewage and wastes to the County shall be connected to facilities of the Metropolitan Sewerage System at such time as any of the facilities of such Metropolitan Sewerage System shall be available to receive sewage collected by such local facilities. Such connection shall be accomplished at the expense of the City and in accordance with the rules and regulations of the County at such point or points as shall be determined by the County *in consultation with the city. The City shall make every reasonable effort to construct local sewage facilities and connect them to the metropolitan sewerage system in the manner and at the time described in this section. The city shall not, however, be required to construct any local sewage facilities outside of the city. If the county elects to treat Carnation sewage outside of the city it shall provide a point or points of connection for local sewage facilities within the city and shall construct, own and operate whatever sewage conveyance facilities are necessary to deliver Carnation sewage from said point or points to the treatment facility. The costs of constructing said conveyance facilities would then, for purposes of this agreement, be included in the capital cost of constructing wastewater treatment facilities to serve the city.*

The county may, at its option, delay its award of a construction contract for the sewage treatment facilities described in Section 3 until such time that the city awards a construction contract for local sewage facilities. The City shall secure and pay for the right to use all Local Sewerage Facilities of another Participant which may be required to delivery the City's sewage to the Metropolitan Sewerage System.

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Section 5. Payment for Sewage Disposal. Commencing with the first month in which sewage is collected and delivered by the City to the County, the City shall pay to the County on or before the last day of each month during the term of this Agreement, a sewage disposal charge determined as provided in this Section 5.

1. For the quarterly periods ending March 31, June 30, September 30 and December 31 of each year every Participant shall submit a written report to the County setting forth (a) the number of Residential Customers billed by such Participant for local sewerage charges as of the last day of the quarter, (b) the total number of all customers billed by such Participant as of such day, and (c) the total water consumption during such quarter for all customers billed by such Participant other than Residential Customers. The quarterly water consumption report shall be taken from water meter records and may be adjusted to exclude water which does not enter the sanitary facilities of a customer. Where actual sewage flow from an individual customer is metered, the metered sewage flows shall be reported in lieu of adjusted water consumption. The total quarterly water consumption report in cubic feet shall be divided by 2,250 to determine the number of Residential Customer equivalents represented by each Participant's customers other than single family residences. The County shall maintain permanent records of the quarterly customer reports from each Participant.

The City's first quarterly report shall cover the first quarterly period following the date when sewage is first delivered to the County and shall be submitted within thirty days following the end of the quarter. Succeeding reports shall be made for each quarterly period thereafter and shall be submitted within thirty (30) days following the end of the quarter.

2. a) To form a basis for determining the monthly sewage disposal charge to be paid by each Participant during any particular quarterly period, the County shall ascertain the number of Residential Customers and Residential Customer equivalents of each Participant. This

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determination shall be made by taking the sum of the actual number of Residential Customers reported as of the last day of the next to the last preceding quarter and the average number of Residential Customer Equivalents per quarter reported for the four quarters ending with said next to the last preceding quarter, adjusted for each Participant to eliminate any Residential Customers or Residential Customer equivalents whose sewage is delivered to a governmental agency other than the County or other than a Participant for disposal outside of the Metropolitan Area.

b) For the initial period until the City shall have submitted six consecutive quarterly reports, the basic reported number of Residential Customers and Residential Customer equivalents of the City shall be determined as provided in this subparagraph (b). On or before the tenth day of each month beginning with the month prior to the month in which sewage from the City is first delivered to the County, the City shall submit a written statement of the number of Residential Customers and Residential Customer equivalents estimated to be billed by the City during the next succeeding month. For the purpose of determining the basic reported number of Residential Customers or Residential Customer equivalents of the City for such next succeeding month, the County may at its discretion adopt either such estimate or the actual number of Residential Customers and Residential Customer equivalents reported by the City as of the last day of the next to the last preceding reported quarter. After the City shall have furnished six consecutive quarterly reports the basic reported number of Residential Customers and Residential Customer equivalents of the City shall be determined as provided in the immediately preceding subparagraph (a).

c) If the City shall fail to submit the required monthly and/or quarterly reports when due, the County may make its own estimate of the number of Residential Customers and Residential

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Customer equivalents of the City and such estimate shall constitute the reported number for the purpose of determining sewage disposal charges.

d) The basic reported number of residential customers and residential customer equivalents of the City shall be further adjusted by adding thereto 65% of said number of residential customers and residential customer equivalents. The sum thus determined is hereafter called the "adjusted reported number". Beginning with the first quarterly report (or written monthly statement) submitted by the City, and continuing each quarter for thirty-five years, the adjusted reported number of residential customers and residential customer equivalents shall be the number reported by the City for the purpose of determining sewage disposal charges pursuant to paragraph 3 of this section.

Not less than one year or more than eighteen months after facilities are constructed by the County for the purpose of providing wastewater treatment service to the City, the County will conduct a review of the additive adjustment described in this subparagraph (d) in the following manner: The capital cost of planning, designing and constructing the wastewater treatment facilities that serve the City shall be calculated and presented to the City along with the original assumptions that formed the basis of this surcharge. Subsequent to said presentation, King County shall lower the above percentage if said percentage results in disproportionate allocation of metropolitan sewerage system capital costs to the City. In that event, the percentage will be lowered to the level necessary to avoid disproportionate allocation of costs to the city and the lowered percentage would then be employed for the duration of the thirty-five year period. For purposes of facilitating the additive adjustment review provided for in this paragraph, the original assumptions that form the basis of the additive adjustment are attached to this agreement as Appendix A.

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The county will attempt to secure grants and low interest loans for the financing of the wastewater treatment facilities mentioned above so that the cost of financing those facilities will be minimized.

3. The monthly sewage disposal charge payable to the County shall be determined as follows:

a) Prior to July 1st of each year the County shall determine its total monetary requirements for the disposal of sewage during the next succeeding calendar year. Such requirements shall include the cost of administration, operation, maintenance, repair and replacement of the Metropolitan Sewerage System, establishment and maintenance of necessary working capital and reserves, the requirements of any resolution providing for the issuance of revenue bonds of the County to finance the acquisition, construction or use of sewerage facilities, plus not to exceed 1% of the foregoing requirements for general administrative overhead costs.

b) To determine the monthly rate per Residential Customer or Residential Customer equivalent to be used during said next succeeding calendar year, the total monetary requirements for the disposal of sewage as determined in subparagraph 3(a) of this section shall be divided by twelve and the resulting quotient shall be divided by the total number of Residential Customers and Residential Customer equivalents of all Participants for the October-December quarter proceeding said July 1st.

c) The monthly sewage disposal charge paid by each Participant to the County shall be obtained by multiplying the monthly rate by the number of Residential Customers and Residential Customer equivalents of the Participant. An additional charge may be made for sewage or wastes of unusual quality or composition requiring special treatment by the County may require pretreatment of such sewage or wastes. An additional charge may be made for quantities of storm or ground waters entering those Local Sewerage Facilities which are

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constructed after January 1, 1961 in excess of the minimum standard established by the general rules and regulations of the County.

d) An additional charge may be made to recover unforseen costs to operate and maintain the Metropolitan Sewerage System or meet debt requirements if the county executive declares and the county council by a majority vote finds that the system cannot be adequately maintained, and debt requirements or debt policies met, without such additional charge. The additional charge shall then be effective the first day of the second month following the emergency declaration described in this subparagraph 3.d) and shall be billed and collected in the same manner as the monthly rate referenced in subparagraph 3.c). The additional charge may be incorporated into the next rate setting cycle but will otherwise terminate within twelve months of the date approved. The additional charge described in this subparagraph 3.d) shall not be made until and unless it also conforms to the sewage disposal agreements with all remaining participants.

4. The parties acknowledge that the County may impose a charge or charges directly on the future customers of a Participant for purposes of paying for capacity in Metropolitan Sewage Facilities and that such charges shall not constitute a breach of this agreement or any part thereof. The proceeds of said charge or charges, if imposed, shall be used only for capital expenditures or defeasance of outstanding revenue bonds prior to maturity.

In the event such a charge or charges are imposed, the City shall, at the County's request, provide such information regarding new Residential Customers and Residential Customer equivalents as may be reasonable and appropriate for purposes of implementing such a charge or charges.

5. A statement of the amount of the monthly sewage disposal charge shall be submitted by the County to each Participant on or before the first day of each month and payment of such

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charge shall be due on the last day of such month. If any charge or portion thereof due to the County shall remain unpaid for fifteen days following its due date, the Participant shall be charged with and pay to the County interest on the amount unpaid from its due date until paid at the rate of 6% per annum, and the County may, upon failure to pay such amount, enforce payment by any remedy available at law or equity.

6. The City irrevocably obligates and binds itself to pay its sewage disposal charge out of the gross revenues of the sewage system of the City. The City further binds itself to establish, maintain and collect charges for sewer service which will at all times be sufficient to pay all costs of maintenance and operation of the sewer system of the City, including the sewage disposal charge payable to the County hereunder and sufficient to pay the principal of and interest on any revenue bonds of the City which shall constitute a charge upon such gross revenues. It is recognized by the County and the City that the sewage disposal charge paid by the City to the County shall constitute an expense of maintenance and operation of the sewer system of the City. The City shall provide in the issuance of future sewer revenue bonds of the City that expenses of maintenance and operation of the sewer system of the City shall be paid before payment of principal and interest of such bonds. The City shall have the right to fix its schedule of rates and charges for sewer service provided that same shall produce revenue sufficient to meet the covenants contained in this Agreement.

Section 6. Responsibility of City. The City shall be responsible for the delivery to the Metropolitan Sewerage System of sewage collected by the City, for the construction, maintenance and operation of Local Sewerage Facilities, and for the payment of all costs incident to the collection of such sewage and its delivery to the Metropolitan Sewerage System. All sewerage facilities of the City carrying sewage delivered to the County shall be constructed

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and maintained in accordance with the rules and regulations of the County and shall be constructed, maintained and operated by the City at no expense or risk to the County.

Section 7. Records. Permanent books and records shall be kept by the County and the City of the respective rates established, the volumes of sewage delivered and discharged into the Metropolitan Sewerage System whenever such volumes are measured and the number of Residential Customers and Residential Customer equivalents reported. In addition the County shall keep complete books of account showing all costs incurred in connection with the Metropolitan Sewerage System and the City shall keep complete records showing the amount billed to each of its customers for sewer service and the basis used for such billing including sewage flow and water consumption for each customer where applicable. The records required by this paragraph shall be available for examination by either party at any reasonable time.

Section 8. Development of Metropolitan Sewerage System. It is contemplated that the Metropolitan Sewerage System will be developed in stages and the nature of facilities to be constructed, acquired or used and the time of such construction, acquisition or use shall be determined by the County, it being contemplated that the County shall ultimately provide sewage disposal service for the entire Metropolitan Area.

Section 10. Insurance and Liability for Damages. The City shall secure and maintain with responsible insurers all such insurance as is customarily maintained with respect to sewage systems of like character against loss of or damage to the sewerage facilities of the City and against public and other liability to the extent that such insurance can be secured and maintained at reasonable cost. Any liability incurred by the County as a result of the operation of the Metropolitan Sewerage System shall be the sole liability of the County and any liability incurred by the City as a result of the operation of the Local Sewerage Facilities of the City shall be the sole liability of the City.

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Section 12. Assignment. The City shall not have the right to assign this Agreement or any of its rights and obligations hereunder either by operation of law or by voluntary agreement without the written consent of the County and neither party may terminate its obligations hereunder by dissolution or otherwise without first securing the written consent of the other party and this Agreement shall be binding upon and inure to the benefit of the respective successors and assigns of the parties hereto. In the event that the City should be dissolved or should no longer be authorized to operate sewer facilities, the Local Sewerage Facilities owned and operated by the City shall be assigned and transferred to the County subject to any outstanding debts of the City which had been incurred for the specific purpose of construction or acquiring such facilities and subject to the acceptance by the County of the obligation to continue to provide sewer service to the residents served by such local facilities upon payment by such residents of sewage disposal charges determined as herein provided and the reasonable costs of local sewer service.

Section 13. Effective Date and Term of Agreement. This Agreement shall be in full force and effect and binding upon the parties hereto upon the execution of the Agreement and shall continue in full force and effect until July 1, 2056.

Section 14. Notice. Whenever in this Agreement notice is required to be given, the same shall be given by registered Mail addressed to the respective parties at the following addresses:

King County
201 S. Jackson St.
Seattle, Washington 98104

City of Carnation
Post Office Box 1238
Carnation, Washington 98014-1238

Unless a different address shall be hereafter designated in writing by either of the parties.

JUN 2 3 2003
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The date of giving such notice shall be deemed to be the date of mailing thereof. Billings for and payments of sewage disposal costs may be made by regular mail.

Section 15. Execution of Documents. This Agreement shall be executed in three counterparts, any of which shall be regarded for all purposes as one original. Each party agrees that it will execute any and all deeds, leases, instruments, documents and resolutions or ordinances necessary to give effect to the terms of this Agreement.

Section 16. Waiver. No waiver by either party of any term or condition of this Agreement shall be deemed or construed as a waiver of any other term or condition, nor shall a waiver of any breach be deemed to constitute a waiver of any subsequent breach whether of the same or a different provision of this Agreement.

Section 17. Remedies. In addition to the remedies provide by law, this Agreement shall be specifically enforceable by either party.

Section 18. Entirety. This agreement merges and supersedes all prior negotiations, representations and agreements between the parties hereto relating to the subject matter hereof and constitutes the entire contract between the parties.

Section 19: Future Amendments. The city agrees to amend and hereby concurs in any amendment to this agreement which incorporates any changes in the terms for sewage disposal and payment therefor as may be proposed by the County and agreed to by those Participants that shall represent, in total, not less than 90% of the Residential Customers and Residential Customer Equivalents then served by the Metropolitan Sewerage System.

Section 20. Dispute Resolution. In the event disputes or claims arise over the interpretation, administration or effect of this agreement, either party may refer the matter to a committee composed of King County's Director of the Department of Natural Resources, the Manager of King County's Wastewater Treatment Division, or their respective designees, a

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member of the Carnation City Council and the City Manager of Carnation. At the request of either party a mediator or other neutral third party agreed upon by the parties to this agreement shall be added to the committee. Any costs incurred by the use of a third party shall be borne equally by the parties. The consideration of the dispute or claim by this committee, in an effort to reach a solution which reflects the best public interest, shall be a prerequisite to any legal action by either party.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

KING COUNTY

By Pam Bissonnette

Pam Bissonnette, Director
Department of Natural Resources

ATTEST:

CITY OF CARNATION

By

Richard Gould,
Interim City Manager

ATTEST:

Mary Otness

Mary Otness, Deputy City Clerk

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The sections below outline the assumptions and methodology used to calculate the surcharge to be added to the normal monthly sewer charge for Carnation customers. This surcharge is implemented by Section 5.2.d) as an additive adjustment of 65 percent of Carnation's residential customers and residential customer equivalents.

I. General Assumptions

1. Treatment Plant costs. Total project cost (excluding financing costs) for construction of the treatment plant is estimated at $10,600,000 in 2001 dollars. The project is assumed to begin in 2002 and be placed in operation in 2006.
2. Capacity charge payments from Carnation customers are credited against treatment plant project costs.
3. Monthly sewage disposal charge described in Section 5 is a regional-system revenue and will cover the operations and maintenance costs of the treatment plant.
4. Surcharge on the monthly charge is designed to compensate King County for the development and financing costs of the treatment plant that are not covered by capacity charge revenues from Carnation customers.
5. Rate, surcharge and capacity charge payments from Carnation customers will not commence until the treatment plant is placed in service. This is currently planned for 2006.
6. All Carnation residences and businesses (customers) pay the capacity charge and monthly charges beginning in 2006.

II. General Financial Assumptions

Table 1.0 presents the basic financial assumptions used in the calculation of the monthly surcharge.

Table 1.0 Carnation Financing Assumptions

Source	Rate	Term	Limit
King County Sewer Revenue Bonds	5.5%	35 years	N/A
Public Works Trust Fund Loan 2004	0.5%	20 years	$10 million per biennium
Discount Rate	5.5%	N/A	N/A
Inflation Rate	3.0%	N/A	N/A
Bond Issuance Costs	2.0%		

III. Public Works Trust Fund Assumptions

The Public Works Trust Fund provides low-interest loans. This surcharge calculation assumes one PWTF loan of $9.7 million in 2004. Other project costs and the 15 percent local matching are financed through the issuance of King County WTD sewer revenue bonds.

1. PWTF loan has a 20 year term.
2. PWTF loan has a 0.5 percent interest rate.
3. 15 percent local match required.
4. First two years of treatment plant project activity are bond funded.
5. PWTF loan disbursed in 2004.

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The following presents the components of financing the Carnation Treatment Plant with sewer revenue bonds and a PWTF loan. Table 2.0 presents the total principal financed, the sum of all debt service payments and the present value of all debt service payments.

2002: $ 779,545 is bond financed resulting in 35 annual payments of $50, 561.
2003: $1,261,750 is bond financed resulting in 35 annual payments of $81,982.
2004: $9,793,003 is borrowed from PWTF resulting in 20 annual payments of $515,763.

Table 2.0 Treatment Plant with 2004 PWTF Loan	
Total Financed*	$11,834,298
Sum of all Debt Service Payments	$14,957,409
Present Value of all Debt Service	$7,501,254

* total amount financed is based on project expense, including inflation and bond issuance cost, in the year those costs occur. Total cost financed therefore exceeds the total project cost of $10.6 million denominated in 2001 dollars.

IV. Surcharge Assumptions and Calculations

1. Surcharge rate is calculated as the ratio of:
   - the net present value (NPV) of principal and interest costs incurred by King County 2002-2040 minus the NPV of the capacity charge revenues.
   - to the NPV of sewer rate revenues paid by Carnation customers 2002-2040.
2. Surcharge components are:
   - NPV, 2002-2040, principal and interest payments $7,501,254
   - NPV, 2002-2040, capacity charge revenue $3,253,499
   - NPV, 2002-2040, rate revenue $6,583,849

$$0.65 = (\$7,501,254 - \$3,253,499) / \$6,583,849$$

The monthly rate and capacity charge forecasts are presented in Table 4.0 on Page 3.

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Table 4.0 Monthly Sewer Rate and Capacity Charge Forecast for Carnation Customers

Year	Monthly Sewer Rate	Surcharge/1/	Monthly Capacity Charge /2/	Total Capacity Charge /3/
2000	$19.50	$0.00	$10.50	$1,890
2001	$19.75	$0.00	$10.50	$1,890
2002	$23.40	$0.00	$17.20	$3,096
2003	$23.40	$0.00	$17.60	$3,168
2004	$23.40	$0.00	$18.13	$3,263
2005	$25.32	$0.00	$18.67	$3,361
2006 /4/	$26.68	$17.34	$19.23	$3,462
2007	$28.14	$18.29	$19.81	$3,566
2008	$29.41	$19.11	$20.40	$3,673
2009	$30.81	$20.02	$21.02	$3,783
2010	$32.23	$20.95	$21.65	$3,896
2011	$32.64	$21.22	$22.30	$4,013
2012	$32.80	$21.32	$22.96	$4,134
2013	$33.11	$21.52	$23.65	$4,258
2014	$33.52	$21.79	$24.36	$4,385
2015	$33.37	$21.69	$25.09	$4,517
2016	$31.23	$20.30	$25.85	$4,652
2017	$31.60	$20.54	$26.62	$4,792
2018	$31.88	$20.72	$27.42	$4,936
2019	$32.08	$20.86	$28.24	$5,084
2020	$32.30	$21.00	$29.09	$5,236
2021	$32.60	$21.19	$29.96	$5,393
2022	$32.89	$21.38	$30.86	$5,555
2023	$33.25	$21.61	$31.79	$5,722
2024	$33.74	$21.93	$32.74	$5,893
2025	$34.26	$22.27	$33.72	$6,070
2026	$34.83	$22.64	$34.74	$6,252
2027	$35.36	$22.98	$35.78	$6,440
2028	$35.90	$23.34	$36.85	$6,633
2029	$36.51	$23.73	$37.96	$6,832
2030	$37.13	$24.13	$39.09	$7,037
2031	$37.76	$24.54	$40.27	$7,248
2032	$38.40	$24.96	$41.48	$7,466
2033	$39.05	$25.38	$42.72	$7,690
2034	$39.72	$25.82	$44.00	$7,920
2035	$40.39	$26.25	$45.32	$8,158

/1/ Rate surcharge is equal to 65% of the monthly rate

/2/ The capacity charge is a monthly fee with a 15-year term. Customers may pay the entire capacity charge at one time.

/3/ This is the amount due if paid in full at the time of connection.

/4/ 2006 is planned on-line date for the Carnation Treatment Plant, hence the first year Carnation customers pay the Surcharge, continuing through 2040.

This long-range forecast is an estimate of future wastewater rates.

APPENDIX D

Severe Public Health Hazard in the City of Carnation Letter

Public Health
Seattle & King County
HEALTHY PEOPLE. HEALTHY COMMUNITIES.
Dorothy F. Teeter, MHA, *Interim Director and Health Officer*

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OCT - 3 2005
ROTHHILL ENGNR. PARTNERS, LLC
BELLEVUE, WA

September 28, 2005

Bill Brandon, City Manager
City of Carnation
4621 Tolt Avenue
P.O. Box 1238
Carnation, WA 98014

RE: **Severe Public Health Hazard** in the City of Carnation

Dear Mr. Brandon,

Due to continued public exposure to surfacing sewage and untreated sewage entering the ground water aquifer, current on- site sewage disposal practices in the City of Carnation are clearly inadequate and present a **Severe Public Health Hazard** to the community.

As stated in a letter dated December 2, 1987, Dr. Bud Nicola, then Director and Health Officer, determined that the existing on-site sewage disposal system was inadequate. He further stated that the soil conditions allow untreated sewage to enter the ground water aquifer which is used as a drinking water source. These problems continue to worsen as existing onsite systems approach the end of their useful lives and as population growth in the area increases the overall waste load.

Public Health--Seattle & King County issued the City of Carnation another Public Health Hazard letter in 2003. While we are encouraged to know the City has made substantial progress toward constructing the necessary public sewer system, we must again express our concern for water quality and protecting public health.

Recent survey information documenting a significant number of failures previously unreported to the Health Department and the citywide distribution of those failures, even in the newest septic systems, causes us both alarm and concern for protection of the health of Carnation's citizens. Many of these failures have included sewage on the surface of the ground, placing citizens at risk of contracting serious and potentially life-threatening illnesses.

Office of the Director
999 Third Avenue, Suite 1200 • Seattle, WA 98104-4039
T 206-296-4600 F 206-296-0166 TTY Relay: 711
www.metrokc.gov/health

Because of these continuing violations of both surface and underground water quality, Public Health strongly supports the development of a sewer system for the City of Carnation to alleviate this Severe Public Health Hazard.

Sincerely,

Dorothy Teeter
Interim Director and Health Officer

cc: Roth Hill Engineering, Attn: Laurie Fulton, P.E., 2600 116th Ave NE, #100, Bellevue, WA 98004
Larry Fay, Wastewater Supervisor, PHSKC

APPENDIX E

City of Carnation Water Reuse Interest Letter

CITY OF CARNATION

June 23, 2004

John Komorita, P.E.
Project Manager
King County Wastewater Treatment Division
201 South Jackson Street
Seattle, WA 98104-3855

Dear John,

The City of Carnation has decided to not pursue water reuse at the time that the new sewer system is installed, 2007. The City understands that if conditions related to reuse change in the future, the City would have the opportunity to utilize the reclaimed water from the new treatment plant. The City would also like to claim first rights to the reclaimed water, but understands that this issue will need to be negotiated with the County and be consistent with the County's overall water reuse policies. Finally, the City understands that the wetlands enhancement alternative that the County is actively pursuing for the treatment plant is also considered a form of reuse and fully supports this creative use of this valuable resource.

Water reuse was discussed at the February 10, 2004 Carnation City Council Special Sewer Meeting, an open public forum, where the Council decided that this would not be a good time to consider implementation of a water reuse program due to: 1) the cost of installing a water reuse pumping and conveyance system, 2) the apparent lack of potential users, 3) the expected rate that would be necessary to charge customers for the water and 4) the lack of adequate grant funding available to help limit the costs for reuse.

The estimated cost to design and construct a reuse pumping and piping system to convey Class A reclaimed water to the City's entire business and residential communities has been reported by the County to be about $4.7 million. A pump station and reservoir owned and operated by the City would be needed to convey the reuse water to the homes in the higher elevations. The cost for the City system assumes that purple reuse pipe could be installed at the same time and in the same trench as the vacuum collection system. The estimated rate which the City would have to charge in order to recover these capital costs, and the annual cost for operations and maintenance of this system, would be about $7 to $8 per one hundred cubic feet ($/ccf). This compares to the existing rate of $4.42/ccf ($26.50 per 600ccf) which the City presently charges for potable water.

Individual business and home owners would also need to construct a separate reuse water system for lawn irrigation, toilet flushing or other onsite uses. This cost is not included in the $4.7 million figure for the City's system. The expected cost to the individual owners would be over $3,000 per onsite system and include connecting to the City reuse water main out in the street and installation of a landscape irrigation system and an entirely new separate water system within the home or business. Costs for retrofitting a school or park would be much greater.

If a reuse system is installed in the City, there would be no savings in the treatment plant since some form of outfall or other discharge option would still be required. This is because reuse in the City would primarily consist of irrigation during the summer months. A means for handling the treatment plant effluent would still be required during other times of the year.

Both the City and the County have been searching extensively for any form of grant which could help offset the costs of the sewer system. It would appear that the same grants that we are researching for the sewer system are the same as those that would apply for a reuse water system. Thus, we could add in the cost of the reuse system in our ongoing grant and loan applications, but we would likely not receive much more with or without the reuse system. There just does not appear to be a lot of grant monies available for sewers or reuse as others have claimed.

We understand that the County is considering a filling station at the treatment plant where customers could bring trailers or tankers to fill with reclaimed water for use such as irrigating parks, etc. We further understand that tapping stations could also be provided along the effluent conveyance line leading out to whichever discharge option is selected. If the City determined in the future that reuse should be implemented, the City could install pump stations at these tap locations to convey the reuse water to the appropriate customers.

The average amount of reuse water which would be available is about 360,000 gallons per day, or 0.36 million gallons/day (mgd). Typical uses of reuse water would be for irrigation at homes, businesses, schools, golf courses, farms and parks or for commercial uses such as for cooling. For Carnation, there would appear to be very limited ongoing uses of potable water for irrigation or for commercial activities. The golf course would be one exception, however, the Carnation golf course presently has a water right to take water from the Snoqualmie River, and is located relatively far away for a pipeline. Thus, if there are limited ongoing potable water uses, or in the case of the golf course the use is presently for free, one could assume that there would be limited demand or willingness to pay for reuse water in the near future. Also, the estimated rates to recover the costs of the reuse system assume that 100% of the water would be utilized for reuse. Based on existing uses, the amount of water that is reused would be less than the amount (360,000 gpd) produced. Thus, the estimated rates would be higher than those shown above.

In closing, the City does not believe it is prudent to pursue water reuse at this time without a definite project to construct. The City's rate payers will already have a great burden to pay for the sewer system. Having to pay more for a reuse system appears not to be practical at this time. The City, however, reserves the right to negotiate with King County if a viable opportunity presents itself to construct.

If you have any questions, please contact me.

Sincerely,

Bill Brandon
Carnation City Manager

Cc: Carnation City Council members
Kelly Snyder, Roth Hill Engineers

APPENDIX F

Preliminary Cost Comparison

Scenario 1: SBR Present Worth
King County DNRP
Carnation Wastewater Treatment Facility

Date: 2/9/2005
By: S. Leung
Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Capital Costs					
Mobilization	1	LS	$650,000		$650,000
Sitework					
Excavation	1	LS	$360,000		$360,000
Backfill	3,600	CY	$30		$108,000
Paving	31,250	SF	$3		$93,750
Misc. utilities	1	LS	$200,000		$200,000
Landscaping	1	LS	$150,000		$150,000
Fencing	2,700	LF	$20		$54,000
Treatment Facility & Lab/Admin Area					
Base slab concrete	1,300	CY	$300		$390,000
Wall concrete	700	CY	$600		$420,000
Elevated concrete	100	CY	$900		$90,000
Screening Equipment	1	LS	$250,000	$30,000	$280,000
Headworks Building	1,800	SF	$100		$180,000
Pre-engineered building	4,500	SF	$40		$180,000
Post-equalization basin	1	LS	$10,000		$10,000
SBR Equipment	1	LS	$500,000	$50,000	$550,000
Filtration	1	LS	$450,000	$20,000	$470,000
UV Disinfection	1	LS	$450,000	$40,000	$490,000
Effluent standpipe equipment	1	LS	$100,000		$100,000
Lab Equipment	1	LS	$100,000		$100,000
Finish Lab/Admin Area	1,200	SF	$50		$60,000
Solids Handling	1	LS	$600,000		$600,000
Chemical storage	1	LS	$100,000		$100,000
HVAC	1	LS	$100,000		$100,000
Electrical and Controls (18% of total)	1	LS	$1,152,100		$1,152,100
Odor Control					
Scrubber	1	LS	$400,000		$400,000
Ductwork	1	LS	$265,000		$265,000
Estimating Contingency (10%)					$755,300
Subtotal					$8,308,150
Overhead and Profit @ 15%					$1,246,200
Sales Tax (8.8%)					$840,800
Direct Construction Cost Subtotal					**$10,395,200**

Scenario 1: SBR Present Worth
King County DNRP
Carnation Wastewater Treatment Facility

Date: 2/9/2005
By: S. Leung
Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Allied Costs					
30% design					
30% design (10.5%)					$1,091,000
Final design (12.5%)					$1,300,000
CM Support Serv's (4%)					$416,000
KC Admin and other allied costs					$1,000,000
Subtotal Allied Costs					**$3,807,000**
Total WWTF Project Costs (July 2004)					**$14,202,200**
Operations and Maintenance Costs					
Labor*	2,080	HR	$43		$90,000
Energy	775,000	KWH	$0.065		$51,000
Maintenance Equipment/Structural	1	LS	$102,500		$102,500
Chemicals	1	LS	$70,000		$70,000
Miscellaneous	1	LS	$20,000		$20,000
Total O&M Costs (July 2004)					$333,500
Present Worth, $ in Millions					
Capital					$14.2
Operations and Maintenance					$4.1
Discount Rate	5.875%				
Period of Analysis (2007 - 2030)	22	YR			
Total Present Worth (July 2004)					$18.3

* Labor estimate for WWTF independent of scenario

Scenario 2: Oxidation Ditch Present Worth
King County DNRP
Carnation Wastewater Treatment Facility

Date: 2/9/2005
By: S. Leung
Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Capital Costs					
Mobilization	1	LS	$600,000		$600,000
Sitework					
Excavation	1	LS	$320,000		$320,000
Backfill	3,200	CY	$30		$96,000
Paving	31,250	SF	$3		$93,750
Misc. utilities	1	LS	$200,000		$200,000
Landscaping	1	LS	$150,000		$150,000
Fencing	2,400	LF	$20		$48,000
Treatment Facility & Lab/Admin Area					
Base slab concrete	1,200	CY	$300		$360,000
Wall concrete	600	CY	$600		$360,000
Elevated concrete	100	CY	$900		$90,000
Screening Equipment	1	LS	$250,000	$30,000	$280,000
Headworks Building	1,800	SF	$100		$180,000
Pre-engineered building	4,500	SF	$40		$180,000
Secondary Clarifiers	2	LS	$90,000	$15,000	$210,000
Oxidation Ditch Equipment	1	LS	$450,000	$50,000	$500,000
Filtration	1	LS	$450,000	$20,000	$470,000
UV Disinfection	1	LS	$450,000	$40,000	$490,000
Effluent standpipe equipment	1	LS	$100,000		$100,000
Lab Equipment	1	LS	$100,000		$100,000
Finish Lab/Admin Area	1,200	SF	$50		$60,000
Solids Handling	1	LS	$500,000		$500,000
Chemical storage	1	LS	$100,000		$100,000
HVAC	1	LS	$100,000		$100,000
Electrical and Controls (18% of total)	1	LS	$1,113,800		$1,113,800
Odor Control					
Scrubber	1	LS	$350,000		$350,000
Ductwork	1	LS	$250,000		$250,000
Estimating Contingency (10%)					$730,200
Subtotal					$8,031,750
Overhead and Profit @ 15%					$1,204,800
Sales Tax (8.8%)					$812,800
Direct Construction Cost Subtotal					**$10,049,400**

Scenario 2: Oxidation Ditch Present Worth
King County DNRP
Carnation Wastewater Treatment Facility

Date: 2/9/2005
By: S. Leung
Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Allied Costs					
30% design					
30% design (10.5%)					$1,055,000
Final design (12.5%)					$1,260,000
CM Support Serv's (4%)					$402,000
KC Admin and other allied costs					$1,000,000
Subtotal Allied Costs					**$3,717,000**
Total WWTF Project Costs (July 2004)					**$13,766,400**
Operations and Maintenance Costs					
Labor*	2,080	HR	$43		$90,000
Energy	780,000	KWH	$0		$51,000
Maintenance Equipment/Structural	1	LS	$97,500		$97,500
Chemicals	1	LS	$70,000		$70,000
Miscellaneous	1	LS	$20,000		$20,000
Total O&M Costs (July 2004)					$328,500
Present Worth, $ in Millions					
Capital					$13.8
Operations and Maintenance					$4.0
Discount Rate	5.875%				
Period of Analysis (2007 - 2030)	22	YR			
Total Present Worth (July 2004)					$17.765

* Labor estimate for WWTF independent of scenario

Scenario 3: MBR Present Worth
King County DNRP
Carnation Wastewater Treatment Facility

Date: 2/9/2005
By: S. Leung
Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Capital Costs					
Mobilization	1	LS	$500,000		$500,000
Sitework					
Excavation	1	LS	$200,000		$200,000
Backfill	2,000	CY	$30		$60,000
Paving	25,000	SF	$3		$75,000
Misc. utilities	1	LS	$200,000		$200,000
Landscaping	1	LS	$100,000		$100,000
Fencing	1,500	LF	$20		$30,000
Treatment Facility & Lab/Admin Area					
Base slab concrete	700	CY	$300		$210,000
Wall concrete	350	CY	$600		$210,000
Elevated concrete	100	CY	$900		$90,000
Screening Equipment	1	LS	$250,000	$30,000	$280,000
Headworks Building	1,800	SF	$100		$180,000
Pre-engineered building	4,500	SF	$40		$180,000
Metal roof structure over membrane area	5,000	SF	$30		$150,000
MBR Treatment equipment	1	LS	$1,155,580	$300,000	$1,455,580
Aeration system	1	LS	$150,000	$50,000	$200,000
UV Disinfection	1	LS	$300,000	$30,000	$330,000
Effluent standpipe equipment	1	LS	$100,000		$100,000
Lab Equipment	1	LS	$100,000		$100,000
Finish Lab/Admin Area	1,200	SF	$50		$60,000
Chemical storage	1	LS	$100,000		$100,000
HVAC	1	LS	$100,000		$100,000
Electrical and Controls (18% of total)	1	LS	$973,900		$973,900
Odor Control					
Scrubber	1	LS	$300,000		$300,000
Ductwork	1	LS	$200,000		$200,000
Estimating Contingency (10%)					$638,400
Subtotal					$7,022,880
Overhead and Profit @ 15%					$1,053,400
Sales Tax (8.8%)					$710,700
Direct Construction Cost Subtotal					**$8,787,000**

Scenario 3: MBR Present Worth
King County DNRP
Carnation Wastewater Treatment Facility

Date: 2/9/2005
By: S. Leung
Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Allied Costs					
Consultant services					
30% design (10.5%)					$923,000
Final design (12.5%)					$1,100,000
CM Support Serv's (4%)					$351,000
KC Admin and other allied costs					$1,000,000
Subtotal Allied Costs					**$3,374,000**
Total WWTF Project Costs (July 2004)					**$12,161,000**
Operations and Maintenance Costs					
Labor*	2,080	HR	$43		$90,000
Energy	1,200,000	KWH	$0.065		$78,000
Maintenance Equipment/Structural	1	LS	$129,340		$129,340
Chemicals	1	LS	$72,000		$72,000
Miscellaneous	1	LS	$20,000		$20,000
Total O&M Costs (July 2004)					$389,340
Present Worth, $ in Millions					
Capital					$12.2
Operations and Maintenance					$4.7
Discount Rate	5.875%				
Period of Analysis (2007 - 2030)	22	YR			
Total Present Worth (July 2004)					$16.9

* Labor estimate for WWTF independent of scenario

APPENDIX G

Salmonid Use of the Snoqualmie River - Tolt Delta Reach

Salmonid Use of the Snoqualmie River–Tolt Delta Reach

March 2005

Prepared by Gino Lucchetti

King County

Department of Natural Resources and Parks
Water and Land Resources Division
Science Section
King Street Center, KSC-NR-0600
201 South Jackson Street, Suite 600
Seattle, WA 98104
206-296-6519 TTY Relay: 711
dnr.metrokc.gov/wlr

Alternate Formats Available

206-296-7380 TTY Relay: 711

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INTRODUCTION

King County Wastewater Treatment Division has been contracted by the City of Carnation to construct and operate a wastewater treatment facility (WWTF) by December 2007. At full capacity, the plant will have an annual average effluent flow at design year (2030) of 0.37 MGD (0.57 cfs) treated to tertiary treatment levels. Further, King County has committed to meet or exceed federal and state regulatory requirements. Despite this level of treatment, there may be very low levels of some metals and endocrine disrupter compounds in the effluent. Therefore, to further assess and reduce potential risk associated with effluent discharge, the question of whether to discharge directly into the river at one of two points (Tolt-MacDonald Park or Carnation Farm Road bridge) is being weighed against a discharge into off-channel wetlands (existing or constructed) in the WDFW-owned Stillwater Wildlife Area, located about three miles down-valley. This report addresses fish use of mainstem reach for the purpose of assessing relative risk to salmonids of the two river discharge options and any non-mainstem discharge options.

PHYSICAL SETTING

The Snoqualmie River is the largest (693 sq. mi.) of the six major rivers in King County. The 270 ft high Snoqualmie Falls (at RM 40.3) is a natural barrier to anadromous salmonids and divides the watershed into lower and upper reaches. Above the Falls, the Snoqualmie River drains steep, mountainous terrain with drainage channels confined by bedrock (Bethel 2004). Below the Falls, the river occupies a broad low gradient, post-glacial trough with a very low sustained gradient of 0.046% over 40 miles (Martin and Benda, 2004) relative to other Puget Sound rivers. The broad valley and low gradient create a river channel that is mostly meandering and slough-like with substrates dominated by sand and silt. As a result, the lower river is largely unsuitable for salmonid spawning with two major exceptions: where it flows over the Raging and Tolt River delta fans. These fans constrict the Snoqualmie River causing locally steep gradients and deposition of gravel suitable for extensive salmon spawning. The City of Carnation is located on the Tolt River delta fan. The two possible locations for river discharge of highly treated effluent are proposed in this reach of the Snoqualmie.

SALMONID USE

OVERVIEW

The Tolt Delta Reach (TDR) of the Snoqualmie River is used by nine species of salmonids: Chinook, chum, pink, coho and sockeye salmon, steelhead, cutthroat and bull trout and mountain whitefish. In particular, the value of this reach as a high use/high quality spawning area for Chinook, chum and pink salmon and steelhead trout is well-known. Thirty years ago, Williams et al. (1975) described fish use in this reach and noted it as having good to excellent gravel composition. Because of its value for spawning, the Washington Department of Fish and Wildlife has been using this reach as an index area to assess salmonid spawning and run size abundance for several decades.

Similar conclusions about the TDR's value for salmonids, and especially for Chinook salmon, are reached in a number of major reports including WDFW et al. (1994), Pentec (1999), WDFW and WWTIT (1994), Snohomish Basin Salmon Recovery Forum (2001), Haring (2002) and the recently completed draft WRIA 7 Salmon Conservation Strategy (Snohomish County 2005)

The Salmonid Habitat Limiting Factors Analysis Snohomish River Watershed–WRIA 7

Final Report (Haring 2002) said the following about salmonid use and value of the TDR:

> "Mainstem Snoqualmie River from the mouth of Harris Creek to the mouth of the Tolt River – This area has a significant concentration of high quality spawning habitat and diversity of salmonid use. This 3-mile reach is one of two reaches of the Snoqualmie River that provide spawning habitat for anadromous salmonids. About 20% of the Chinook salmon that return to the Snoqualmie River watershed spawn in this area. Approximately 50% of the shorelines in this reach are in public ownership, providing considerable opportunity to restore impaired habitat functions."

CHINOOK SALMON

Perhaps because of the TDR's well-known value for Chinook spawning and listing of Puget Sound Chinook as threatened under the federal Endangered Species Act, more is known about Chinook use in this area than for other salmonids. Table 1 summarizes WDFW Chinook spawner data since 1999. (Note: The TDR is the same as the Snoqualmie (RM 20.5-24.9) reach). Of the six mainstem river reaches surveyed (i.e., excluding Tokul, Cherry and Griffin Creeks), the TDR had the second highest six-year average (480 fish/year) and density (109 fish/mi) of spawners, second only to the Raging River delta reach, which had 824 and 123 total and density of spawners, respectively.

Table 1. Snoqualmie Chinook Escapement Estimates 1999-2004 (compiled by James Schroeder, King County DNRP)

Subbasin	1999	2000	2001	2002	2003	2004
Snoqualmie (RM 20.5-24.9)*	183		658	760	333	715
Snoqualmie (RM 32.9-39.6)	440	643	865	1,240	845	913
Tokul (RM 0.0-0.3)	347	128	215	123	265	538
Tokul (RM 0.3-0.6)				25	3	5
Raging (RM0.0-4.6)	130	180	1,213	118	188	428
Tolt (RM 0.0-4.6)	138	148	343	455	210	240
Tolt (RM 6.0-8.7)	68	60	168		70	79
SF Tolt (RM 0.0-1.6)	38	40	40	10	63	72
Cherry			43			
Griffin			45			
TOTAL**	**1,344**	**1,427**	**3,590**	**2,731**	**1,977**	**2,990**

* The Tolt Delta Reach

** Does not include Snoqualmie population spawning in mainstem Snohomish

Furthermore, for Chinook salmon, the Snohomish Basin Near Term Action Agenda (Snohomish Basin Salmon Recovery Forum 2001) identified the TDR as one of twelve focus areas in the Snohomish River basin considered critical for protection and restoration efforts. Martin and Benda (2004) used reach and valley scale geomorphic indicators and detailed data on Chinook spawner spatial use patterns and found

that the TDR qualified as one of two core areas (i.e., areas of intense spawning use) for Chinook in the Snoqualmie River.

Within the TDR, number and density of Chinook spawning above Carnation Farm Road bridge is slightly higher than below based on 2004 surveys (Chad Jackson, WDFW, February 23, 2005 e-mail). In 2004, above the Carnation Farm Road bridge (a two-mile reach extending from the mouth of the Tolt River downstream to the bridge), the estimated density of Chinook redds averaged 86.5 redds/mile while below the bridge (extending 1.5 miles downstream from the bridge), the average estimated redd density was 75.3 redds/mile. A map of 2004 redd locations using WDFW data was produced by Benn Burke, Adolfson Associates (Figure 1). The map shows areas of high intensity spawning based on three boat and aerial surveys (September 24, October 14–15, and October 27). Above the bridge most Chinook spawn in two clusters. One cluster starts roughly at the footbridge and extends downstream for about 1,500 feet. The other cluster starts roughly 4,200 feet from the footbridge and extends for about 800 feet downstream. Below the bridge, the primary area of high intensity spawning starts roughly 1,500 feet downstream the bridge and extends for about 1,000 feet. These areas are approximate and may shift due to changes in substrate and flows. However, they give a sense of the highest use areas for Chinook spawning within the reach.

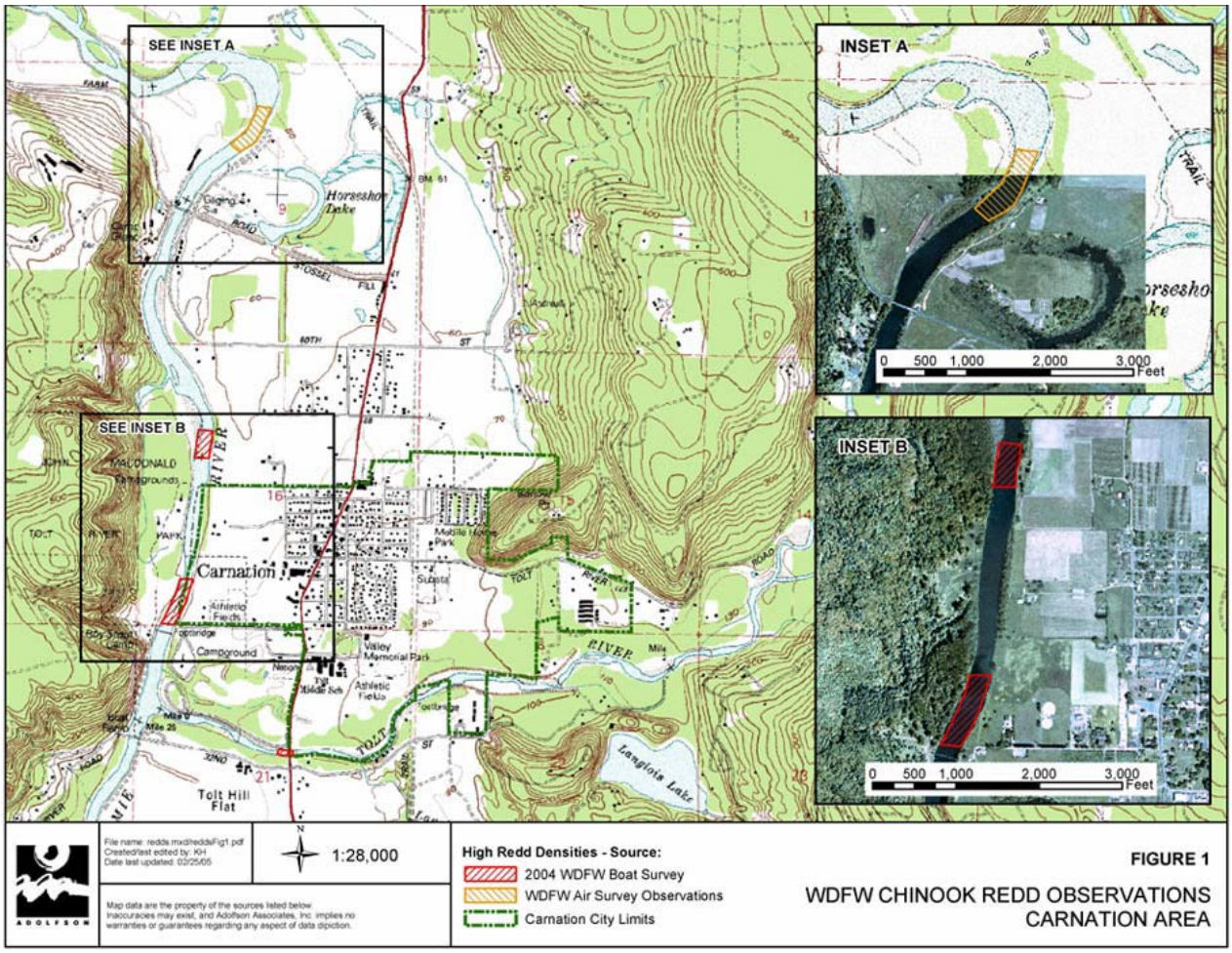

Figure 1. WDFW Chinook Redd Observations–Carnation Area

The TDR exhibits high quality characteristics for juvenile Chinook rearing, including moderate to high velocities and large pools and riffle pocket-water with extensive cobble and small boulder substrates. The condition of freshwater habitat may be of special importance for the Snoqualmie stock because, in contrast to most Puget Sound Chinook populations which are dominated by the "ocean-type" juvenile behavior, where juveniles spend a relatively short (three month) time in freshwater, Snoqualmie Chinook juveniles exhibit a relatively high (upwards of 30%) proportion of "stream-type" behavior, wherein juveniles spend upwards of a year in freshwater. As a result, they may have a higher reliance on freshwater habitat conditions than other Puget Sound Chinook stocks. There are no definitive studies as to why the Snoqualmie Chinook exhibit this behavior or whether they use Snoqualmie habitats or the TDR reach preferentially.

STEELHEAD TROUT

Steelhead trout are another salmonid with relatively high levels of spawning in the TDR. Curtis Kraemer, a senior biologist with WDFW(e-mail March 12, 2003 and March 13, 2003), described their general spawning use as follows: "…winter steelhead use the same reaches [*as Chinook*] with the highest density down by the Carnation Farm bridge." In 2004 (the only year for which WDFW data were made available), a total of 178 redds were counted in the TDR between April 2 and May 13. Of these, the majority (116, 65%) were spawned above the Carnation Farm Road bridge. Redd density averaged 58 redds/mile and 31 redds/mile above and below the bridge, respectively.

Steelhead juveniles typically spend two years in freshwater before migrating out to sea (Wydoski and Whitney 2004). No data are available on juvenile steelhead use in the TDR. It is likely, however, that the TDR is a highly productive area for juvenile steelhead rearing as they are known to rear in large river channels, especially upper ends of large pools and in higher-velocity riffle pocket water, such as this reach provides. The fact that this reach provides such habitat in close proximity to major spawning areas suggests this reach is a likely high use area for steelhead juveniles as well.

CHUM AND PINK SALMON

These species use the TDR for spawning, but formal surveys are not conducted for them. As a result, only limited, qualitative information is available about how chum and pink salmon use the TDR. Curtis Kraemer, a senior biologist with WDFW, describes spawning use by these species as follows (e-mail March 12, 2003 and March 13, 2003):

> "Pink use in the Snoqualmie is limited. In 2001 there were less than 1,000 pinks that spawned in the above reach - by far the highest counts in years."
>
> "The chum spawn in 2 general locations. One on stream bank left just downstream of the foot bridge at the Park. The second just upstream of the Carnation Farm bridge."

In addition, Kirk Anderson, Snoqualmie Basin Steward, has observed considerable use of the TDR by pink salmon with similar densities below the Carnation Farm Road bridge and in the vicinity of the Tolt-MacDonald Park footbridge.

Quantitative data on chum spawning is limited because high and often turbid water during their November–December spawning period prevents accurate counting of spawners.

Freshwater juvenile rearing by these species is short-term (days to weeks). Their juveniles tend to migrate to marine waters almost immediately after emerging from spawning gravel. Therefore, water quality and

other habitat conditions in freshwater will likely not impact chum and pink juveniles as much as other species of salmonids that spend one year or more in freshwater before beginning their seaward migration.

BULL TROUT

Bull trout are not known to spawn in the TDR. Typically they prefer very high quality, pristine (or nearly so) habitat, and extremely cold water for spawning and successful egg incubation (USFWS 2004). As a result, the USFWS (2004) has concluded that this part of the Snoqualmie is used by bull trout for sub-adult and adult foraging, migration and over-wintering. As confirmation of their use of the reach, a lone bull trout was observed in 2001 from the footbridge at Tolt MacDonald Park and a few bull trout have been caught in nearby Tolt River (Hans Berge, 2005, King County DNRP, personal communication).

COHO SALMON

Coho are generally considered tributary rather than mainstem spawners. As a result, directed spawner surveys for them are focused on streams that are much smaller than the Snoqualmie River. However, it is conceivable that some coho spawn in the TDR, where substrate, depth, and velocity conditions are adequate. Regardless, coho adults migrate through and juveniles are known to rear in the TDR. Some of the more productive coho spawning tributaries in the Snohomish River Basin are Snoqualmie River tributaries, including Griffin Creek and Harris Creek (Nelson 1996, Frissell 2000). Juveniles observed in the TDR may have migrated from tributaries such as these or could have resulted from spawning in the TDR or a combination of both places.

CUTTHROAT TROUT

Cutthroat trout are ubiquitous in Puget Sound streams exhibiting both freshwater-resident and migratory sea-run life histories (Wydoski and Whitney 2003). Based on occasional angler catches, they are known to be present in at least moderate numbers in the TDR. No formal spawner surveys are conducted for cutthroat trout. As with coho, they are believed to spawn primarily in tributaries rather than mainstem rivers. However, given proper substrate, depth, and velocity it is conceivable they would spawn in the TDR.

MOUNTAIN WHITEFISH

Mountain whitefish are common in Puget Sound rivers (Wydoski and Whitney 2003) and are known to be present in the Snoqualmie River, but there are no known studies of their use of the TDR. Anglers commonly catch them here suggesting that, at a minimum, they rear and mature in this reach. Given local substrate, depth, and velocity, it is probable but not confirmed, that they also spawn in it as well.

SOCKEYE SALMON

Sockeye are most common in large lake systems (Wydoski and Whitney 2003). However, small populations of riverine-based sockeye appear in most large Puget Sound rivers, including the Snoqualmie (WDFW et al. 1993). Little is known about the Snoqualmie sockeye, in particular whether they are a small, self-sustaining run or strays from other river systems with abundant sockeye populations, such as Lake Washington or the Baker River (Skagit). At least one has been caught by an angler and verified by

a county biologist in the Tolt River a short distance from the confluence with the Snoqualmie (Hans Berge, 2005, personal communication). Otherwise, little else is known about their use of the reach and whether the TDR plays a role in spawning or rearing.

SUMMARY AND CONCLUSION

There is considerable documentation of nine salmonid species in the TDR. At least four species (Chinook, chum, and pink salmon and steelhead trout) are known to use the area in moderate to very high numbers for spawning. Of these, chum and pink fry will spend little time (days) rearing in the TDR. Conversely, Chinook will rear for three months to a year and steelhead up to two years. Coho salmon, cutthroat trout, and mountain whitefish are not known to spawn in the TDR, although it's likely that at least a few do. Regardless, they rear and migrate extensively in the TDR. Bull trout use is most likely limited to sub-adult and adult foraging, migration and over wintering. Sockeye are present but their abundance and usage is uncertain.

Various recent studies and planning documents have noted the high use and value of the TDR for salmonids and have concluded that it is a high priority area for their protection and restoration, especially federally-listed Puget Sound Chinook salmon. Within the reach, based on data from a single year (2004), Chinook and steelhead spawn in slightly higher numbers and densities above the bridge than below it. Anecdotal information suggests this pattern is true for chum and pink salmon spawning as well. Limited detailed data on Chinook spawning distribution between the mouth of the Tolt River and the Carnation Farm Road bridge, shows two main clusters of redds, the largest of which is situated directly off-shore from the proposed treatment plant. Downstream of the Carnation Farm Road, there is one are of high intensity spawning starting roughly 1,500 feet downstream of the bridge.

Given the above information, a river discharge location at the Carnation Farm Road bridge would expose fewer fish to effluent and have lower risk than a discharge at the Tolt-MacDonald Park. An even lower incremental amount of risk would be achieved by discharge into off-channel wetlands that discharge downstream of the TDR, such as those that exist in the WDFW Stillwater Wildlife Management Area. In those wetlands, effluent exposure would likely be limited to rearing coho and cutthroat and, on rare occasion, a sub-adult or adult bull trout, which may use the wetland to feed on those species. Additionally, the effluent would get additional treatment via flow through the wetland and ultimately discharge into the Snoqualmie River below the TDR and below almost all mainstem spawning habitats.

ACKNOWLEDGEMENTS

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APPENDIX H

Discharge Hydraulix™

PROJECT : Carnation Wastewater Treatment Facility
King County DNRP - WWTF to Snoqualmie River

JOB # : 6620A.10 **REVISION:** 1

CHECKED : B. Einfeld **DATE :** 3/3/2005

BY : S. Leung **DATE :** 3/1/2005

	Equation Ref.	HGL	EGL

DOWNSTREAM CONTROL

WSE =	**64.10**		
Flow =	**1.40 mgd =**	**2.17 cfs**	

Base flood elevation at Bridge (NAVD 88) — HGL 64.10, EGL 64.10

(FEMA Map 53033C0420G, 12/6/01)

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] **{ 4 }**

Flow	1.4	mgd =	2.2 cfs
Pipe Diameter, D	8	inch	*ductile iron pipe*
Pipe Length, L	310	ft	
Absolute Roughness, ε	0.00040	ft	
Pipe velocity, v	6.23	fps	
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	415085		
Friction factor, f	0.0184		
Friction Energy Loss, h_L	5.15	ft	

MINOR PIPE LOSS HEADING

Flow, Q 1.4 mgd = 2.2 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
3	90 º Bend - Regular Fl.	1.40	2.17	0.30	8	----	6.23	----	0.60	0.54
1	Check Valve - Swing	1.40	2.17	2.50	8	----	6.23	----	0.60	1.50
1	Gate Valve (Open)	1.40	2.17	0.19	8	----	6.23	----	0.60	0.11
1	Outlet Loss - Still Water	1.40	2.17	1.00	8	----	6.23	----	0.60	0.60
									Sum =	2.76

Total Energy Loss = 7.92 ft

Upstream Condition — HGL 72.02, EGL 72.02

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] **{ 4 }**

Flow	1.4	mgd =	2.2 cfs
Pipe Diameter, D	12	inch	*HDPE SDR 27 pipe*
Pipe Length, L	4120	ft	
Absolute Roughness, ε	0.00040	ft	
Pipe velocity, v	2.90	fps	
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	283093		
Friction factor, f	0.0178		
Friction Energy Loss, h_L	9.75	ft	

PROJECT : Carnation Wastewater Treatment Facility
King County DNRP - WWTF to Snoqualmie River

JOB # : 6620A.10 **REVISION:** 1

CHECKED : B. Einfeld **BY :** S. Leung
DATE : 3/3/2005 **DATE :** 3/1/2005

	Equation Ref.	HGL	EGL

MINOR PIPE LOSS HEADING

Flow, Q 1.4 mgd = 2.2 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	90 º Elbow - Regular Fl.	1.40	2.17	0.30	12	----	2.90	----	0.13	0.04
1	Reducer	1.40	2.17	0.25	12	8	2.90	6.23	0.60	0.15
									Sum =	0.19

Total Energy Loss = 9.94 ft

Upstream Condition 81.96 81.96

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] **{ 4 }**

Flow 1.4 mgd = 2.2 cfs

Pipe Diameter, D 12 inch *HDPE SDR 27 pipe*
Pipe Length, L 4200 ft
Absolute Roughness, ε 0.00040 ft
Pipe velocity, v 2.90 fps
Kinematic Viscosity 1.000E-05 ft^2/sec
Reynold's Number, R 283093
Friction factor, f 0.0178

Friction Energy Loss, h_L 9.94 ft

MINOR PIPE LOSS HEADING

Flow, Q 1.4 mgd = 2.2 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Entrance Loss - Flush	1.40	2.17	0.50	----	12	----	2.90	0.13	0.07
2	Gate Valve (Open)	1.40	2.17	0.19	12	----	2.90	----	0.13	0.05
4	90 º Elbow - Regular Fl.	1.40	2.17	0.30	12	----	2.90	----	0.13	0.16
									Sum =	0.27

Total Energy Loss = 10.21 ft

Upstream Condition 92.17 92.17

WWTF site elevation 72.6 ft (NAVD 88)
WSE w/ 30' standpipe 97.6 ft
(25' water)

Gravity flow **OK**

PROJECT : Carnation Wastewater Treatment Facility
King County DNRP - WWTF to Stillwater

JOB # : 6620A.10 **REVISION:** 1

CHECKED : B. Einfeld **DATE :** 3/3/2005

BY : S. Leung **DATE :** 3/1/2005

	Equation Ref.	HGL	EGL

DOWNSTREAM CONTROL

WSE =	**59.60**		
Flow =	**1.40 mgd =**	**2.17 cfs**	

Base flood elevation at SWA (NAVD 88) — HGL 59.60, EGL 59.60

(FEMA Map 53033C0420G, 12/6/01)

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] — **{ 4 }**

Flow	1.4	mgd =	2.2 cfs
Pipe Diameter, D	12	inch	
Pipe Length, L	12770	ft	
Absolute Roughness, ε	0.00040	ft	
Pipe velocity, v	2.89	fps	
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	282106		
Friction factor, f	0.0178		
Friction Energy Loss, h_L	30.02	ft	

HDPE SDR 27 pipe

MINOR PIPE LOSS HEADING

Flow, Q: 1.4 mgd = 2.2 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
4	90 º Elbow - Regular Fl.	1.40	2.17	0.30	12	----	2.89	----	0.13	0.16
4	45 º Bend - Regular Fl.	1.40	2.17	0.23	12	----	2.89	----	0.13	0.12
1	Check Valve - Swing	1.40	2.17	2.50	12	----	2.89	----	0.13	0.32
1	Gate Valve (Open)	1.40	2.17	0.19	12	----	2.89	----	0.13	0.02
1	Outlet Loss - Still Water	1.40	2.17	1.00	12	----	2.89	----	0.13	0.13
									Sum =	0.75

Total Energy Loss = 30.77 ft

Upstream Condition — HGL 90.37, EGL 90.37

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] — **{ 4 }**

Flow	1.4	mgd =	2.2 cfs
Pipe Diameter, D	12	inch	
Pipe Length, L	4200	ft	
Absolute Roughness, ε	0.00040	ft	
Pipe velocity, v	2.89	fps	
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	282106		
Friction factor, f	0.0178		
Friction Energy Loss, h_L	9.87	ft	

HDPE SDR 27 pipe

PROJECT : Carnation Wastewater Treatment Facility
King County DNRP - WWTF to Stillwater

JOB # : 6620A.10 **REVISION:** 1

CHECKED : B. Einfeld **BY :** S. Leung
DATE : 3/3/2005 **DATE :** 3/1/2005

											Equation Ref.	HGL	EGL

MINOR PIPE LOSS HEADING

Flow, Q 1.4 mgd = 2.2 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Entrance Loss - Flush	1.40	2.17	0.50	----	12	----	2.89	0.13	0.06
2	Gate Valve (Open)	1.40	2.17	0.19	12	----	2.89	----	0.13	0.05
4	90 º Elbow - Regular Fl.	1.40	2.17	0.30	12	----	2.89	----	0.13	0.16
									Sum =	0.27

Total Energy Loss = 10.14 ft

Upstream Condition				100.51	100.51

WWTF site elevation 72.6 ft (NAVD 88)
WSE w/ 38' standpipe 106.6 ft
(34' water)

Gravity flow **OK**

APPENDIX I

Reliability Checklist and Water Quality Comparison

Reliability Checklist and Water Quality Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

The appendix is designed to provide an indication of the general facility design requirements as set forth by the reclamation standards in terms of reliability and water quality. The appendix is not intended to provide an all-inclusive list of criteria, which must be met to use reclaimed water. The reliability checklist provides a comparison of the anticipated Carnation Wastewater Treatment Facility design against the requirements of the Washington Water Reclamation & Reuse Standards (Washington Department of Ecology, 1997).

Flexibility of Design	Required	Optional	Included	Deleted	Deferred to Design
Sufficient flexibility for convenience & efficiency in operations and maintenance	✓		**x**		

	Required	Optional	Included	Deleted	Deferred to Design
Alarm conditions					
Loss of power from normal power supply	✓		**x**		
Biological treatment process failure	✓		**x**		
Disinfection process failure	✓		**x**		
Coagulation process failure	✓			x	
Filtration process failure	✓			x	
Membrane process failure	✓		***x***		
Independence					
Alarms independent of normal power supply	✓		**x**		x
Personnel notified:	✓		**x**		x
Plant operator					
Superintendent					
Other: KCDNRP Regional Facility			**x**		x
Master alarm:					
Inter-connect all site alarms	✓		**x**		x
Location- convenient observation by attendant	✓		**x**		x
Less than 24 hour plant attendance:					
Alarms interconnected to	✓		**x**		x
Police station					
Fire station					
Other full-time service unit:			**x**		x

Reclamation Standards Reliability Requirements	Required[1]	Optional[2]	Provided	Deleted	Deferred to Design
Power Supply Reliability[3]					
Alarm and standby power source			**x**		x
Alarm & automatically actuated short term storage or disposal			**x**		x
Automatically actuated long term storage/disposal			**x**		x
Storage without alternative disposal system					
Retain reclaimed water under adverse weather conditions					
Wet weather conditions: Retain reclaimed water during 10-year storm as determined from on 20 years of weather data					
Minimum storage capacity: $V = 3 \times Q_{Ave\ Day}$					
Emergency Storage & Disposal					
Short-term emergency storage					
Facility reserved solely for reclaimed wastewater storage or disposal			**x**		x
Minimum of 24 hour storage period			**x**		x
All equipment provided with standby power or independent of normal power source			**x**		x
Pumping & pump-back equipment provided			**x**		x
Long term emergency storage					
Diversion to alternative, approved reuse site					
Diversion to discharge point approved by Department of Ecology					
Automatically actuated emergency storage provisions			**x**		
Provide all necessary sensors, instruments, valves & other devices for					
Fully automated diversion of untreated or partially treated effluent			**x**		x
Failure of treatment process			**x**		x
Manual reset to prevent automatic restart			**x**		x
Biological Treatment					
Alarm & multiple treatment units capable producing oxidized wastewater with one unit inoperable		✓	**x**		
Alarm & short-term storage/disposal provisions with standby replacement equipment		✓			
Alarm & long term storage or disposal		✓			
Automatically actuated long-term storage or disposal provisions		✓			
Membrane Separation			***x***		
Multiple membrane modules capable of treating the entire flow with one unit inoperable		✓	**x**		

[1] Required reliability features must be provided even if optional reliability features are provided unless approved by the regulatory agencies.
[2] Optional reliability features: one or more can be provided in addition to required reliability features.
[3] Provide at least one reliability feature.

Reclamation Standards Reliability Requirements	Required[1]	Optional[2]	Provided	Deleted	Deferred to Design
Secondary Sedimentation				**x**	
Multiple sedimentation units capable of treating the entire flow with one unit inoperable		✓			
Standby sedimentation unit process		✓			
Long term storage or disposal provisions		✓			
Coagulation				**x**	
Standby by feeders	✓				
Adequate chemical storage & conveyance facilities	✓				
Adequate reserve chemical supply	✓				
Automatic dosage control	✓				
Alarm & multiple treatment units capable producing oxidized wastewater w/1 unit inoperable		✓			
Alarm & short-term storage/disposal provisions with standby replacement equipment		✓			
Alarm & long term storage or disposal		✓			
Automatically actuated long-term storage or disposal provisions		✓			
Filtration				**x**	
Alarm & multiple filter units capable treating the entire flow with one unit inoperable		✓			
Alarm & short-term storage/disposal provisions with standby replacement equipment		✓			
Alarm & long term storage or disposal		✓			
Automatically actuated long-term storage or disposal provisions		✓			
Alarm & standby filtration unit process		✓			
Ultraviolet Disinfection					
Standby UV Module	✓		**x**		
Continuous UVT and power monitoring	✓		**x**		
Alarm & standby UV Module		✓	**x**		
Alarm & short-term storage/disposal provisions with standby replacement equipment		✓	**x**		
Alarm & long term storage or disposal		✓			
Automatically actuated long-term storage or disposal provisions		✓			
Independent power source		✓	**x**		
Chlorine Disinfection				**X**	

See Appendix I of the Washington Water Reclamation & Reuse Standards (Washington Department of Ecology, 1997) for additional general use area requirements including signage, use, cross-connections, aesthetic issues, and public health protection practices.

Water Quality Monitoring Comparison	**General Class A Reclaimed Requirements**		**Additional Requirements to Stillwater Wildlife Area**		**CWWTF**
	Sample Type & Frequency	Compliance	Sample Type & Frequency	Compliance	Corresponding effluent requirements for discharge to the Snoqualmie River
Biochemical Oxygen Demand (BOD_5)	24-hour composite, collected at least weekly	Shall not exceed 30 mg/L determined monthly, based on the arithmetic mean of all samples collected during the month	*Same as Class A requirement.*	Shall not exceed 20 mg/L on an average annual basis. *Also subject to TMDL limitations due to hydraulic continuity with the Snoqualmie River (see CWWTF effluent limitations).*	The average monthly and weekly effluent limitations are based on the arithmetic mean of the samples taken. The average monthly effluent concentration shall not exceed the more stringent of 1) 15 percent of the respective monthly average influent concentrations or 2) Non-TMDL Seasonal Limitations (Nov - Jul): • Avg monthly of 30 mg/L, 155 lb/day • Avg weekly of 45 mg/L, 233 lb/day TMDL Seasonal Limitations (Aug to Oct): • Avg monthly of 30 mg/L, 25 lb/day • Avg weekly of 45 mg/L, 233 lb/day
Total Suspended Solids (TSS)	24-hour composite, collected at least daily*	Shall not exceed 30 mg/L determined monthly, based on the arithmetic mean of all samples collected during the month	24-hour composite, collected at least weekly	Shall not exceed 20 mg/L on an average annual basis *Also subject to TMDL limitations due to hydraulic continuity with the Snoqualmie River (see CWWTF effluent limitations).*	The average monthly and weekly effluent limitations are based on the arithmetic mean of the samples taken. The average monthly effluent concentration shall not exceed the more stringent of 1) 15 percent of the respective monthly average influent concentrations or 2) • Avg monthly of 30 mg/L, 155 lb/day • Avg weekly of 45 mg/L, 233 lb/day
Total Coliform	Grab, collected at least daily	Compliance determined daily, based on the median value determined from the bacteriological results of the last 7 days for which analyses have been completed	*Same as Class A requirement.*	*Same as Class A requirement.*	*Not currently regulated by NPDES permit.*

Water Quality Monitoring Comparison	**General Class A Reclaimed Requirements**		**Additional Requirements to Stillwater Wildlife Area**		**CWWTF**
	Sample Type & Frequency	Compliance	Sample Type & Frequency	Compliance	Corresponding effluent requirements for discharge to the Snoqualmie River
Turbidity	Continuous recording turbidimeter	Filtered wastewater shall not exceed an average operating turbidity of 2 NTU, determined monthly, and shall not exceed 5 NTU at any time	*Same as Class A requirement.*	*Same as Class A requirement.*	One-day maximum turbidity allowed as a result of human actions of 5 NTU over background when the background is 50 NTU or less or a 10-percent increase in turbidity when the background turbidity is more than 50 NTU.
Dissolved Oxygen (DO)	Grab, collected at least daily	Shall contain dissolved oxygen	*Same as Class A requirement.*	*Same as Class A requirement.* *Also subject to Surface Water Standards due to hydraulic continuity with the Snoqualmie River (see CWWTF effluent limitations).*	Lowest 1-day minimum of 9.5 mg/L. When the DO in the water body is lower than 9.5 mg/L due to natural conditions, human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L.
Total Kjeldahl Nitrogen (TKN)	*Not currently regulated.*	*Not currently regulated.*	24-hour composite collected weekly	Shall not exceed 3 mg/L as TKN-N on an average annual basis.	*Not currently regulated by NPDES permit.*
Total Ammonia-Nitrogen (NH_3)	*Not currently regulated.*	*Not currently regulated.*	24-hour composite collected weekly	Shall not exceed WA chronic standards for fresh surface water without use of a mixing zone unless net environmental benefit is demonstrated.	Shall not exceed WA surface water quality standards with anticipated allowable use of a mixing zone.
Total Phosphorus (P)	*Not currently regulated.*	*Not currently regulated.*	24-hour composite collected weekly	Shall not exceed 1 mg/L as P on an average annual basis.	*Not currently regulated by NPDES permit.*

Water Quality Monitoring Comparison	General Class A Reclaimed Requirements		Additional Requirements to Stillwater Wildlife Area		CWWTF
	Sample Type & Frequency	Compliance	Sample Type & Frequency	Compliance	Corresponding effluent requirements for discharge to the Snoqualmie River
Metals	*Not currently regulated.*	*Not currently regulated.*	24-hour composite collected weekly	Shall not exceed WA surface water quality standards without use of a mixing zone unless absence of toxicity or net environmental benefits is demonstrated.	Shall not exceed WA surface water quality standards with anticipated allowable use of a mixing zone.

* TSS sampling may be reduced for those projects generating Class A reclaimed water on a case by case basis by Health and Ecology.

Sources:

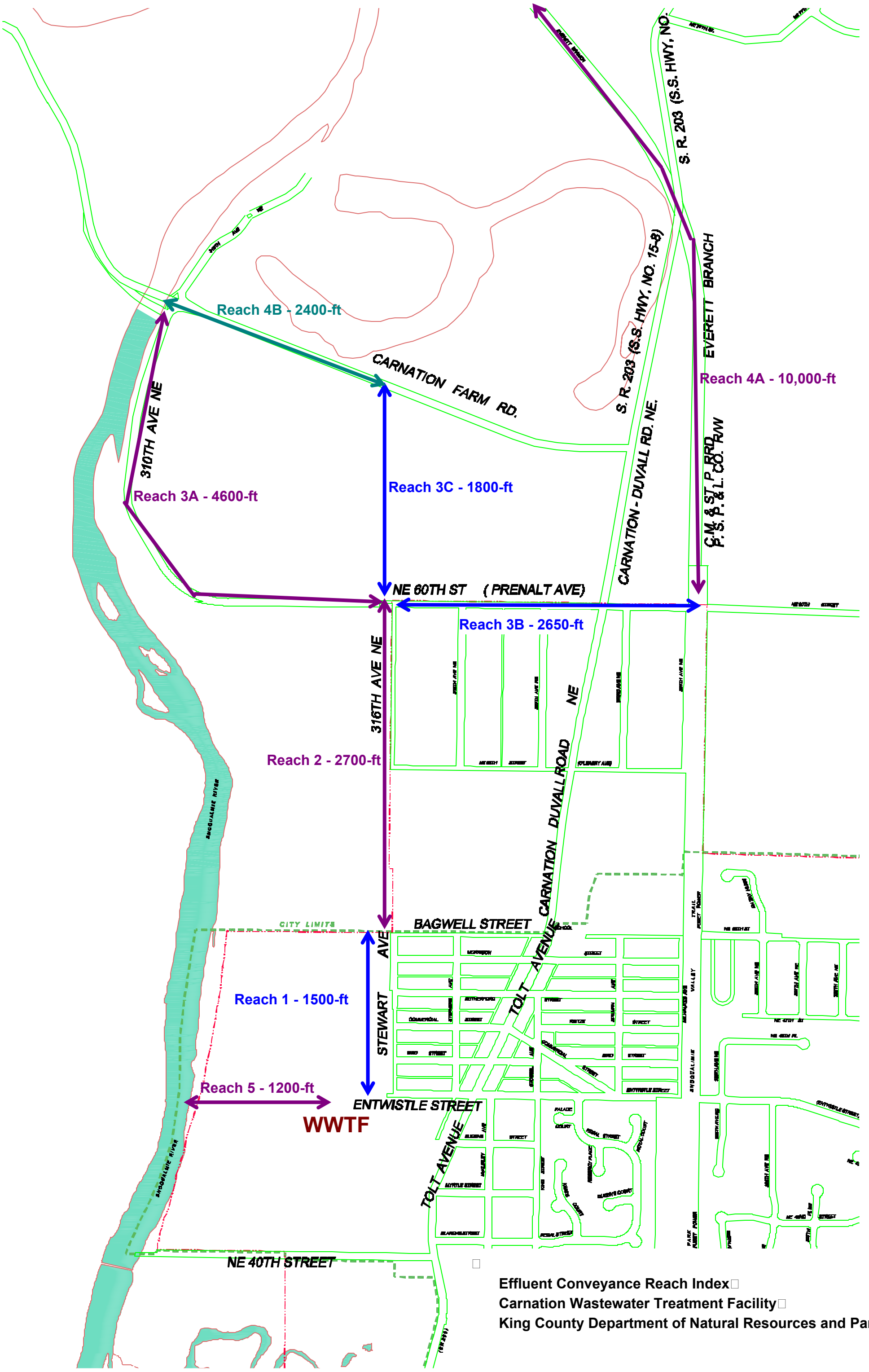
Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.

Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.

Water quality standards for surface waters of the state of Washington, WAC 173-201A, 2003.

APPENDIX J

Conveyance Cost Estimate Support



Effluent Conveyance Reach Index
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

carollo engineers

DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 2/25/2005

LOCATION CARNATION, WA

BY : SML/AMP

ELEMENT : EFFLUENT CONVEYANCE REACH 1 (WWTF TO BAGWELL ST)

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	LABOR	SUB	EQUIP	OTHER	UNIT COST	SUBTOTAL	TOTAL
02000	**SITEWORK**										
	DEMOLITION										
	Pavement Cutting, 4" Thick	6,000	In Ft	$0.00	$0.00	$0.18	$0.18	$0.00	$0.40	$2,398	
	Remove Asphalt Pavement	1,667	SY	$0.00	$0.00	$0.68	$0.00	$0.00	$0.75	$1,258	
	Haul Asphalt Pavement to Landfill, 10 MI/EW	185	CY	$0.00	$0.00	$7.35	$0.00	$0.00	$8.16	$1,511	
	Dispose AC (Tipping Fee)	185	CY	$0.00	$0.00	$5.18	$0.00	$0.00	$5.74	$1,064	
	Total Demolition										$6,230
	EARTHWORK										
02318	Trench Excavation	833	CY	$0.00	$0.00	$10.00	$0.00	$0.00	$11.10	$9,250	
	Imported Fill (bed & zone fill, 50% above zone	540	CY	$0.00	$0.00	$0.00	$0.00	$0.00	$42.00	$22,667	
	Native Fill (50% above zone)	250	CY	$0.00	$0.00	$0.00	$15.33	$0.00	$17.02	$4,254	
	Dispose Trench Spoils, 10 Mi/RT	958	CY	$0.00	$0.00	$5.13	$0.00	$0.00	$5.69	$5,457	
	Total Earthwork										$41,629
	PAVING										
	4" AC Paving on Native Soil (ABC inc in Fill C	15,000	SF	$0.00	$0.00	$2.48	$0.00	$0.00	$2.75	$41,292	
	General Contractor Markup on Sub	1	LS	$0.00	$0.00	$0.00	$0.00	$4,129.20	$4,129.20	$4,129	
	Total Paving										$45,421
	Traffic Control Allowance	1	LS						$5,000.00	$5,000	$5,000
15000	**MECHANICAL**										
	12" HDPE (SDR 17) Pipe, Butt-Weld Installed	1,500	LF	$15.10	$11.90	$2.70	$0.00	$0.00	$29.70	$44,550	
											$44,550
	TOTAL DIRECT COST										**$142,830**

Cost per LF **$95**

carollo engineers

DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 2/25/2005

LOCATION CARNATION, WA

BY : SML/AMP

ELEMENT : EFFLUENT CONVEYANCE REACH 2 (BAGWELL ST TO NE 60TH)

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	LABOR	SUB	EQUIP	OTHER	UNIT COST	SUBTOTAL	TOTAL
02000	**SITEWORK**										
	Trench Excavation (Open Cut)	1,500	CY	$0.00	$0.00	$10.00	$0.00	$0.00	$11.10	$16,650.00	
	Imported Fill (bed, zone, 25% of fill above zc	746	CY	$0.00	$0.00	$0.00	$0.00	$0.00	$42.00	$31,351.33	
	Native Backfill (75% of fill above zone)	675	CY	$0.00	$0.00	$0.00	$15.33	$0.00	$17.02	$11,486.00	
	Dispose Trench Spoils, 10 Mi/RT	949	CY	$0.00	$0.00	$5.13	$0.00	$0.00	$5.69	$5,402.47	
	Gravel Road Allowance	3,000	SY	$6.25	$0.37	$0.00	$0.54	$0.00	$7.95	$23,842.80	
	Dewatering Allowance	0	LF	$0.00	$0.00	$0.00	$0.00	$0.00	$20.00	$0.00	
	Total Earthwork										$88,733
15000	**MECHANICAL**										
	12" HDPE (SDR 17) Pipe, Butt-Weld Installe	2,700	LF	$15.10	$11.90	$2.70	$0.00	$0.00	$29.70	$80,190	
	Total HDPE Pipe										$80,190
	TOTAL DIRECT COST										**$168,923**

Cost LF **$63**

carollo engineers

DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 2/25/2005

LOCATION CARNATION, WA

BY : SML/AMP

ELEMENT : EFFLUENT CONVEYANCE REACH 3A (NE 60TH ST TO OUTFALL)

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	LABOR	SUB	EQUIP	OTHER	UNIT COST	SUBTOTAL	TOTAL
02000	**SITEWORK**										
	DEMOLITION										
	Pavement Cutting, 4" Thick	18,400	In Ft	$0.00	$0.00	$0.18	$0.18	$0.00	$0.40	$7,353	
	Remove Asphalt Pavement	5,111	SY	$0.00	$0.00	$0.68	$0.00	$0.00	$0.75	$3,858	
	Haul Asphalt Pavement to Landfill, 10 MI/EW	568	CY	$0.00	$0.00	$7.35	$0.00	$0.00	$8.16	$4,633	
	Dispose AC (Tipping Fee)	568	CY	$0.00	$0.00	$5.18	$0.00	$0.00	$5.74	$3,262	
	Total Demolition										$19,106
	EARTHWORK										
02318	Trench Excavation	2,556	CY	$0.00	$0.00	$10.00	$0.00	$0.00	$11.10	$28,367	
	Imported Fill (bed & zone fill, 50% above zone	1,655	CY	$0.00	$0.00	$0.00	$0.00	$0.00	$42.00	$69,513	
	Native Fill (50% above zone)	767	CY	$0.00	$0.00	$0.00	$15.33	$0.00	$17.02	$13,046	
	Dispose Trench Spoils, 10 Mi/RT	2,939	CY	$0.00	$0.00	$5.13	$0.00	$0.00	$5.69	$16,735	
	Total Earthwork										$127,661
	PAVING										
	4" AC Paving on Native Soil (ABC inc in Fill C	46,000	SF	$0.00	$0.00	$2.48	$0.00	$0.00	$2.75	$126,629	
	General Contractor Markup on Sub	1	LS	$0.00	$0.00	$0.00	$0.00	$12,662.88	$12,662.88	$12,663	
	Total Paving										$139,292
	Traffic Control Allowance	1	LS						$10,000.00	$10,000	$10,000
15000	**MECHANICAL**										
	12" HDPE (SDR 17) Pipe, Butt-Weld Installed	4,600	LF	$15.10	$11.90	$2.70	$0.00	$0.00	$29.70	$136,620	
											$136,620
	TOTAL DIRECT COST										**$432,678**

Cost per LF **$95**

carollo engineers

DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 2/24/2005

LOCATION CARNATION, WA

BY : SML/AMP

ELEMENT : EFFLUENT CONVEYANCE REACH 3B (NE 60TH ST TO SNOQUALMIE VALLEY TRAIL)

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	LABOR	SUB	EQUIP	OTHER	UNIT COST	SUBTOTAL	TOTAL
02000	**SITEWORK**										
	DEMOLITION										
	Pavement Cutting, 4" Thick	10,600	In Ft	$0.00	$0.00	$0.18	$0.18	$0.00	$0.40	$4,236	
	Remove Asphalt Pavement	2,944	SY	$0.00	$0.00	$0.68	$0.00	$0.00	$0.75	$2,222	
	Haul Asphalt Pavement to Landfill, 10 MI/EW	327	CY	$0.00	$0.00	$7.35	$0.00	$0.00	$8.16	$2,669	
	Dispose AC (Tipping Fee)	327	CY	$0.00	$0.00	$5.18	$0.00	$0.00	$5.74	$1,879	
	Total Demolition										$11,007
	EARTHWORK										
02318	Trench Excavation	1,472	CY	$0.00	$0.00	$10.00	$0.00	$0.00	$11.10	$16,342	
	Imported Fill (bed & zone fill, 50% above zone	953	CY	$0.00	$0.00	$0.00	$0.00	$0.00	$42.00	$40,046	
	Native Fill (50% above zone)	442	CY	$0.00	$0.00	$0.00	$15.33	$0.00	$17.02	$7,516	
	Dispose Trench Spoils, 10 Mi/RT	1,693	CY	$0.00	$0.00	$5.13	$0.00	$0.00	$5.69	$9,641	
	Total Earthwork										$73,544
	PAVING										
	4" AC Paving on Native Soil (ABC inc in Fill C	26,500	SF	$0.00	$0.00	$2.48	$0.00	$0.00	$2.75	$72,949	
	General Contractor Markup on Sub	1	LS	$0.00	$0.00	$0.00	$0.00	$7,294.92	$7,294.92	$7,295	
	Total Paving										$80,244
	Traffic Control Allowance	1	LS						$10,000.00	$10,000	$10,000
15000	**MECHANICAL**										
	12" HDPE (SDR 17) Pipe, Butt-Weld Installed	2,650	LF	$15.10	$11.90	$2.70	$0.00	$0.00	$29.70	$78,705	
											$78,705
	TOTAL DIRECT COST										**$253,499**

Cost per LF **$96**

carollo engineers

DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 3/11/2005

LOCATION CARNATION, WA

BY : SML

ELEMENT : EFFLUENT CONVEYANCE REACH 3C (NE 60TH TO CARNATION FARM ROAD)

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	LABOR	SUB	EQUIP	OTHER	UNIT COST	SUBTOTAL	TOTAL
02000	**SITEWORK**										
	Trench Excavation (Open Cut)	1,000	CY	$0.00	$0.00	$10.00	$0.00	$0.00	$11.10	$11,100.00	
	Imported Fill (bed, zone, 25% of fill above zc	498	CY	$0.00	$0.00	$0.00	$0.00	$0.00	$42.00	$20,900.89	
	Native Backfill (75% of fill above zone)	450	CY	$0.00	$0.00	$0.00	$15.33	$0.00	$17.02	$7,657.34	
	Dispose Trench Spoils, 10 Mi/RT	633	CY	$0.00	$0.00	$5.13	$0.00	$0.00	$5.69	$3,601.64	
	Gravel Road Allowance	2,000	SY	$6.25	$0.37	$0.00	$0.54	$0.00	$7.95	$15,895.20	
	Dewatering Allowance	0	LF	$0.00	$0.00	$0.00	$0.00	$0.00	$20.00	$0.00	
	Total Earthwork										$59,155
15000	**MECHANICAL**										
	12" HDPE (SDR 17) Pipe, Butt-Weld Installe	1,800	LF	$15.10	$11.90	$2.70	$0.00	$0.00	$29.70	$53,460	
	Total HDPE Pipe										$53,460
	TOTAL DIRECT COST										**$112,615**

Cost LF **$63**

carollo engineers

DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 2/25/2005

LOCATION CARNATION, WA

BY : SML/AMP

ELEMENT : EFFLUENT CONVEYANCE REACH 4A (Snoqualmie Valley Trail)

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	LABOR	SUB	EQUIP	OTHER	UNIT COST	SUBTOTAL	TOTAL
02000	**SITEWORK**										
	Trench Excavation (Open Cut)	5,556	CY	$0.00	$0.00	$10.00	$0.00	$0.00	$11.10	$61,666.67	
	Imported Fill (bed & zone)	1,931	CY	$0.00	$0.00	$0.00	$0.00	$0.00	$42.00	$81,116.03	
	Native Backfill (fill above zone)	3,333	CY	$0.00	$0.00	$0.00	$15.33	$0.00	$17.02	$56,721.00	
	Dispose Trench Spoils, 10 Mi/RT	2,556	CY	$0.00	$0.00	$5.13	$0.00	$0.00	$5.69	$14,552.10	
	Gravel Road Allowance	11,111	SY	$6.25	$0.37	$0.00	$0.54	$0.00	$7.95	$88,306.67	
	Dewatering Allowance	0	LF	$0.00	$0.00	$0.00	$0.00	$0.00	$20.00	$0.00	
	Total Earthwork										$302,362
15000	**MECHANICAL**										
	12" HDPE (SDR 17) Pipe, Butt-Weld Installe	10,000	LF	$15.10	$11.90	$2.70	$0.00	$0.00	$29.70	$297,000	
	Total HDPE Pipe										$297,000
	TOTAL DIRECT COST										**$599,362**

Cost per LF **$60**

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DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 3/11/2005

LOCATION CARNATION, WA

BY : SML

ELEMENT : EFFLUENT CONVEYANCE REACH 4B (CARNATION FARM ROAD TO OUTFALL)

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	LABOR	SUB	EQUIP	OTHER	UNIT COST	SUBTOTAL	TOTAL
02000	**SITEWORK**										
	DEMOLITION										
	Pavement Cutting, 4" Thick	9,600	In Ft	$0.00	$0.00	$0.18	$0.18	$0.00	$0.40	$3,836	
	Remove Asphalt Pavement	2,667	SY	$0.00	$0.00	$0.68	$0.00	$0.00	$0.75	$2,013	
	Haul Asphalt Pavement to Landfill, 10 MI/EW	296	CY	$0.00	$0.00	$7.35	$0.00	$0.00	$8.16	$2,417	
	Dispose AC (Tipping Fee)	296	CY	$0.00	$0.00	$5.18	$0.00	$0.00	$5.74	$1,702	
	Total Demolition										$9,968
	EARTHWORK										
02318	Trench Excavation	1,333	CY	$0.00	$0.00	$10.00	$0.00	$0.00	$11.10	$14,800	
	Imported Fill (bed & zone fill, 50% above zone	864	CY	$0.00	$0.00	$0.00	$0.00	$0.00	$42.00	$36,268	
	Native Fill (50% above zone)	400	CY	$0.00	$0.00	$0.00	$15.33	$0.00	$17.02	$6,807	
	Dispose Trench Spoils, 10 Mi/RT	1,533	CY	$0.00	$0.00	$5.13	$0.00	$0.00	$5.69	$8,731	
	Total Earthwork										$66,606
	PAVING										
	4" AC Paving on Native Soil (ABC inc in Fill C	24,000	SF	$0.00	$0.00	$2.48	$0.00	$0.00	$2.75	$66,067	
	General Contractor Markup on Sub	1	LS	$0.00	$0.00	$0.00	$0.00	$6,606.72	$6,606.72	$6,607	
	Total Paving										$72,674
	Traffic Control Allowance	1	LS						$10,000.00	$10,000	$10,000
15000	**MECHANICAL**										
	12" HDPE (SDR 17) Pipe, Butt-Weld Installed	2,400	LF	$15.10	$11.90	$2.70	$0.00	$0.00	$29.70	$71,280	
											$71,280
	TOTAL DIRECT COST										**$230,528**

Cost per LF **$96**

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DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 3/10/2005

LOCATION CARNATION, WA

BY : SML

ELEMENT : EFFLUENT CONVEYANCE REACH 5 (WWTF to SNOQ RIVER AT TOLT MACDONALD PARK)

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	LABOR	SUB	EQUIP	OTHER	UNIT COST	SUBTOTAL	TOTAL
02000	**SITEWORK**										
	Trench Excavation (Open Cut)	667	CY	$0.00	$0.00	$10.00	$0.00	$0.00	$11.10	$7,400.00	
	Imported Fill (bed, zone, 25% of fill above zc	332	CY	$0.00	$0.00	$0.00	$0.00	$0.00	$42.00	$13,933.92	
	Native Backfill (75% of fill above zone)	300	CY	$0.00	$0.00	$0.00	$15.33	$0.00	$17.02	$5,104.89	
	Dispose Trench Spoils, 10 Mi/RT	422	CY	$0.00	$0.00	$5.13	$0.00	$0.00	$5.69	$2,401.10	
	Gravel Road Allowance	1,200	SY	$6.25	$0.37	$0.00	$0.54	$0.00	$7.95	$9,537.12	
	Dewatering Allowance	0	LF	$0.00	$0.00	$0.00	$0.00	$0.00	$20.00	$0.00	
	Total Earthwork										$38,377
15000	**MECHANICAL**										
	12" HDPE (SDR 17) Pipe, Butt-Weld Installe	1,200	LF	$15.10	$11.90	$2.70	$0.00	$0.00	$29.70	$35,640	
	Total HDPE Pipe										$35,640
	TOTAL DIRECT COST										**$74,017**

Cost LF **$62**

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DETAILED COST ESTIMATE

PROJECT : Carnation Wastewater Treatment Facility

JOB # : 6620a10

LOCATION Carnation, WA

ELEMENT : HIGHWAY 203 INTERSECTIONS

LOCATION FACTOR: 1.11

DATE : 2/25/2005

BY : SML

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	MATERIAL	INSTALL	UNIT COST	SUBTOTAL	TOTAL
	BORED/JACKED INTERSECTIONS							
	Setup/Removal	1	LS		4,504.50	5,000.00	5,000.00	
	36" diameter Boring	80	LF			400.00	32,000.00	
	Boring Pit (40'L, 12'W)	2	pits		28,378.38	31,500.00	63,000.00	
	UNIT COST PER BORED/JACKED INTERSECTION							**$100,000**

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DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 2/25/2005

LOCATION CARNATION, WA

BY : BJE

ELEMENT : OUTFALL SUPPORTED FROM CARNATION FARM ROAD BRIDGE

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	TOTAL
	8" DI SUPPORTED FROM BRIDGE (PIPE & INSTALLATI	280	LF	$300.00	$84,000	
	8" DI VERTICAL PIPING (PIPE & INSTALLATION)	1	LS	$20,000.00	$20,000	
	IN-WATER WORK	1	LS	$80,000.00	$80,000	
						$184,000
	TOTAL DIRECT COST					**$184,000**

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DETAILED COST ESTIMATE

PROJECT : CARNATION WWTF

LOCATION FACTOR: 1.11

JOB # : 6620a10

DATE : 2/25/2005

LOCATION CARNATION, WA

BY : SML

ELEMENT : OUTFALL NEAR TOLT MACDONALD PARK

REVIEWED BY:

SPEC. NO.	DESCRIPTION	QUAN	UNIT	UNIT COST	SUBTOTAL	TOTAL
	8" DI PIPING (PIPE & INSTALLATION)	35	LF	$16.65	$583	583
	OUTFALL SUPPORT	1	LS	$80,000.00	$80,000	80,000
	IN-WATER WORK	1	LS	$100,000.00	$100,000	100000
	TOTAL DIRECT COST					**$181,000**

APPENDIX K

Alternate WWTF Cost Estimate (discharge to SWA)

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Alternate WWTF Cost Estimate (discharge to SWA) | Date: 3/8/2005
Carnation Wastewater Treatment Facility | By: S. Leung
King County Department of Natural Resources and Parks | Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Wastewater Treatment Facility					
Capital Costs					
Mobilization	1	LS	$500,000		$500,000
(5) Sitework					
Excavation	4,200	CY	$30		$126,000
Backfill	2,100	CY	$30		$63,000
Yard Piping	1	LS	$150,000		$150,000
Paving	20,400	SF	$4		$81,600
Misc. utilities	1	LS	$200,000		$200,000
Landscaping	1	LS	$100,000		$100,000
Fencing	1,000	LF	$15		$15,000
Lab/Admin Building					
Building Structure	3,500	SF	$150		$525,000
Lab Equipment	1	LS	$100,000		$100,000
Finish Lab/Admin Area	1,500	SF	$50		$75,000
Chemical storage	1	LS	$100,000		$100,000
HVAC	1	LS	$100,000		$100,000
Headworks/Treatment Basins					
Base slab concrete	260	CY	$250		$65,000
Wall concrete	530	CY	$750		$397,500
Elevated concrete	60	CY	$500		$30,000
Headworks Building	1,900	SF	$100		$190,000
Screening Equipment	1	LS	$250,000	$30,000	$280,000
Aeration system	1	LS	$150,000	$50,000	$200,000
Solids Handling/Wetwell Covers	1	LS	$100,000		$100,000
Odor control scrubber/ductwork	1	LS	$500,000		$500,000
MBR/UV Area					
Base slab concrete	140	CY	$250		$65,000
Wall concrete	50	CY	$750		$37,500
Metal roof structure over MBR area	2,450	SF	$30		$73,500
MBR Treatment equipment	1	LS	$900,000	$300,000	$1,200,000
UV Disinfection equipment	1	LS	$500,000	$50,000	$550,000
Effluent standpipe equipment	1	LS	$100,000		$100,000
Electrical and Controls (15% of total)	1	LS	$888,600		$888,600
Estimating Contingency	10	%		+	$681,300
Capital Costs Subtotal					$7,494,000
Contractor Overhead and Profit	10	%			$749,400
Sales Tax	8.8	%		+	$725,400
Direct Construction Cost Subtotal					**$8,968,800**

Alternate WWTF Cost Estimate (discharge to SWA) | Date: 3/8/2005
Carnation Wastewater Treatment Facility | By: S. Leung
King County Department of Natural Resources and Parks | Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Allied Costs					
Consultant services					
30% design					$827,000
Final design					$990,000
CM Support Serv's	4	%			$359,000
KC Admin and other allied costs				+	$900,000
Allied Costs Subtotal					**$3,076,000**
Total WWTF Project Costs (Jan 2005)					**$12,044,800**
Conveyance & Discharge to Wetlands					
Capital Costs					
(6) 12' HDPE - WWTF to Bagwell St.	1500	LF	$95		$143,000
(7) 12" HDPE - Bagwell St. to NE 60th	2700	LF	$63		$171,000
(6) 12" HDPE - NE 60th to Snoqualmie Trail	2650	LF	$96		$255,000
(8) 12" HDPE - Snoqualmie Trail	10000	LF	$60		$600,000
Support from culvert bridge (along NE 60th)	1	LS	$40,000		$40,000
(9) Jacked/Bored Crossings	2	LS	$100,000		$200,000
(10) Wetlands at SWA	1	LS	$600,000		$600,000
24 Hour Emergency Storage (steel tank)	1	LS	$280,000		$280,000
Vert Pump in Standpipe, 975 gpm, 25' TDH	1	LS	$80,000		$80,000
Mechanical Valves and Appurtenances	1	LS	$70,000		$70,000
(11) Estimating Contingency	25	%		+	$610,000
Capital Costs Subtotal					$3,049,000
Contractor Overhead and Profit	10	%			$305,000
Sales Tax	8.8	%		+	$295,000
Direct Construction Cost Subtotal					**$3,649,000**
(12) *Easement Allowance*	2700	LF	$14		**$38,000**

Alternate WWTF Cost Estimate (discharge to SWA) Date: 3/8/2005
Carnation Wastewater Treatment Facility By: S. Leung
King County Department of Natural Resources and Parks Checked: B. Einfeld

DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL	TOTAL
Allied Costs					
Consultant services					
30% design					$92,000
Final design					$110,000
CM Support Services	4	%			$12,000
KC Admin and other allied costs				+	$100,000
Allied Costs Subtotal					**$314,000**
Total Conveyance/Discharge Project Costs (Feb 2005)					**$4,001,000**
Total Project Cost					**$16,045,800**

General Notes:

(1) The cost estimate herein is based on our perception of current conditions. The estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures.

(2) Carollo Engineers has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies.

(3) Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

(4) General Exclusions: All costs associated with the identification/mitigation of hazardous materials. All costs associated with historical/cultural discoveries on site. All costs associated with dewatering.

Facility Notes:

(5) Foundation pilings are not anticipated to be required for the project based on recent soil borings on the site.

Conveyance and Discharge Notes:

(6) Asphalt paved roads with no curbs or gutters. Open-cut trenching costs include 10 ft wide pavement demolition, earthwork, and pavement restoration. Assumes excavation to an average of 5 ft below ground surface, traffic control, and 50% native backfill above pipe zone. Does not assume costs for shoring.

(7) Open-cut trenching costs include earthwork and gravel surface restoration. Assumes excavation to an average of 5 ft below ground surface and use of 75% native backfill above pipe zone. Does not assume costs related to shoring. Easement allowance for conveyance right-of-way listed separately.

(8) Open-cut trenching costs include earthwork and gravel surface restoration. Assumes excavation to an average of 5 ft below ground surface and use of 100% native backfill above pipe zone. Does not assume costs related to shoring or traffic control.

(9) Highway intersection allowance includes setup/removal, 80 LF of 36" dia bored casing, and 2 40 ft long, 12 ft wide boring pits.

(10) Assumes 10 acres at $60,000 per acre.

(11) Conceptual cost estimate.

(12) Street.

APPENDIX L

Public Involvement Chronology

Table 1 Public Involvement Chronology
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Dates	Project Activity	Public Information/Outreach Activity[a]
December 2002 – March 2003	**Planning** ♦ Develop work plans	✓ Draft public involvement plan ✓ Conduct community interviews – January and February 2003 ✓ Form Citizen Advisory Committee (CAC) for Carnation Wastewater Treatment Facility (CWWTF) siting process – January 2003
March – June 2003	**Evaluate Treatment Facility Sites and Discharge Options** ♦ Evaluate discharge locations within 2.5 miles of City ♦ Evaluate CWWTF sites within urban growth area (UGA)	✓ **CAC meeting #1** – 4/8/03 - introduce treatment facility and obtain feedback on siting process and issues ✓ **Community meeting** – 4/30/03 - introduce project and review siting criteria and other current project information ✓ **CAC meeting #2** – 5/7/03 - agree on treatment facility siting criteria and other siting issues ✓ **Property owner meeting** – 5/29/04 - upland discharge area ✓ **CAC meeting #3** – 6/25/03 - review refined siting criteria and process ✓ **Community meeting** – 6/30/03 - provide information on treatment and discharge options, the siting process and criteria, and opportunities for public involvement
July – October 2003	**Environmental Scoping Process** ♦ Collect public comments on scope of EIS ♦ Select alternatives to be evaluated in Draft EIS – Two treatment facility sites – Three discharge options: upland discharge study area near City-owned landfill; river outfall at Carnation Farm Road Bridge; wetland at Stillwater Wildlife Area	✓ **City Council resolution** – 7/1/03 - adopt CAC's recommendations on siting process and criteria ✓ **4th of July Celebration** – 7/4/03 - present current project information ✓ **CAC #4** – 7/9/03 - reviewed treatment facility sites and three discharge options to be evaluated in EIS ✓ **EIS scoping notice issued** – 7/28/03 - 30-day comment period begins ✓ **EIS public scoping meeting** – 8/6/03 ✓ **River outfall property owner meeting** – 10/7/03 ✓ **City Council Resolution No. 288** – 10/7/03 - approves treatment facility sites and discharge options to be evaluated in Draft EIS

[a] Key: ✓ means item is completed; • means items is open

Table 1 Public Involvement Chronology
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Dates	Project Activity	Public Information/Outreach Activity[a]
November 2003 – September 2004	**Prepare Draft and Final EIS** ♦ Prepare Draft EIS ♦ Issue Draft EIS for public comment ♦ Response to comments ♦ Issue Final EIS ♦ Adopt decision process and criteria (cost, engineering, environmental, community, and policy issues)	✓ **Wetland design charrette for stakeholders** – 11/06/03 ✓ **Updated public involvement plan** – November 2003 ✓ **Community meeting** – 12/10/03 - treatment and discharge technologies seminar ✓ **River outfall property owner meeting** – 12/19/04 ✓ **Community Open House** – 3/9/04 - City collection system and wetland discharge option ✓ **City Council Resolution No. 291** – 4/20/04 - approves the decision process and criteria (cost, engineering, environmental, community, and policy) for selecting a treatment facility site, discharge option, and conveyance route ✓ **Wetlands site tour at Stillwater Wildlife Area** – 5/1/04 ✓ **Draft EIS issued for 30-day public comment period** – 6/28/04 ✓ **Participate in 4th of July festival** ✓ **Agency briefing on Draft EIS** – 6/30/04 ✓ **City Council briefing on Draft EIS** – 7/13/04 ✓ **Public hearing on Draft EIS** – 7/14/04 - public review of draft EIS ✓ **Final EIS issued** – September 2004 - does not recommend a preferred alternative
September 2004 – December 2005	**Decision Process Implementation** ♦ Select treatment facility site (City-owned site) ♦ Drop upland discharge ♦ Carry forward river outfall and wetland discharge options ♦ Aggressive fundraising for wetland ♦ Begin predesign of river outfall and treatment facility	✓ **Community meeting** – 9/9/04 - share decision process, criteria and preliminary results, and obtain feedback ✓ **City Council briefing** – 10/19/04 - staff recommendation on the treatment facility site, discharge options, and conveyance route ✓ **City Council Resolution No. 297** – 11/2/04 - accepts staff recommendation on the treatment facility site, discharge options, and conveyance route ✓ **County Executive decision** – 12/10/04 - letter to Mayor Yvonne Funderburg, concurring with the City Council's recommendation ✓ **City Council briefing** – 12/19/05 - plans for public input during CWWTF design

Table 1 Public Involvement Chronology
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Dates	Project Activity	Public Information/Outreach Activity[a]
January – May 2005	**Preliminary Design** ♦ Develop CWWTF site layout, architectural renderings; landscaping plan ♦ Develop river outfall conceptual design (downspout on bridge) ♦ Continue evaluation and fundraising for wetland discharge	• **River outfall property owner meeting** – 1/19/05 • **Community meetin**g – 1/26/05 - input on treatment facility site layout, information on river and wetland discharge decision • **River outfall property owner meeting** – 4/11/05 • **City Council briefing** – 4/12/05 - County moving forward to permit river outfall, pursuing wetland as a future option • **Community meeting** – 5/4/05 - input on treatment facility architecture and landscaping plans, project updates
June 2005 – 2006	**Design and Permitting**	• Newsletters • Booth at 4th of July festival – CWWTF design • Updates to City Council • County Landmarks Commission – public meeting on placing pipe on historic bridge • Community consultation on construction impacts • Pre-construction community meeting • Groundbreaking ceremony • News release/event for above
2006 – 2007	**Construction**	• Community/business notification • Community/business information meeting(s) • Construction information signs • 24-hour construction hotline • Construction updates (fliers) • Ribbon cutting ceremony (with news release/event)
2007 and beyond	**Operation and Maintenance**	• 24-hour information line • Educational opportunities • Emergency response plans • Open houses • Occasional news releases as needed

Table 1 Public Involvement Chronology
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Dates	Project Activity	Public Information/Outreach Activity[a]
Ongoing	**All**	✓ Central information contacts – e-mail, toll free phone number ✓ Community, tribal, and environmental organization briefings ✓ Updated fact sheets ✓ Respond to information requests ✓ Letters to the Editor ✓ City newsletter articles ✓ Press releases – as needed ✓ County and City Web site updates ✓ Identify public issues and target audiences ✓ Participate in community events, including 4th of July festival