Chelan County
Comprehensive Stormwater Plan
July 2012

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CHELAN COUNTY

COMPREHENSIVE STORMWATER PLAN

JULY 2012

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DEFINITIONS

BMP	Best Management Practice
BNSF	Burlington Northern Santa Fe
BOD	Biochemical Oxygen Demand
CAO	Critical Areas Ordinance
CCWF	Centennial Clean Water Grant
CDBG	Community Development Block Grant
cfs	Cubic Feet per Second
City	City of Wenatchee
CIP	Capital Improvement Plan
CMP	Corrugated Metal Pipe
CN	Curve number
COE	U.S. Army Corps of Engineers
COD	Chemical Oxygen Demand
County	Chelan County
CPEP	Corrugated-Smooth Interior Polyethylene Pipe
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DEM	Digital elevation model (DEM) is a digital model or 3-D representation of a terrain's surface.
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FCAAP	Flood Control Assistance Account Program
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map

FIS	Flood Insurance Study
GIS	Geographic Information System
GMA	Growth Management Act
GPS	Global Positioning System (GPS) is a satellite-based survey system made up of a network of satellites. GPS receivers use precise satellite orbit information to triangulate an exact location.
HDPE	High Density Polyethylene
HGL	Hydraulic Grade Line
HPA	Hydraulic Project Approval
HSPF	Hydrological Simulation Program
IDDE	Illicit Discharge Detection and Elimination
LID	Local Improvement District
LMI	Low- to Moderate-Income
LOMR	Letter of Map Revision
LUD	Land Use Description
Manual	Department of Ecology 2004 Stormwater Management Manual for Eastern Washington
MS4s	Municipal Separate Storm Sewer Systems
NAD	North American Datum
NFID	National Flood Insurance Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
Permit	Eastern Washington Phase II Municipal Stormwater Permit
PUD	Public Utility District
PVC	Polyvinyl Chloride

PWTF	Public Works Trust Fund
RCP	Reinforced Concrete Pipe
RCW	Revised Code of Washington
SBUH	Santa Barbara Urban Hydrograph
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SEPA	State Environmental Policy Act
SFHA	Special Flood Hazard Area
SRF	State Revolving Fund
SSO	Sanitary Sewer Overflow
SWMM	Storm Water Management Model
SWMMEW	Stormwater Management Manual for Eastern Washington as developed by the Washington State Department of Ecology in 2004.
SWPPP	Stormwater Pollution Prevention Plan
Tc	Time of Concentration
TMDL	Total Maximum Daily Load
UGA	Urban Growth Area
UIC	Underground Injection Control
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WCC	Wenatchee City Code
WSDOT	Washington State Department of Transportation
WVSTAC	Wenatchee Valley Stormwater Technical Advisory Committee was formed, to comply with Clean Water Act regulations, Chelan County joined with Douglas County, the City of Wenatchee, and the City of East Wenatchee to

	create a joint stormwater program.
Zone AO	FEMA designation defined as areas subject to inundation by 1-percent annual chance shallow flooding where average depth is between one and three feet. Property within the Zone AO is required to maintain flood insurance.
Zone X	FEMA designation defined those areas where average depth of flooding is less than one foot in depth.

1 INTRODUCTION

Chelan County Public Works (Public Works) hired Erlandsen, in association with HDR Engineering, to complete the 2011 Greater Wenatchee Area Stormwater Comprehensive Plan (Comprehensive Plan). The objective of the Comprehensive Plan is to identify and prioritize projects for Public Works. The Comprehensive Plan addresses conveyance deficiencies, water quality elements and proposes improvements to minimize system deficiencies in the major stormwater systems within the Study area.

1.1 Stormwater Utility

Public Works, in addition to Ecology and the EPA are responsible for surface water management in unincorporated Chelan County. In carrying out this responsibility, Public Works plans, designs, and secures permits for new public drainage facilities, reviews private drainage system designs and maintains existing public storm drainage and surface water management facilities. Public Works also identifies non-structural solutions to surface water problems such as monitoring needs, enforcement, regulatory changes, or services. Related responsibilities include compliance with the stormwater quality requirements of the Federal *Clean Water Act*, the County's Phase II, Municipal Stormwater General Permit, and the habitat protection requirements of the ESA. Stormwater utility fees paid by property owners in the Service Area, the Public Works Department, and grant funds fund these facilities and services.

Chelan County, to comply with Clean Water Act regulations, joined with Douglas County, the City of Wenatchee, and the City of East Wenatchee to create a joint stormwater program, the WVSTAC. The Committee was formed in response to the EPA introduction of the Phase II, Municipal Stormwater General Permit program requiring a permit for stormwater discharges to certain MS4s. On January 17, 2007, Ecology issued the Eastern Washington Phase II Municipal Stormwater Permit (hereinafter referred to as "Permit") which authorizes permittees to discharge to waters in Washington in accordance with the special and general conditions listed in the Permit. As the owner and operator of regulated small MS4s, Chelan County is required to comply with conditions of the Permit and, as part of the WVSTAC; Chelan County has been able to leverage funds and resources to implement elements associated with the Permit common to the WVSTAC.

In January 2008, Chelan County adopted a surface storm water utility to manage stormwater needs in developing areas around Wenatchee. All developed properties containing impervious surfaces (including rooftops and paved areas) are charged a service fee. Within this area, Chelan County has been evaluating options for addressing the stormwater management needs which include conveyance, detention and water quality elements.

1.2 Stormwater Utility Service Area/Study Area

The Study area consists of approximately 13,100 acres, or about 20.4 square miles of unincorporated land around the City of Wenatchee. The Study area consists of those developed areas around the City of Wenatchee including Sunnyslope, South Wenatchee, No. 1 and No. 2 Canyons and areas that are islands within the city limits. Exhibit 1.2-1 outlines those areas of Chelan County within the Study area. These islands and canyons were further addressed in the City of Wenatchee Comprehensive Stormwater Plan Update (HDR 2009). The Comprehensive Plan also included a general analysis for No. 1 and No. 2 Canyons and Dry Gulch.

Characteristics of the drainage network serving the area vary significantly with location. The City's system and areas directly connected are generally highly developed and almost entirely piped with limited detention systems. The surrounding areas within the Study area are generally less dense and storm runoff is typically conveyed through a combination of open ditches, pipes, culverts and swales.

1.3 Previous Studies

Several studies have been completed for areas within Chelan County's Study area. The following sections summarize the previous studies.

1.3.1 Flood Control of Canyons No. 1 and 2

Department of the Army, Corps of Engineers (November 1974)

In 1974 the COE completed an evaluation of No. 1 and No. 2 Canyons to develop alternatives for addressing floodwater that originates within the two basins. The report recommended constructing reinforced-concrete channels to carry runoff from both canyons through the City of Wenatchee to the Columbia River. Congress authorized federal funding for the project which was estimated at $24,440,000 (1977 price level) and funds were deauthorized in 1990 under provisions of Public Law 99-662.

1.3.2 Wenatchee Area Flood Hazard Report for Canyon No. 1, Canyon No. 2 and Dry Gulch

Munson Engineers (1980)

Completed for Chelan County, the report evaluated the feasibility of using debris-control dams in the drainage channels and detention/infiltration facilities at the mouths of the canyons.

1.3.3 Flood Hazard Investigation of Alluvial Fans below Canyons No. 1 and No. 2 and Dry Gulch

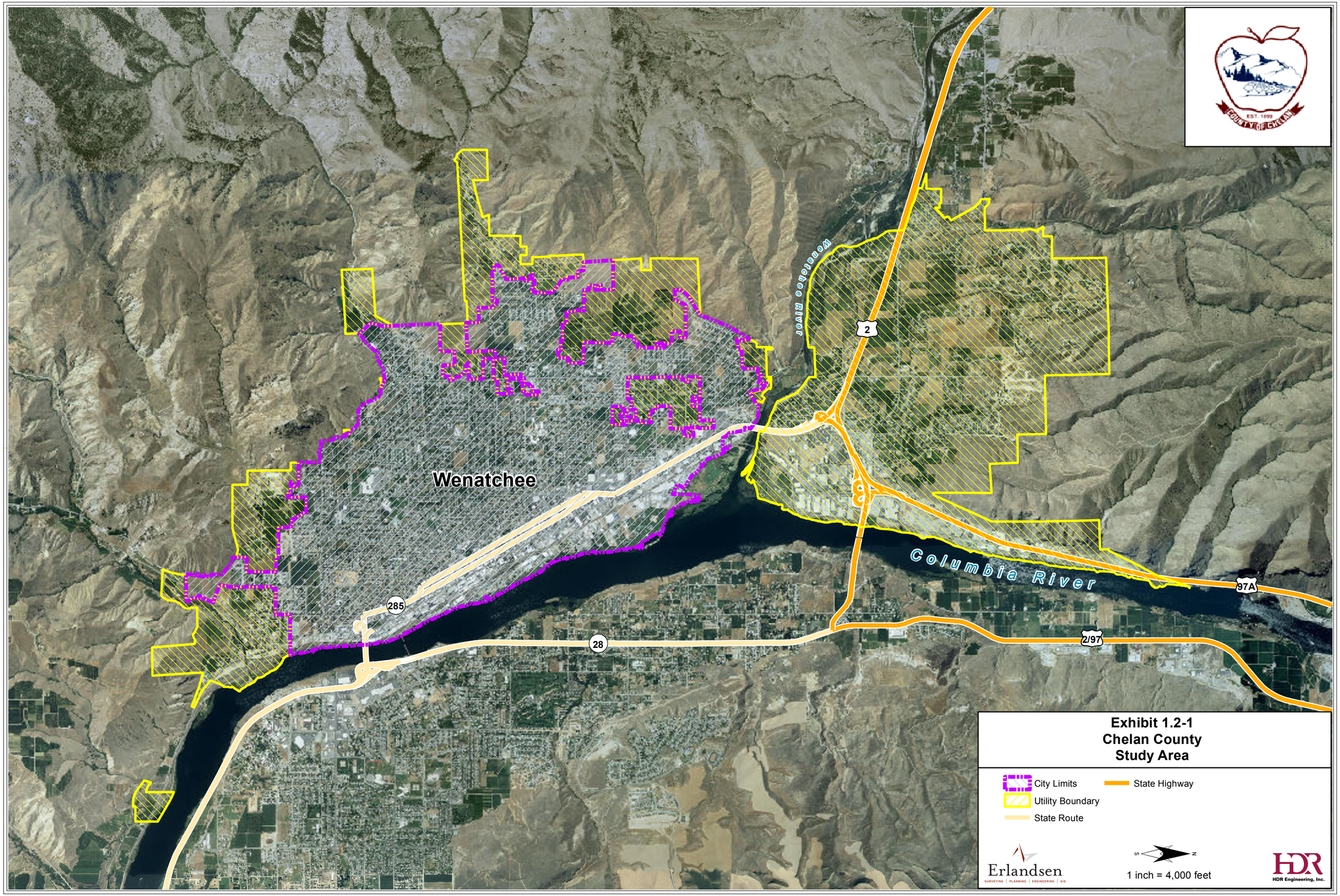
Northwest Hydraulic Consultants (1996)

The report investigated opportunities for reducing the floodplain limits below the mouths of all three canyons based upon hydrologic/hydraulic modeling of canyon runoff. The investigation was used by the City to request and obtain a revised FIRM from the FEMA.

1.3.4 Comprehensive Stormwater Plan Update

HDR (2009)

The report outlined the planning and engineering strategies for the City of Wenatchee to manage stormwater within the UGA. While not in the Study area, stormwater planning activities of both jurisdictions overlap especially in regards to canyon drainages and management strategies within the City's UGA.


Wenatchee
Wenatchee River
Columbia River
2
285
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2/97
Exhibit 1.2-1
Chelan County
Study Area
City Limits
Utility Boundary
State Route
State Highway
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1 inch = 4,000 feet
HDR
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1.4 Basin Planning Program Goals and Objectives

When this Comprehensive Plan was envisioned, Public Works staff defined a common set of goals and objectives for the project. "Goals" refer to the desired outcomes of implementing each plan, and "Objectives" describe measurable indicators that the goals are being achieved. In addition to the shared goals and objectives of all plans, basin-specific goals and objectives may be developed in conjunction with basin stakeholders if appropriate. The goals and objectives developed by Public Works for the basin planning program are listed below.

1.4.1 Drainage Mapping

- Map drainage basins in the Sunnyslope Basin.
- Investigate and map drainages within the Study area to aid in hydraulic modeling and provide a basis for the County to manage future development within the Study area.
- Develop a GIS based upon the field data.

1.4.2 Reduce Flood Hazards

- Analyze and recommend solutions to improve the County's conveyance systems (where necessary).
- Identify areas where detention improvements can minimize conveyance improvements.

1.4.3 Improve Water Quality

- Meet or exceed Washington's Surface Water Quality Standards (WAC 173-201a).
- Maintain compliance with the terms and commitments in Chelan County's Permit for stormwater discharge.
- Reduce the risk of groundwater contamination.
- Reduce rates of erosion.
- Reduce public and private property damage.

1.4.4 Coordinated and Responsible Use of Public Resources

- Reduce the cost of maintaining stormwater facilities.
- Ensure favorable project value when benefits are measured against costs.
- Increase public awareness of flooding, habitat, and water quality issues.
- Ensure that monitoring and enforcement programs demonstrate an increase in services per dollar spent.

1.4.5 Influence Location and Methods for New Development

- Foster the use of low impact development techniques.
- Ensure the wide use of effective *Best Management Practices*.

2 SYSTEM INVENTORY

2.1 Hydrologic Characteristics

The hydraulic modeling area consists of approximately 41,700 acres, or about 65 square miles of unincorporated land around the City and those areas which discharge runoff into the Study area. The Study area encompasses those areas around the City including Sunnyslope, South Wenatchee and areas that are islands within the city limits. This study also included a general analysis for No. 1 and No. 2 Canyons and Dry Gulch. The hydraulic modeling area greatly exceeds the Study area as the actual drainages that contribute water into the Study area extend upwards to the top of the natural landforms.

Characteristics of the drainage network serving the area vary significantly with location. The system serving the core area for the City is highly developed and is almost entirely piped with limited detention systems. This triangular core area extends from the Columbia River, west to Miller Street with Ferry/Russell Streets serving as the south border. The surrounding areas, outside of the City Limits within the Study area, are generally less dense and storm runoff is typically conveyed through open ditches and swales with culverts used to convey water under roadways. Developed areas within the Study area have localized collection and conveyance systems.

2.2 Population

The estimated population of Wenatchee for 2010 is 31,120 (OFM, 2010).Wenatchee and the surrounding area is the largest population center in the county which has a total estimated population for 2010 of 73,300 (OFM, 2010). The City is expected to have large population growths into the coming decades with an estimated population in 2025 of 46,265 (City of Wenatchee, 2007).

Much of the expected growth in the area will occur in Sunnyslope. It is estimated that the current population of Sunnyslope is over 3,100 and in the next 20 years it is expected that this number will grow by as much as 6,000 (Studio Cascade, 2007). A summary of the area's population is shown in Table 2.2-1.

Table 2.2-1
City of Wenatchee and Chelan County Population Estimates

	Year			
	2000[1]	**2005[2]**	**2010[2]**	**2025[3]**
City of Wenatchee	27,856	29,320	31,120	46,265
Chelan County	66,616	69,200	73,300	100,696

1. Source: U.S. Census Bureau as cited in City of Wenatchee 2007.
2. Source: (OFM, 2010)
3. Source: City of Wenatchee 2007 states that the city of Wenatchee will grow by 16,945 people between 2025. This was added to the city's 2005 population estimate of 29,320(OFM, 2010).

2.3 Planning Area Description

The Chelan County Study area was separated into six distinct basins based upon their natural drainages. Exhibit 2.3-1 shows the drainage basins. These areas consist of Sunnyslope, Squilchuck and the Atwood Orchard Area. No. 1 Canyon, No. 2 Canyon, Dry Gulch and isolated areas within City limits are also evaluated based upon previous modeling completed under separate studies for both Chelan County and the City of Wenatchee.

2.3.1 Sunnyslope

A drainage area was defined for the Sunnyslope area which includes the North Wenatchee Business District and up into the foothills north of the City. The Sunnyslope area is made up of commercial and industrial areas and expands to the west and north into residential and urban developed areas. The majority of the area to the north and west of the urban area is the foothills area and is made up of rural residential which opens to scrub brush and grasslands. This area is about 12,000 acres in size and contains 183 drainage sub-basins.

2.3.2 Squilchuck

Squilchuck, the area south of Wenatchee, was also studied. However, only the lower reaches of the basin were included in the model, which were divided into 6 sub-basins with a total area of about 250 acres. This area is made up of some urban areas, some commercial orchards, brush, and grasslands. The upper areas of Squilchuck are extensive with various drainage elements all affecting Squilchuck Creek. Only the drainages that discharge into Squilchuck Creek within the Study area were evaluated.

2.3.3 Atwood Orchards

Atwood Orchards, which is south of Squilchuck Creek is divided into 9 sub-basins with an area of about 1,100 acres. This basin is primarily commercial orchards and grasslands with some urban areas.

2.3.4 Canyons

No. 1 Canyon, No. 2 Canyon and Dry Gulch are each located on the western edge of the City. These drainages are largely undeveloped and remain vegetated with natural plant species. Development has occurred along the eastern fringes where the canyons discharge runoff into the City. These interface zones have experience flooding problems in recent years due to a lack of defined drainage channels as they flow through the City where they ultimately discharged into the Columbia River. The Dry Gulch drainage does have some existing detention facilities that were developed during the closure of the Asamera Mine. Outside of those areas immediately adjacent to the City, conveyance systems consist of open ditches. An evaluation of these areas is based upon previous modeling that has been completed for these areas.

2.3.5 South Wenatchee

The South Wenatchee drainage basin is defined as that area located outside of the City Limits but within the UGA for the City near Squilchuck Creek. These areas are served by a collection system that discharges into Squilchuck Creek. An evaluation of this area is based upon previous modeling results completed under separated studies for this area.

No. 1 Canyon

No. 2 Canyon

South Wenatchee

Wenatchee

Sunnyslope

Atwood Orchards

Squilchuck

Wenatchee River

Columbia River

2

285

28

97A

2/97

Exhibit 2.3-1
Chelan County
Basin Drainages

State Route
State Highway
Basins
Sub Basins
City Limits
Study Area

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1 inch = 5,000 feet

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2.4 Soils

Soils types within the Study area were divided into four groups based upon infiltration rates as defined by the United States Natural Resources Conservation Service. Exhibit 2.4-1 shows the four major soil types which are defined further below. Appendix A contains a detailed breakdown of the soil types.

- Type A Soils – These soils are defined as having a low runoff potential. These soils are classified has having a high infiltration rate even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or graves. These soils have a high rate of water transmission.
- Type B Soils – These soils are defined as having a moderately low runoff potential. These soils have a moderate infiltration rate when thoroughly wetted and consist of moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.
- Type C Soils – These soils have a moderately high runoff potential. Soil characteristics have a slow infiltration rate when thoroughly wetted and consist of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. These soils have a slow rate of water transmission.
- Type D Soils – These soils have a high runoff potential. Soils are classified as having a very slow infiltration rate when thoroughly wetted and consist mainly of clay soils with a high swelling potential. Soils with a permanent high water table, soils with a hardpan or clay layer at or near the surface, and shallow soils over nearly impervious material are also encountered. These soils have a very slow rate of water transmission.

2.5 Groundwater

The depth to groundwater varies across the Study area. Near the Columbia River groundwater can be encountered at depths near 15-feet with the depths approaching 100-feet as you near the foothills. Historically groundwater has had little impacts to infiltration systems within the Wenatchee area. The Sunnyslope area has been experiencing an increase in shallow groundwater issues that are assumed to be connected to the numerous septic systems located throughout the area. These shallow groundwater issues have been discovered during residential foundation excavation work and again following construction with several houses experiencing settlement problems directly attributed to groundwater.

Based upon a review of Ecology's Well Log Inventory System, very few private wells are located within the Study area. Domestic water service is provided through the Wenatchee Regional Water Supply System which is jointly managed by the City, East Wenatchee Water District and Chelan County PUD. Water for irrigation use originates in the Wenatchee River or Columbia River systems and is distributed throughout the Study area through a series of private irrigation systems.

Wenatchee

Columbia River

Wenatchee River

2

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2/97

Exhibit 2.4-1
Chelan County
Major Soil Types

Major Soil Type Groups
- A
- B
- C
- D

- Basins
- City Limits
- Study Area

- State Route
- State Highway

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1 inch = 5,000 feet

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2.5.1 Waste Disposal

The Study area is currently served by a combination of sanitary sewer and on-site septic systems. The residential Sunnyslope area is predominantly served by on-site septic systems, while the commercial area within the Sunnyslope area (Olds Station) is served by a sanitary sewer system which discharges into the City's Wastewater Treatment Plant (WWTP). There are numerous documented issues with groundwater problems within the Sunnyslope area. These issues vary from problems with residential foundation settlement to natural springs that are visible throughout the area. These groundwater issues will need to be investigated during the siting of any infiltration system that is to be located within the Sunnyslope area.

Those areas located to the west and the south of the City, within the Study area, are also served by a combination of sanitary sewer and on-site septic systems. There are no known groundwater issues within these areas.

2.6 Topography and Slope

Topographic information for the Study area is based upon Digital Elevation Model (DEM) information obtained from the US Geological Service. See Exhibit 2.6-1. A DEM is a gridded array of elevations. The DEM surface for Chelan County was developed by the Federal Government using a 40-foot contour interval and its surface does exhibit some differences from actual field conditions.

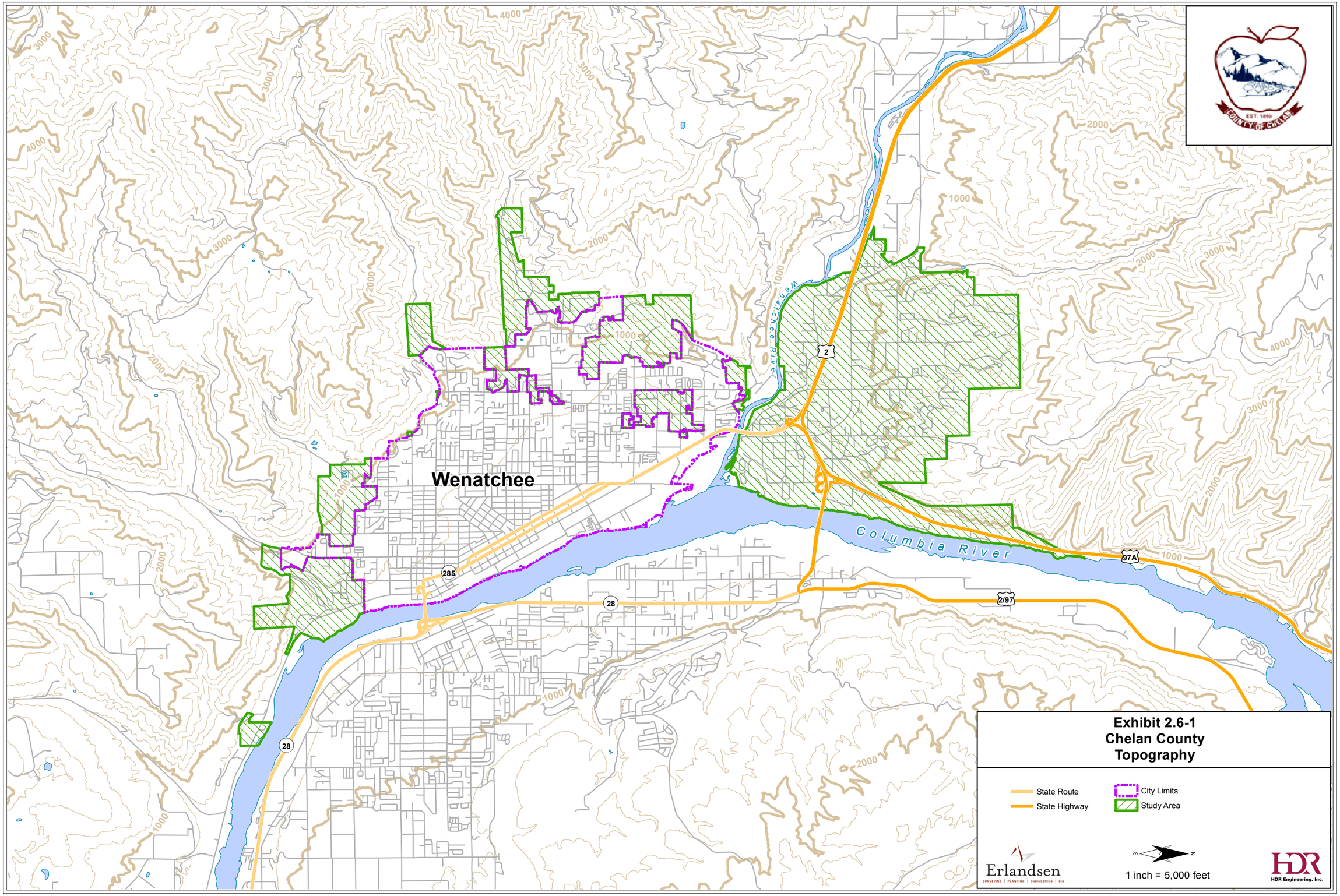
To improve the accuracy of the model, drainage slopes and detention volumes were calculated based upon field survey information obtained by Erlandsen survey personnel.

2.7 Land Use and Cover

Land use is based upon zoning as developed in the Chelan County Comprehensive Plan (Chelan County 2009). The Chelan County Comprehensive Plan goals are to:

- Establish Urban Growth Areas
- Promote continuous and orderly development
- Develop county-wide transportation facilities and strategies
- Utilize joint county and city planning within Urban Growth Areas

In the Comprehensive Plan planning area, the County was divided into eight areas with the City taking the lead role for development of the Comprehensive Plan for the Wenatchee Urban Area. Within the Study area, the County was divided into eleven distinct land use categories. These land use categories are listed in Table 2.7-1.


Wenatchee
Columbia River
Wenatchee River
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97A
4000
3000
2000
1000
Exhibit 2.6-1
Chelan County
Topography
State Route
State Highway
City Limits
Study Area
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1 inch = 5,000 feet
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Table 2.7-1 Chelan County Land Use Inventory	
Agriculture	Undeveloped
Mineral Resource	Single Family
Multi Family	Commercial
Industrial	Parks and Recreation
Public/Quasi Public	Transportation/Utilities
Vacant	

To evaluate the Study area for both current and future conditions, two separate land use projections were developed. Existing land use was developed from future land use projections. Future land use conditions represent the 20-year zoning plan for the County. In order to develop existing conditions to allow the system to be modeled for the near term, future zoning projections were modified to reflect existing property uses. Table 2.7-2 outlines the zoning designations which are present within the Study area.

Runoff volumes associated with the Study area are directly related to land use. The higher the density of the land use, the higher the runoff coefficient assigned to land use classifications. The hydraulic modeling utilizes the effective impervious area of each of the land use categories listed in Table 2.7-1. Effective impervious area is basically the impervious cover that provides stormwater flows the ability to directly and quickly discharge into a drainage channel. For example, a paved parking lot surrounded by grass lawn at a school might have less impact than the same lot surrounded by a gravel surface. A look at the percent effective impervious area could exclude the parking lot surrounded by a grass lawn from the estimate of impervious cover. The effective impervious factors are less conservative and more closely replicate actual conditions.

Table 2.7-2 Study Area Zoning Designations			
Zoning/Land Use		*Description*	*Effective Impervious*
RR 2.5	Rural Residential/Resource (1 Dwelling Unit / 2.5 acres)	Minimum lot size: 2.5-acres Maximum Lot Coverage: 35% Chelan County Zoning Designation	10%
RR 5	Rural Residential/Resource (1 Dwelling Unit / 5 acres)	Minimum lot size: 5-acres Maximum Lot Coverage: 35% Chelan County Zoning Designation	10%
RR 10	Rural Residential/Resource (1 Dwelling Unit / 10 acres)	Minimum lot size: 10-acres Maximum Lot Coverage: 35% Chelan County Zoning Designation	10%
RR20	Rural Residential/Resource (1 Dwelling Unit / 20 acres)	Minimum lot size: 20-acres Maximum Lot Coverage: 35% Chelan County Zoning Designation	10%
RV	Rural Village	Minimum lot size: 12,000-square feet Maximum Lot Coverage: 35% Chelan County Zoning Designation	10%
RL	Residential Low	Minimum lot size: 7,000-square feet Maximum Lot Coverage: 35% City of Wenatchee Zoning Designation	26%
RS	Residential Single	Minimum lot size: 10,000-square feet Maximum Lot Coverage: 35% City of Wenatchee Zoning Designation	26%
RM	Residential Moderate	Minimum lot size: 6,000-square feet Maximum Lot Coverage: 45% City of Wenatchee Zoning Designation	26%
RH	Residential High	Minimum lot size: 4,000-square feet Maximum Lot Coverage: 55% City of Wenatchee Zoning Designation	48%
CN	Neighborhood	Minimum lot size: 10,000-square feet Maximum Lot Coverage: 50% City of Wenatchee Zoning Designation	86%
NWBD	North Wenatchee Business District	Minimum lot size: NA Maximum Lot Coverage: 65% City of Wenatchee Zoning Designation	86%
I	Industrial	Minimum lot size: 5,000-square feet Maximum Lot Coverage: 70% City of Wenatchee Zoning Designation	86%
O	Orchard/Park	Minimum lot size: NA Maximum Lot Coverage: NA	3%
G	Grasslands	Minimum lot size: NA Maximum Lot Coverage: NA	1%

2.7.1 Existing Land Use

Existing land use modeling was completed following adjustments to Chelan County's land use layer developed in the 2009 Chelan County Comprehensive Plan (Chelan County 2009). To make the adjustments, aerial photography was reviewed to determine those areas within the Study area whose current use did not match the land use projections. In those specific areas, zoning was modified to reflect the current use. In most instances, land use was modified to reflect either orchard or grassland areas that have not been developed into future zoning allowances. See Exhibit 2.7-1.

2.7.2 Future Land Use

Future land use modeling was completed using Chelan County's Zoning Projections from the 2009 Comprehensive Plan. See Exhibit 2.7-2. This document was developed by the County to guide development throughout the Study area and this zoning represents the future land use that can be expected within those areas.

2.8 Critical Areas

Chelan County is responsible for developing and administering policies and development regulations to protect the functions and values of critical areas. Chelan County updated their Critical Areas Ordinance (CAO) in 2007 with Chapter 11 of the Zoning code describing critical areas and their setback requirements. In addition to the CAO, Chelan County participated in the 2010 update to the Natural Hazard Mitigation Plan (Chelan County 2011). Exhibit 2.8-1 shows those specific critical areas within the Study area.

Wildfire

Portions of the Study area are susceptible to wildfires due to their natural vegetated state. These areas, following a wildfire, have the potential to develop significant erosion/runoff events if heavy rainfall were to occur prior to the reestablishment of vegetation. This event, should it occur, has the potential to greatly affect the Study area both in the Sunnyslope and Canyon drainage areas. With no vegetation, excessive runoff events with heavy debris loads could impact all downstream drainage facilities.

Wetlands

Wetlands within the Study area are shown on Exhibit 2.8-1. These wetlands are managed under the CAO and development within these areas or their buffers is limited unless mitigation is provided in accordance with Chelan County development requirements.

Flood Hazard

Flooding is one of the most common natural hazards within Chelan County. The largest mapped flood zones within the Study area are located within Canyons No.1 and No. 2 in addition to Dry Gulch. FEMA has completed several updates to the initial Canyon Flood Study, with the most recent update occurring in 2004. The floodplains identified in the study are shown in Exhibit 2.8-1.

Existing Land Use

- Central Business District (CBD)
- Industrial District (I)
- Neighborhood Commercial (CN)
- Neighborhood Commercial Overlay (CNO)
- North Wenatchee Business District (NWB)
- OPEN (OPEN)
- Office Mixed Use (OMU)
- Orchard (ORCHARD)
- Pedestrian Overlay (PO)
- Recreational/Residential Overylay (RRO)
- Residential High (RH)
- Residential Low (RL)
- Residential Medium (RM)
- Residential Single-Family (RS)
- Rural Residential 10 Acre (RR10)
- Rural Residential 2.5 Acre (RR2.5)
- Rural Residential 5 Acre (RR5)
- Rural Village (RV)
- South Wentachee Business District (SWB)
- Waterfront Mixed Use (WMU)

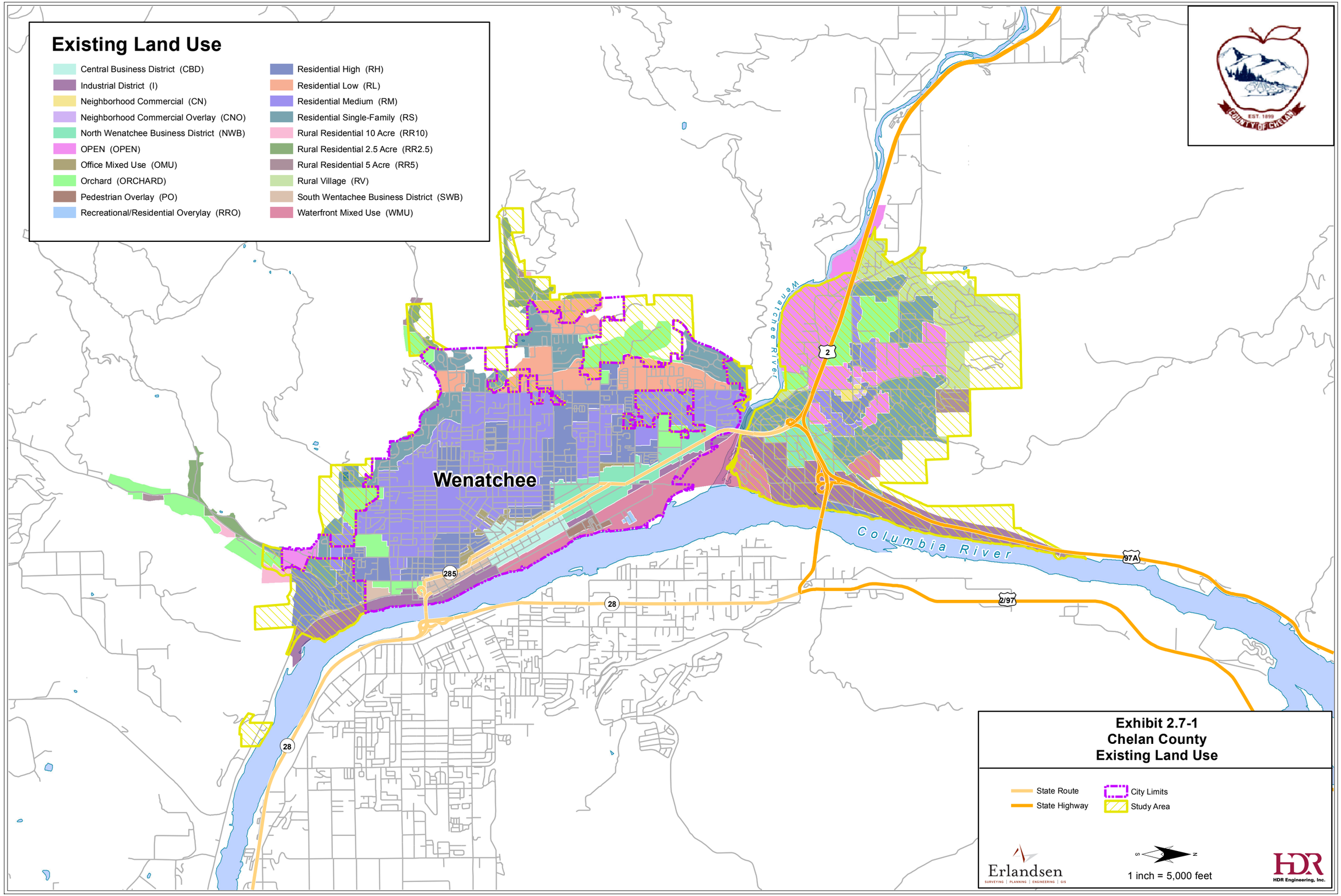

Exhibit 2.7-1
Chelan County
Existing Land Use

- State Route
- State Highway
- City Limits
- Study Area

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1 inch = 5,000 feet

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Future Land Use

- Agricultural Commercial (AC)
- Central Business District (CBD)
- Industrial District (I)
- Neighborhood Commercial (CN)
- Neighborhood Commercial Overlay (CNO)
- North Wenatchee Business District (NWB)
- OPEN (OPEN)
- Office Mixed Use (OMU)
- Orchard (ORCHARD)
- Pedestrian Overlay (PO)
- Recreational/Residential Overylay (RRO)
- Residential High (RH)
- Residential Low (RL)
- Residential Medium (RM)
- Residential Single-Family (RS)
- Rural Residential 10 Acre (RR10)
- Rural Residential 2.5 Acre (RR2.5)
- Rural Residential 20 Acre (RR20)
- Rural Residential 5 Acre (RR5)
- Rural Village (RV)
- South Wentachee Business District (SWB)
- Waterfront Mixed Use (WMU)

Wenatchee

Wenatchee River

Columbia River

2

285

28

28

97A

2/97

Exhibit 2.7-2
Chelan County
Future Land Use

State Route
State Highway
City Limits
Study Area

Note: Future land use based on Chelan County Comprehensive Plan 2009

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1 inch = 5,000 feet

HDR
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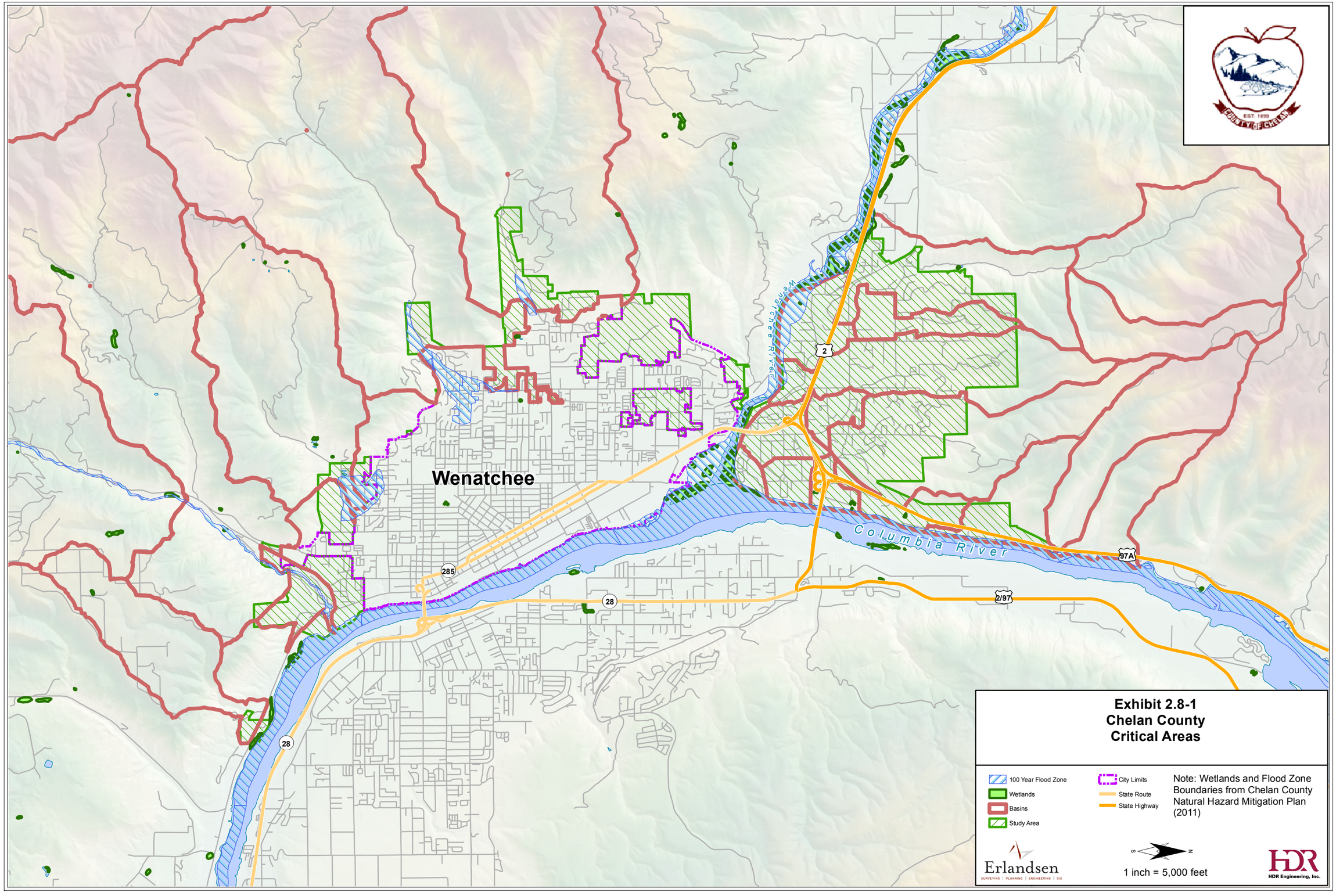
Wenatchee
Columbia River
Wenatchee River
2
285
28
28
2/97
97A
Exhibit 2.8-1
Chelan County
Critical Areas
100 Year Flood Zone
Wetlands
Basins
Study Area
City Limits
State Route
State Highway
Note: Wetlands and Flood Zone Boundaries from Chelan County Natural Hazard Mitigation Plan (2011)
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
1 inch = 5,000 feet
HDR Engineering, Inc.

3 EXISTING STORMWATER SYSTEMS

3.1 Mapping

Historical records on file with Chelan County of the existing conveyance systems in the Study area consisted of open ditches located in the bottoms of natural drainages, culverts, pipes, roadside ditches and concrete canals. As part of this study, Erlandsen mapped major drainages within the Sunnyslope and South Wenatchee Areas. Major drainages were defined as an extent or an area of land where surface water from rain and melting snow converges to a single point which ultimately discharges to a river or a point where surface water is lost underground. Given the extensive size of the No. 1 Canyon, No. 2 Canyon and Dry Gulch drainages, mapping was not completed within these areas. In order to effectively model drainages within the Study area, limited surveys of these drainage channels were completed at regular intervals. Culvert inlets and outlets within the major drainage were mapped along with volumetric surveys of the existing detention facilities was completed. Previous Canyon modeling results are further discussed in Chapter 5. Mapping within the Study areas was completed using GPS survey equipment in order to gain correct elevations for elements critical to the hydraulic modeling effort. Following the data collection, this information was incorporated into a GIS layer that served as the basis for the hydraulic modeling effort.

3.2 Drainage Systems

Within the Study area there are numerous conveyance systems that consist of either open (canal/ditch) or closed (pipe) conveyance systems. These systems are used to convey stormwater from hard surfaces to either a water body or into an infiltration system.

Open Systems – Open systems are conveyance systems that are open to the atmosphere. These systems generally consist of either natural or manmade ditches/canals. The Study area has systems which consist of both types.

Canals are typically a manmade conveyance system that is lined with either concrete or some other hard surface that conveys stormwater with minimal infiltration of water into the ground. These particular systems, when manmade, are designed with erosion protection elements that dissipate areas of high energy in the conveyed water. Within the Study area there is only one canal system which is located south of Easy Street and west of School Street. The canal, which is owned by the Wenatchee Reclamation District, provides water to orchards and other residential systems located within the Study area. This canal is not designed to convey stormwater originating from within any drainage in the Study area, but its overflow is located in the bottom of a natural drainage. This overflow, which consists of a concrete lined ditch, is combined with water from natural drainage systems at its discharge location near to the Wenatchee Reclamation District office located on Easy Street. Water in this system is discharged into the Wenatchee River.

Ditches are located throughout the entire Study area and are formed as a small to moderate depression created to channel water. In most instances, these conveyance systems are located along the bottom of natural drainages in addition to road side ditches. The natural drainages have meandered over time based upon geologic conditions and road development and are greatly impacted by stormwater runoff rates that erode their channels. Natural drainages are only periodically maintained by property owners when conditions warrant repair work with the

County clearing and maintaining roadside ditches in accordance with their maintenance schedules.

Closed Systems – The Study area has various closed collection systems which consist of concrete, PVC, HDPE and CMP pipes. These systems are typically located within the urban areas of the Study area where development has necessitated the routing of stormwater across property in a closed system. Closed systems allow property to be developed to its highest potential.

Table 3.2-1 summarizes the total lengths of pipes within the Study area and Table 3.2-2 summarizes the lengths of pipe within the Study area by pipe composition. Exhibit 3.2-1 shows the locations of pipes by size within the Study area with Exhibit 3.2-2 shows pipes by composition within the Study area.

Table 3.2-1
Pipe Sizes and Length in Study Area

Size (inches)	Length (ft)
12	2,543
15	395
18	5,970
24	5,781
27	1,214
36	4,731
42	55
48	1,549
54	889
60	457
72	1,375

Table 3.2-2
Pipe Type in Study Area

Size (inches)	Length (ft)
Concrete	4,083
PVC	4,269
HDPE	218
CMP	16,197
RCP	150
Steel	42

97A

2

Columbia River

Wenatchee River

Note:
Only pipes participating
in the model are shown.

Exhibit 3.2-1
Chelan County
Location of Pipes By Size

Pipes by Diameter

12" 24" 42" 60"
15" 27" 48" 72"
18" 36" 54"

State Route
State Highway
Study Area

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1 inch = 1,500 feet

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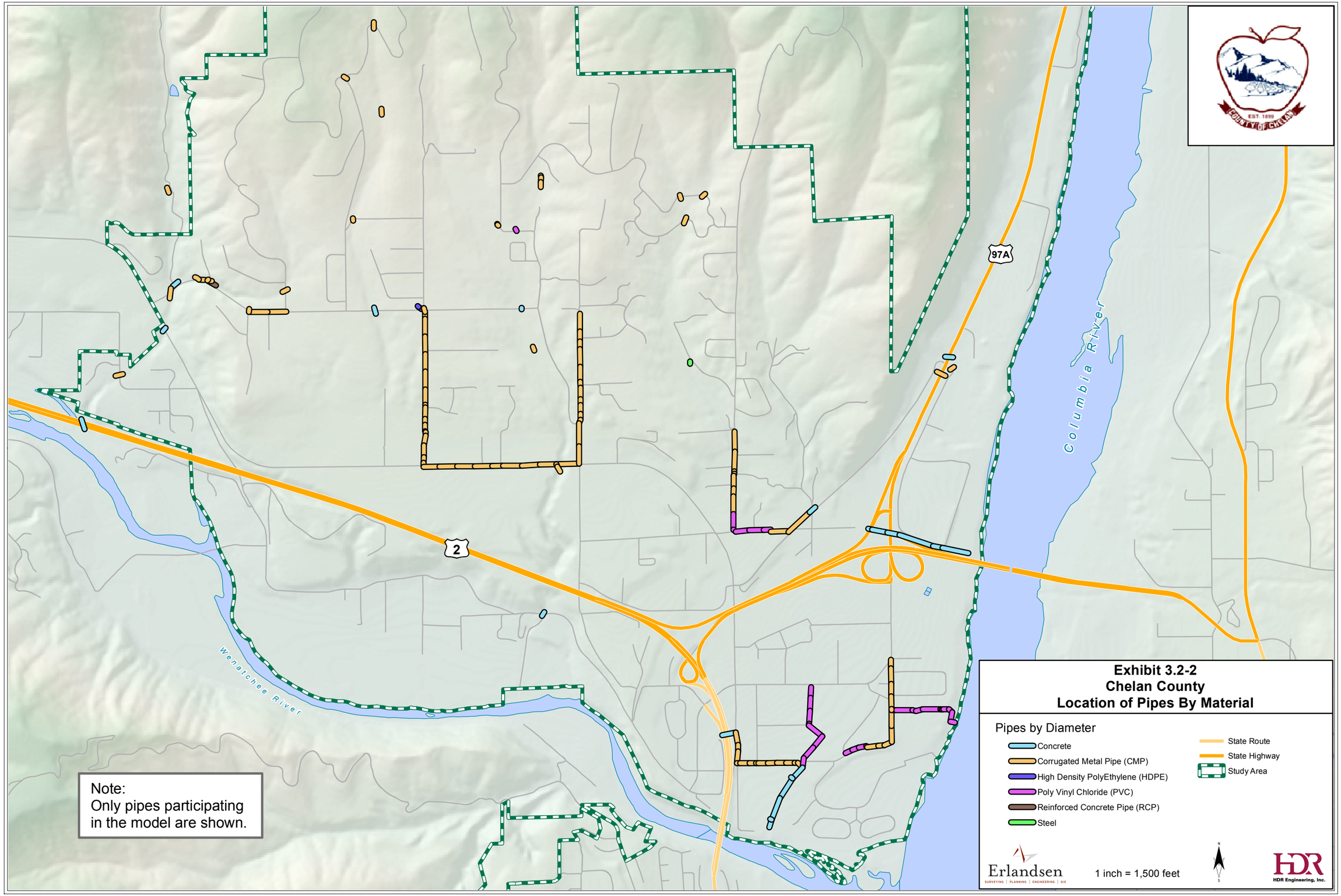

97A
2
Columbia River
Wenatchee River
Note:
Only pipes participating
in the model are shown.
Exhibit 3.2-2
Chelan County
Location of Pipes By Material
Pipes by Diameter
Concrete
Corrugated Metal Pipe (CMP)
High Density PolyEthylene (HDPE)
Poly Vinyl Chloride (PVC)
Reinforced Concrete Pipe (RCP)
Steel
State Route
State Highway
Study Area
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
1 inch = 1,500 feet
HDR Engineering, Inc.

3.3 Manholes

A manhole is the top opening to an underground pipe and is located at changes in grade or direction. These structures are typically spaced between 300 and 500 feet apart to facilitate pipe maintenance which includes cleaning. In addition, some manhole structures also include sediment sumps which serve to collect suspended solids during periods of low storm activity as the suspended material settles out of the stormwater. Chelan County currently uses WSDOT standard manhole structures. A detail of a typical manhole is included in Appendix A, Figure 1.

3.4 Catch Basins

Catch basins are typically located along the edges of roadways in the curb line. These structures are designed to drain excess rain from paved surfaces with discharges connected into underground stormwater piping. Each of these structures has a grated cast iron inlet which introduces water into the system. There are numerous styles of inlets each having a different inflow capacities.

Catch basins can also be installed with, or without, a sump. The sump serves as a sediment trap in the same manner as does a manhole.

A detail of a typical catch basin is included in Appendix A, Figure 2.

3.5 Drywells

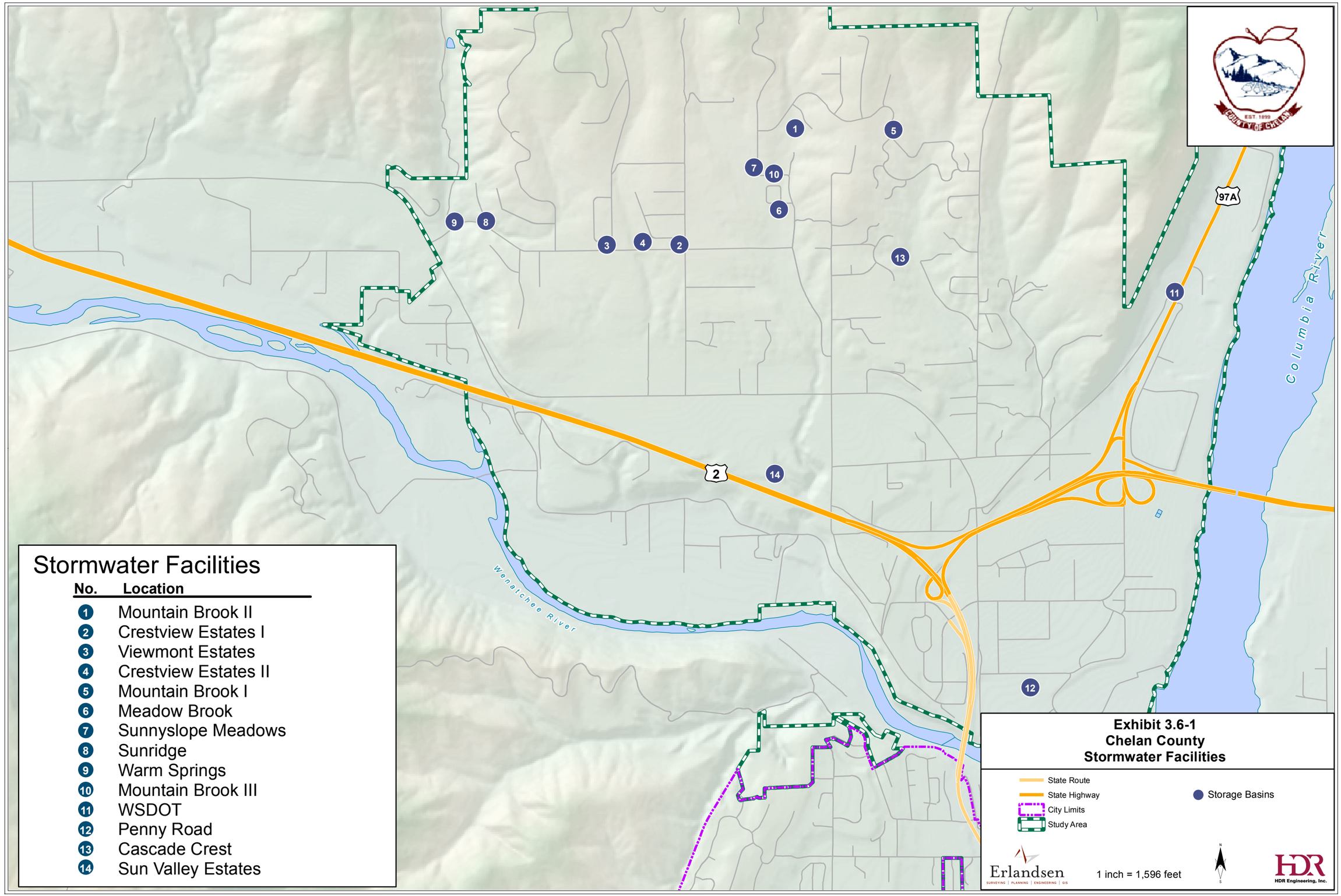
A drywell is an underground structure that disposes of stormwater by dissipating it into the ground where it ultimately becomes groundwater. Within the Study area, Chelan County operates and maintains numerous drywells. These structures, when installed prior to 2010, did not historically have pretreatment devices in which sediments or other debris was filtered out. Without pretreatment, these structures have historically been problematic to maintain as eventually the system does clog with sediments decreasing the infiltration of water. Current regulations require that pretreatment devices be installed to minimize maintenance on these structures. These structures are regulated under the UIC (Underground Injection Control) program administered by Ecology. A detail of a typical drywell is included in Appendix A. Figure 3.

3.6 Detention Facilities

Within the Study area, predominantly in the Sunnyslope area, there are numerous detention facilities that have been constructed as part of residential/ commercial developments or municipal improvement projects. These facilities serve to manage stormwater for the localized areas by detaining and releasing stormwater that has been collected from the development back into the natural drainage channel at a controlled rate. These stormwater releases are designed to be at a discharge rate that is similar to the predeveloped rate with infiltration from the facility also being taken into account. These facilities have been included in the hydraulic model. Table 3.6-1 outlines the major facilities within the Study area. Exhibit 3.6-1 shows the locations of these facilities.

Table 3.6-1 Existing Major Detention Facilities	
Crestview Estates I	Private system with overflow to natural drainage. Storage Capacity: 11,300 cubic feet combined storage
Crestview Estates II	Private system with overflow to natural drainage. Storage Capacity: 11,300 cubic feet combined storage
Mountain Brook I	Private system with three large ponds designed for localized development and some upstream drainage discharges. Storage Capacity: 26,900 cubic feet combined capacity
Mountain Brook II	Small private localized detention facility. Storage Capacity: 26,900 cubic feet combined capacity
Mountain Brook III	Small private localized detention facility. Storage Capacity: 26,900 cubic feet combined capacity
Viewmont Estates	Small private localized detention facility. Storage Capacity: 14,000 cubic feet
Meadow Brook	Private system with overflow to natural drainage. Storage Capacity 22,000 cubic feet
Sunnyslope Meadows	Small private localized detention facility. Storage Capacity: 8,000 cubic feet combined capacity
Sunridge	Small private localized detention facility. Storage Capacity: 3,600 cubic feet
WSDOT	Municipal pond within WSDOT ROW located at north end of Ohme Garden Road. Developed to control ROW runoff. Storage Capacity: 106,800 cubic feet
Penny Road	Chelan County Regional Facility for the Olds Station area. Overflow to Wenatchee River. Storage Capacity: 386,300 cubic feet
Cascade Crest	Small municipal localized detention facility. Storage Capacity: 300 cubic feet
Warm Springs	Overflow to natural drainage. Storage Capacity 6,700 cubic feet
Sun Valley Estates	Overflow to a natural drainage. Storage Capacity 34,000 cubic feet

Exhibit 3.6-1 identifies the locations of the detention facilities.


1
5
7
10
6
9
8
3
4
2
13
11
14
12
97A
2
Columbia River
Wenatchee River
Stormwater Facilities
No. Location
1 Mountain Brook II
2 Crestview Estates I
3 Viewmont Estates
4 Crestview Estates II
5 Mountain Brook I
6 Meadow Brook
7 Sunnyslope Meadows
8 Sunridge
9 Warm Springs
10 Mountain Brook III
11 WSDOT
12 Penny Road
13 Cascade Crest
14 Sun Valley Estates
Exhibit 3.6-1
Chelan County
Stormwater Facilities
State Route
State Highway
City Limits
Study Area
Storage Basins
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
1 inch = 1,596 feet
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HDR
HDR Engineering, Inc.

3.7 Pretreatment Facilities

Pretreatment facilities are stormwater water quality facilities that are designed to provide treatment through the use of mechanical or natural treatment systems prior to the discharge of stormwater. Mechanical systems consist of hydrodynamic or cartridge systems which are located in an underground structures. These systems rely upon physical devices to remove sediments and other contaminants from stormwater. Natural systems, such as swales, rely upon grasses or other landscaping elements, to slow water allowing suspended solids to fall out effectively reduce pollutant loadings. These facilities are usually installed during transportation improvement projects along major arterials that have high traffic volumes. Chelan County has not completed any major improvements within the Study area that would have warranted installation of these facilities in the last 10-years. With new stormwater regulations, these systems may be required during transportation improvement projects along major arterials in the future.

3.8 Overflows

All drainage facilities are designed around a specific storm event that has been accepted by the local agency as the design event. Chelan County's development regulations require that all facilities be designed to maintain 25-year peak runoff rates. If a storm event were to exceed the facilities capacity, excess water needs to be routed out of the facility in a controlled manner to reduce the potential for damage to that existing facility. These overflows systems are traditionally designed as a low depression along the top of the pond that is reinforced with erosion control mats supplemented with quarry spalls. The combinations of these elements minimize the potential for erosion during events that exceed the capacity of the facility.

Overflow systems can also be constructed with a physical inlet device (Manhole with grated inlet) that is installed such that water can flow into the structure at an elevation that is usually 12-inches below the top of the pond. Flows entering this structure are then routed to the natural overflow channel.

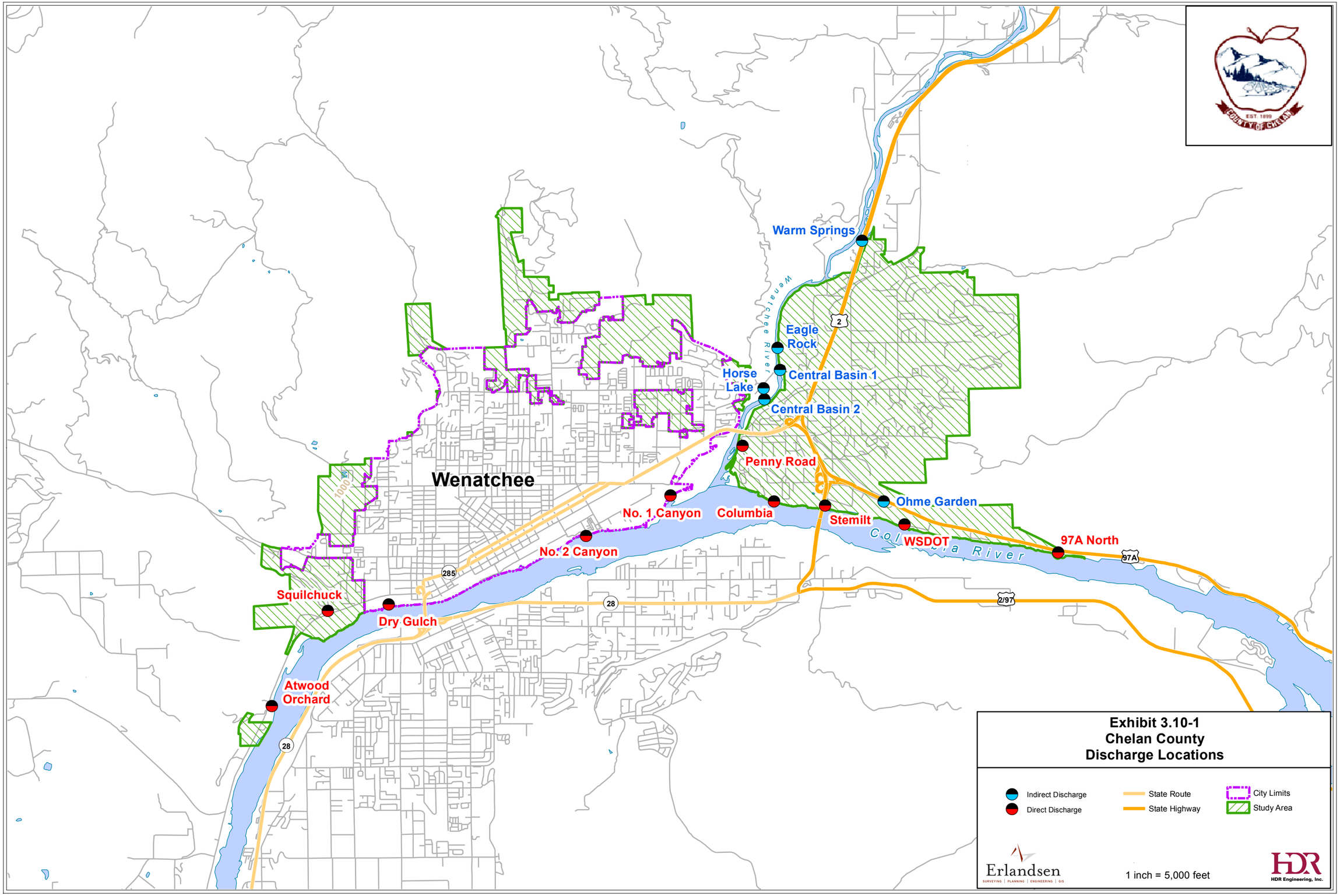
3.9 Combined Irrigation Overflows

Within Chelan County there are numerous irrigation systems of which some are pressurized and others are unpressurized. Excess water from these systems, if not used for irrigation, discharges directly back to surface waters. There are few areas within the Sunnyslope area in which irrigation water overflows are directed into existing drainage channels where natural runoff is routed either to the Wenatchee or Columbia Rivers.

3.10 Outfalls

Within the Study area there are ten direct drainage outfalls that discharge into the Columbia River, Squilchuck Creek, or the Wenatchee River (Exhibit 3.10-1). In addition to the direct discharges, there are also six indirect discharge locations. Direct discharges are defined as those conveyance systems where water flows directly from the end of the pipe into the river or creek. Indirect discharges are defined as those systems whose water is discharged into an infiltration system or natural drainage prior to reaching the river or creek. Table 3.10-1 outlines these discharge locations.

Table 3.10-1 Outfalls			
Discharge	**Location**	**Diameter**	**Comment**
Atwood	North of Malaga Highway and west of Lower Hedges Road	Direct 36" HDPE	Discharges into Columbia River
Squilchuck	Near Appleyard	Direct 48"	Submerged discharge into Squilchuck Creek
Dry Gulch	East of Wenatchee Ave and 400 feet south of Crawford Avenue	Direct 48"	Submerged outlet into Columbia River
No. 1 Canyon	Edge of orchard north of Hawley Street	Direct 36" CMP	Submerged outfall into Columbia River
No. 2 Canyon	300' southeast of the east end of Island View Drive	Direct 48" CMP	Discharge onto concrete/rubble prior to flowing into Columbia River
Horselake	Horselake Road 0.3 miles northwest of Quail Hollow Road	Indirect Ditch	Outfall is into an existing orchard.
Penny Road	South of Penny Road detention pond	Direct 72" Concrete	Discharges into armored flow spreader
Stemilt	100' north of Highway 97	Direct 27" CMP	Discharges into Columbia River
Columbia	East of Euclid Ave and Euclid Court	Direct 24" PVC	Discharges into Columbia River
Ohme Garden	Goodfellow Brothers Gravel Pit	Indirect 18" CMP	Infiltration Facility
97A North	2.4 miles north of Ohme Garden Road	Direct 36" CMP	Discharges into Columbia River
Eagle Rock	Off of Lower Sunnyslope Road	Indirect	Discharges to Wenatchee River
Central Basin 1	Off of Lower Sunnyslope Road	Indirect	Discharges to Wenatchee River
Central Basin 2	Off of Lower Sunnyslope Road	Indirect	Discharges to Wenatchee River
Warm Springs	Located 0.55 miles west of Lower Sunnyslope Road	Indirect 60" Concrete	Pipe discharges into vegetated channel leading to Wenatchee River
WSDOT	Located north of Stemilt	Direct 36" Concrete	Discharges into Columbia River


Warm Springs
Eagle Rock
Horse Lake
Central Basin 1
Central Basin 2
Penny Road
Wenatchee
No. 1 Canyon
Columbia
Stemilt
Ohme Garden
WSDOT
97A North
No. 2 Canyon
Squilchuck
Dry Gulch
Atwood Orchard
Wenatchee River
Columbia River
2
285
28
97A
2/97
Exhibit 3.10-1
Chelan County
Discharge Locations
Indirect Discharge
Direct Discharge
State Route
State Highway
City Limits
Study Area
Erlandsen
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1 inch = 5,000 feet
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4 HYDRAULIC MODELING

Hydraulic modeling for the Study area was completed for the Sunnyslope, Squilchuck and Atwood Orchard basins as part of this study. Runoff originating in No. 1 Canyon, No. 2 Canyon and Dry Gulch is further discussed in Chapter 5 as several modeling efforts have been completed on the Canyons. The extensive inventory work required to accurately model the Canyons is outside the scope of work for this project. Improvements required within the Study area are further summarized in Chapter 7.

4.1 Provided Data

Data developed for this study included: drainage area delineations, data for current and future land use projections derived through zoning information, soils data, 40-ft contours, color aerial imagery, and a digital elevation model DEM file. The data was entered into GIS with attributes needed for modeling purposes.

4.2 Selected Modeling

Hydrologic and hydraulic modeling was completed using the XP-Software XP-SWMM™ program. This program was selected because it is a comprehensive software package for dynamic modeling of stormwater, sanitary, and river systems. XP-SWMM™ simulates natural rainfall-runoff processes and the performance of engineered systems that manage our water resources. It also simulates flow and pollutant transport in engineered and natural systems including ponds, rivers, lakes, floodplains and the interaction with groundwater. The model solves for the full dynamic equations, which provide results far more accurate and closer to real life than a steady state model. Dynamic models allow the effects of storage and backwater in conduits and floodplains and the timing of the hydrographs to yield a true representation of the water surface elevation, also known as a HGL, at any point in space and time. XP-SWMM™ is a node link model.

Nodes are used to represent collection points for runoff from catchments, storage, manholes, and discharge points. Links are the connection between nodes and model flow between the nodes. Links are used for overland flow via stream channels. Links are also used to model control devices like weirs, orifice and pumps. The XP-SWMM™ model support numerous hydrological routing methods including, but not limited to, the SCS hydrological routing method.

4.3 Storm Events

Storm events that were modeled were for the 2, 10, 25, and 100 year recurrence intervals within the Study area. For each of these storm events, modeled scenarios were evaluated for the current land use conditions, 20 year, and full build-out conditions of the basins in accordance with county planning documents. For existing land use conditions within the County, current zoning information was utilized. Evaluating the 20 year and full build-out conditions, future zoning information was utilized. The SCS Type IA storm was used for rainfall distribution. A listing of the rainfall depths that were used in the model is listed in Table 3.3-1. These values were taken from the City of Wenatchee Comprehensive Stormwater Plan Update. (HDR 2009) in order to maintain continuity for the area and the data represents the best available data at the time of this Study.

Table 3.3-1 24-Hour Rainfall Depths	
	(inches)
2 years	1.10
10 years	1.80
25 years	2.04
100 years	2.60

Source: *City of Wenatchee Comprehensive Stormwater Plan Update (HDR 2009)*

4.4 Modeling Methodologies

Direction for the model methodologies were provided in the 2004 SWMMEW. The SWMMEW provides for three methods of hydraulic modeling. They are the rational, SBUH, and SCS methods. The SCS method was selected for this modeling effort.

SCS uses a unit-hydrograph procedure to delay the instantaneous runoff in the calculations. The SBUH procedure delays the runoff component by use of a routing procedure through an imaginary reservoir. The SBUH procedure is simpler to perform while the SCS procedure requires software and takes longer to calculate. The SBUH was developed partly to provide a faster and easier alternative to the SCS method. Runoff volumes are relatively similar between the methods.

The SCS method requires several modeling parameters. These parameters are sub-basin drainage area, the SCS CN and time of concentration. The sub-basin drainage area was defined in the GIS.

4.4.1 Curve Numbers

The CN is a number that represents the amount of rainfall that will contribute to direct runoff. The CN incorporates cover type, land treatment, soils information, and how wet the soil is at the beginning of the rainfall event. Data for the CN was generated by using the zoning information that was provided for current and future conditions and the LUD for the Study area.

Each of the zoning category LUD's were assigned a SCS Curve number land use cover type (see Table 3.4-1). These land use codes are described out of the NRCS Technical Release 55 "Urban Hydrology for Small Watersheds", June 1986. The land use cover types contain values for various hydrologic units which are based on soil conditions. The provided soils data contained the hydrologic unit value which was an A, B, C or D. The hydrologic unit values are representative of the permeability rates of the soil with A soils being highly permeable and D soils having the lowest permeability rate. Soil types are further addressed in Section 2.4.

In order to get the respective hydrologic unit assigned to its county land use, GIS was used to intersect the soils data with the land use cover types. The respective CN's were assigned to the land use codes. Next, the land use codes with their respective CN values were assigned to their respective sub-basin. This was accomplished by taking the land use codes and intersecting them with the sub-basins so a weighted CN could be calculated for each sub-basin.

Table 3.4-1 Land Use Codes and TR-55 Land Cover Types						
Study Area Land Use		**NRCS TR-55 Land Cover Type**				
Land Use Codes		**Land Cover Type**				
LUD	**Description**	**Description**	**CN A**	**CN B**	**CN C**	**CN D**
CBD	Central Business District	Impervious Areas - Other: Paved parking lots, roofs, driveways, etc.:	98	98	98	98
CN	Neighborhood Commercial	Urban districts: Commercial and business	89	92	94	95
CNO	Neighborhood Commercial Overlay	Urban districts: Industrial	81	88	91	93
I	Industrial District	Urban districts: Industrial	81	88	91	93
NWB	North Wenatchee Business District	Impervious Areas - Streets and roads: Paved; curbs and storm sewers (excluding right-of-way)	98	98	98	98
OMU	Office Mixed Use	Urban districts: Commercial and business	89	92	94	95
OPEN	OPEN	Open space: lawns, parks, golf courses, cemeteries, etc.: Fair (grass cover 50% to 75%)	49	69	79	84
RH	Residential High	Residential districts by average lot size: 1/8 acre or less - town houses	77	85	90	92
RL	Residential Low	Residential districts by average lot size: 1/3 acre	57	72	81	86
RM	Residential Medium	Residential districts by average lot size: 1/4 acre	61	75	83	87
RR10	Rural Residential 10 Acre	Open space: lawns, parks, golf courses, cemeteries, etc.: Fair (grass cover 50% to 75%)	49	69	79	84
RR2.5	Rural Residential 2.5 Acre	Residential districts by average lot size: 2 acres	46	65	77	82
RR5	Rural Residential 5 Acre	Open space: lawns, parks, golf courses, cemeteries, etc.: Fair (grass cover 50% to 75%)	49	69	79	84
RR20	Rural Residential 20 Acre	Open space: lawns, parks, golf courses, cemeteries, etc.: Fair (grass cover 50% to 75%)	49	69	79	84
RRO	Recreational/Residential Overlay	Open space: lawns, parks, golf courses, cemeteries, etc.: Poor (grass cover < 50%)	68	79	86	89
RS	Residential Single-Family	Residential districts by average lot size: 1/4 acre	61	75	83	87
RV	Rural Village	Residential districts by average lot size: 1 acre	51	68	79	84
SWB	South Wenatchee Business District	Urban districts: Commercial and business	89	92	94	95
WMU	Waterfront Mixed Use	Impervious Areas - Other: Paved parking lots, roofs, driveways, etc.:	98	98	98	98
ORCHARD	Orchard	Woods -- grass combination : orchard or tree farm: Poor	57	73	82	86
PO	Pedestrian Overlay	Residential districts by average lot size: 1/8 acre or less - town houses	77	85	90	92
Grasslands	Grasslands	Pasture, grassland, or range-continuous forage or grazing: : Fair	49	69	79	84

Note: *Land use codes included within the Table represent those codes developed between the City of Wenatchee and Chelan County which are found within the Study area.*

4.4.2 Time of Concentration

Tc is the time for runoff to travel from the hydraulically most distant point of the sub-basin to a point of outflow from the sub-basin (ASCE 1992). Tc was calculated using the TR-55 varied flow rate method. The varied flow rate method includes three types of overland flow. The first is sheet flow, which generally takes place at the beginning as water flows over the surface. Next, sheet flow runoff begins to collect and becomes a shallow concentrated flow. Finally, shallow concentrated flows come together and form an open channel flow. Travel times for each of

these types of overland flows were calculated and added together to get the total Tc for each sub-basin. GIS data was utilized to determine these values.

4.4.3 **Input Parameters**

Input parameters for the hydrological model include the sub-basin name (which is the same as the facility ID), CN, and Tc. The existing condition input values for Squilchuck, Atwood Orchard, and Sunnyslope are found in Appendix C, Tables 1, 2 and 3, respectively. Hydraulic modeling of No. 1 and No.2 Canyons and Dry Gulch are further discussed in Chapter 5.

Input parameters for future conditions can be found in Appendix C Tables 4, 5 and 6, respectively.

4.5 Model Results

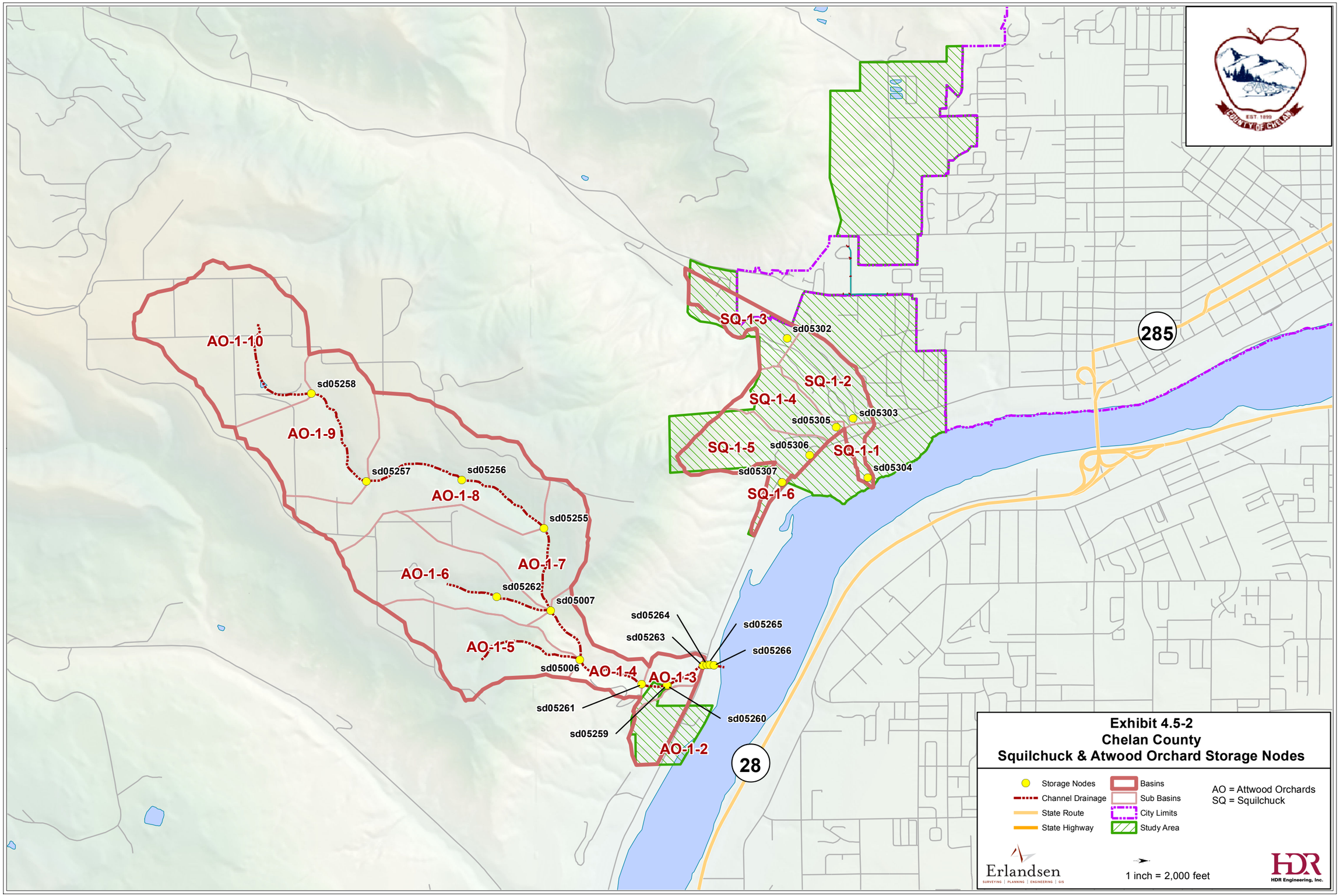
Results of the hydrological model analysis are provided in Appendix D (current land use) and E (future land use). The Appendices display information for the three Study areas for each of the storm events. The information that is provided is for the total amount of runoff for each of the sub-basins. Below is a description of the information in the tables:

- Name – Name of the point in the model that the sub-basin drains to.
- Basin - The number of the sub-basin that drains to the collection point in the model. These numbers range from 1 to 5 and indicate the number of sub-basin that drains to a collection point.
- Area – Sub-basin drainage area, in acres (ac).
- Catchment Total Surface Runoff – The total calculated runoff volume from the rainfall event, in cubic feet (ft^3).

4.5.1 Storage Node Information

Information about the modeling results for the storage nodes for existing conditions is detailed in Appendix F, while Appendix G presents information for the future conditions. These tables in present information about the facility number, the capacity of that facility for the 2, 10, 25 and 100 year storm events, and the depth of the storage facility to the overflow. Exhibit 4.5-1 includes node labels for the Sunnyslope Basin and Exhibit 4.5-2 includes node labels for the Squilchuck Basin and the Atwood Orchard Basin.

Exhibit 4.5-1 is attached at the back of the document as a fold out Exhibit.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SQ-1-6
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Exhibit 4.5-2
Chelan County
Squilchuck & Atwood Orchard Storage Nodes
Storage Nodes
Channel Drainage
State Route
State Highway
Basins
Sub Basins
City Limits
Study Area
AO = Attwood Orchards
SQ = Squilchuck
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
1 inch = 2,000 feet
HDR
HDR Engineering, Inc.

4.6 Flooding Conditions

Using the information gathered from the system inventory, a hydraulic network was developed and entered into the model. This included the culverts, structures, storage sites, storm system, and discharge points. The XP-SWMM™ hydraulic model incorporates both storage and backwater components. Stream flows are solved using the full dynamic wave equations. Inflow hydrographs which were generated by the hydrology model were used as the input for this hydraulic analysis. Results of the hydraulic model analysis are provided in Appendix F for current conditions and Appendix G for future conditions. The results of this modeling effort are used to identify deficiencies in capacity collection and conveyance.

Exhibit 4.6-1 shows the location of the flooded nodes for existing conditions and Exhibit 4.6-2 shows flooded nodes for future conditions.

4.6.1 Squilchuck Basin

There was no hydraulic analysis completed for Squilchuck basin because only the lower reaches of the basin were studied to obtain runoff values for those basins and there are no defined drainage channels for the lower reaches due to the close proximity of the basins to Squilchuck Creek.

4.6.2 Atwood Orchard Basin

There are no problem areas identified in the Atwood Orchard basin. There are only two culverts identified and both appear to have adequate capacity to carry the 100 year storm.

4.6.3 Sunnyslope Drainage Basin

Appendix F presents the results of the channel or pipe segments that experienced flooding for existing conditions. The results of flooding for future conditions are presented in Appendix G. The information provided includes the design flow capacity and the maximum flow in the pipe or the channel. The node that had the flooding is listed with the volume of flooding. The problem is identified for each area. The problems were identified to be either due to insufficient capacity or inadequate conveyance.

There were no problems identified for the two year storm. For the 10 year to 100 year storms, there are about 11 to 16 sites with flooding.

Following is a brief description of the flooding problem:

- sd00444 –appears to be a deficiency in the size of the 12-inch culvert going under American Fruit Road just west of Knowles Road.
- sd00176 –appears to be a deficiency in the size of the 12-inch storm pipe at the intersection of Alt 97 and Highway 2.
- sd00178 –appears to be a deficiency in the size of the 12-inch storm pipe at the intersection of Alt 97 and Highway 2.
- sd00340 –appears to be a deficiency in the size of the 18-inch storm pipe along Euclid Avenue and intersection with Penny Road.
- sd00163 –appears to be a deficiency in the size of the 18-inch storm pipe along Burch Mountain Road. The pipe is flooded up to sd00159.

- sd00157 –appears to be a deficiency in the size of the 18-inch storm pipe along Burch Mountain Road.
- sd00342 –appears to be a deficiency in the size of the 18-inch storm pipe along Euclid and intersection with Penny.
- sd00341 –appears to be a deficiency in the size of the 18-inch storm pipe along Euclid Avenue and intersection with Penny Road.
- sd00158 –appears to be a deficiency in the size of the 18-inch storm pipe along Burch Mountain Road.
- sd00159 –appears to be a deficiency in the size of the 18-inch storm pipe along Burch Mountain Road. The pipe is flooded down to sd00163.
- sd00165 –appears to be a deficiency in the size of the 12-inch storm pipe at the intersection of Burch Mountain Road and Peters Street.
- sd00167 –appears to be a deficiency in the size of the 12-inch storm pipe along Peters Street to the east of Burch Mountain Road. In general, there is a deficiency in the pipe size along Burch Mountain and then to the east along Peters Street.
- sd00755 –appears to be a deficiency in the size of the 18-inch culvert that is under Alternate 97A between Ohme Garden Road and Warehouse Road.
- sd00175 –appears to be a deficiency in the size of the 18-inch pipe that is under Ohme Garden Road and just north of the intersection with Peters Street.
- sd00743 –appears to be a deficiency in the size of the 24-inch culvert that is located along Warm Springs Canyon.
- sd00762 –appears to be a deficiency in the size of the pipe that leads into three storage pipes located east of Knowles Road and Rolling Hills Lane and may be due to flooding within the pond area.

5 CANYON DRAINAGES

Chapter 5 information was originally developed and written for the City of Wenatchee 2009 Stormwater Comprehensive Plan Update by HDR Engineering in association with Erlandsen. Chapter 5, associated figures and appendices, were utilized here as information developed in that document is critical to Chelan County and their development of stormwater regulations. Section 5.7 has been added to this Chapter as part of this Study to further define improvements for the County.

5.1 Introduction

This chapter presents an overview of the recent flood hazard studies associated with No. 1 and No. 2 Canyons and Dry Gulch and discusses proposed alternatives and potential next steps for pursuing additional studies, design, and construction through COE funding program opportunities and other opportunities.

5.2 Watershed Description

No. 1 and No. 2 Canyons and Dry Gulch are located immediately west of Wenatchee. These basins are situated along the east slopes of the Cascade Mountain foothills on the western edge of the semi-arid desert. Exhibit 5.2-1 shows the basin areas and the location of No. 1 and No. 2 Canyons and Dry Gulch. No. 1 Canyon (the farthest north) has a basin area of about 6.8 square miles. No. 2 Canyon has a basin area of about 9.5 square miles. Dry Gulch (the farthest south) has a total basin area of about 4.0 square miles; about 2.4 square miles is largely controlled by an old mine tailings dam, while the remaining 1.6 square miles is uncontrolled (Northwest Hydraulics 1996).

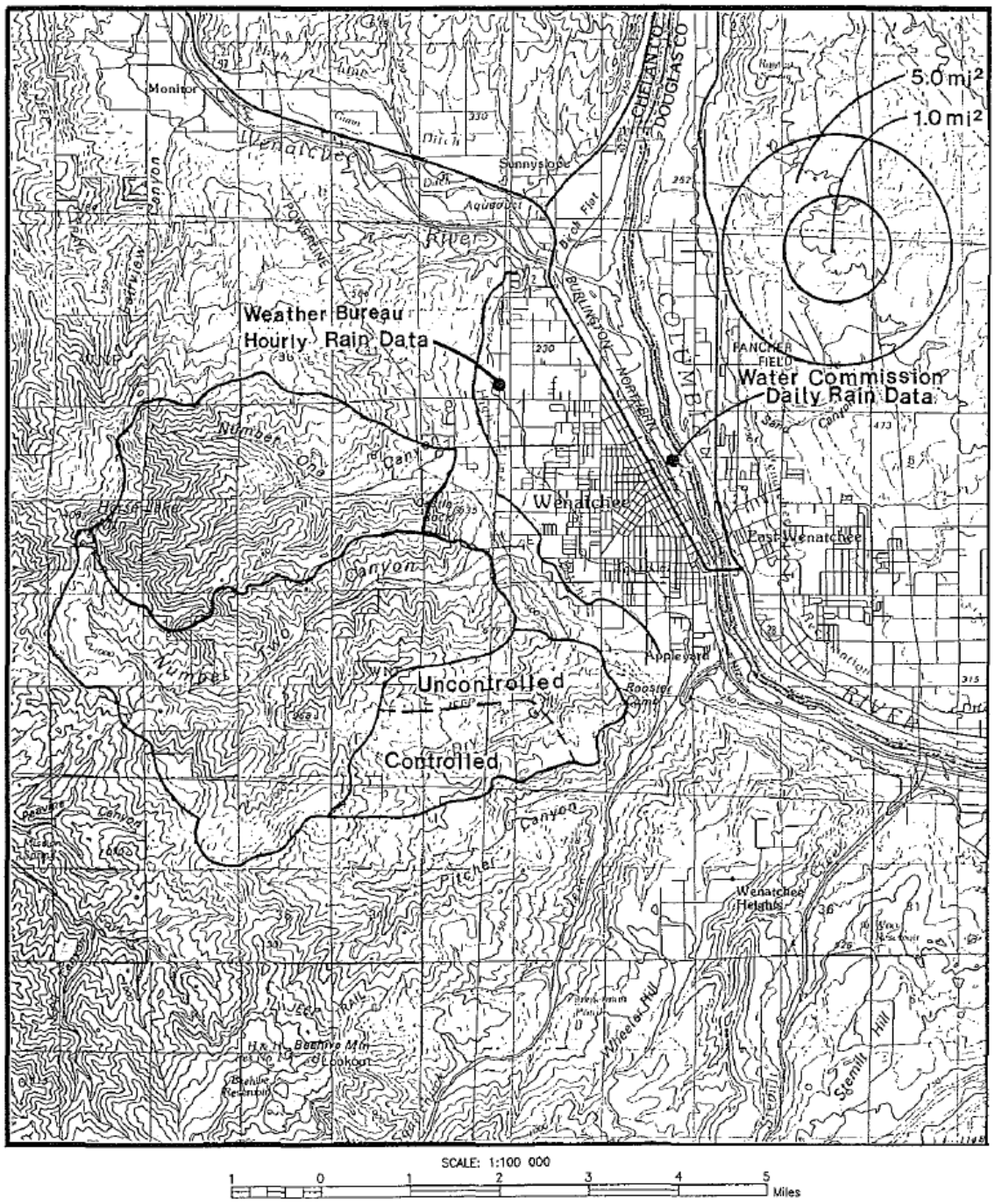
The basins are generally undeveloped outside the city limits, and impacts during storms extend into the city. Sagebrush and native grasses are the dominant native vegetation lower in the basin, with dense stands of Ponderosa pine and Douglas fir in the headwaters. Mean annual precipitation in the lower basin is about 15 inches, while the upper basin falls in the 20- to 25-inch precipitation zone. Based on soil types in the watershed, the runoff potential is relatively low (Type “B” Cashmere and Cashmont Sandy Loams/Gravelly Sandy Loam).

5.3 Past Flood Hazard Studies

Over the last 35 years, several studies have been conducted to evaluate and propose flood hazard mitigation options and to outline future actions. The studies discussed both structural and non-structural BMPs to reduce flood hazards, erosion, and sedimentation and to improve water quality. The following list identifies these studies.

- COE Study (1974)
- Chelan County Public Works Study (1977)
- Munson Engineers Wenatchee Area Flood Hazard Report (1980)
- Northwest Hydraulics Flood Hazard Investigation of Alluvial Fans below Canyon No. 1, Canyon No. 2, and Dry Gulch (1996)
- Hammond Collier Wade Livingstone Stormwater Management Plan for City of Wenatchee (2000)

Exhibit 5.2-1 Watershed Boundaries of Canyons No. 1 and 2 and Dry Gulch (Northwest Hydraulics 1996)



Hydrologic studies of the basin have shown the difficulty with estimating peak discharge rates for the small catchments in the planning area due to limited data and variability between accepted methods. Table 5.3-1, which is adapted from Hammond Collier Wade Livingstone (2000), presents estimated flows in cfs for a range of flood frequencies for the three basins.

Table 5.3-1 Summary of Estimate Peak Discharge Estimates by Basin and Study Source *(cfs)*				
Event	COE	Munson Engineers	Northwest Hydraulics	Hammond Collier
No. 1 Canyon				
2-year	120		20	75
10-year	510		130	205
25-year	860		380	300
50-year	1,220		920	385
100-year	1,680	980	1,150	485
200-year	2,200			
No. 2 Canyon				
2-year	130		25	100
10-year	580		160	270
25-year	1,000		500	395
50-year	1,430		1,030	505
100-year	1,980	900	1,200	635
200-year	2,600			
Dry Gulch				
2-year				
10-year				
25-year				
50-year				
100-year		560		
200-year				

In addition to these studies, the Federal Emergency Management Agency (FEMA) has prepared a Flood Insurance Study (FIS), as well as several updates to the initial study, for the City. The most recent FIS is dated January 6, 1994, and the Flood Insurance Rate Map (FIRM), Panel No. 530020 005C, shows the areas of the 100-year and 500-year floodplains.

The City of Wenatchee is a participating community in the National Flood Insurance Program (NFIP), which means that the community is eligible for flood damage assistance and property owners are able to obtain flood insurance through the NFIP. In order to be participating community in the NFIP, the City of Wenatchee was required by FEMA to adopt a floodplain-management ordinance that conforms to the requirements of 44 CFR Parts 60 to 65. This means

that minimum federal standards must be met for all encroachments into the floodplains shown on the FEMA FIRMs. This also means that the peak discharge values that are used as a basis for those FIRMs must be used as minimum regulatory values for floodplain-management purposes. The community is encouraged to use more restrictive floodplain-management criteria but must meet the minimum federal standards.

A FEMA Letter of Map Revision (LOMR) and accompanying revised floodplain delineation to the city dated May 13, 1996, revises the mapped floodplain and provides some updated peak discharges for No. 1 and No. 2 Canyons and Dry Gulch (see Exhibits 5.3-1 and 5.3-2). The significance of this LOMR is that the area delineated as being within the 100-year floodplain was reduced significantly. Those areas upgradient of the "Revised Lower Limit" boundary are classified as Zone AO, with those areas downstream of this boundary being classified as Zone X according to FEMA.

The FEMA FIS identifies flood zones for these three drainages based on the assumption that these floodplains are active alluvial fans. Alluvial fans are, by their nature, unstable and unpredictable floodplain features. Alluvial fans differ from riverine floodplains in that alluvial fans have a radial pattern with channels that are too small to convey the entire flow from an extreme flood. Flows exiting the mountain front are also heavily laden with sediment and debris. The deposition of debris, combined with the topographic shape (radial pattern), results in flows bifurcating into multiple flow paths and forming new channels on the alluvial fan surface below the mountain front that will vary with each event.

The methods used by FEMA to map the hazards associated with alluvial fans are based on the uncertainties associated with the paths that these flows can take, the potential for sediment and debris to be deposited in the upper region of the fan, and the potential for erosion or formation of new channels within the floodplain. Therefore, the fan shape of the floodplain on the FEMA FIRM is not the area that is expected to be flooded by a single event. But, since the flow could take an unpredictable direction with each event, the outer extents of the potential area that could be affected by unpredictable flow paths is shown with the potential depth and velocity associated with channel-forming flows in that region of the fan surface.

For comparison purposes, Table 5.3-2 summarizes the discharges (in cfs) for a range of flood frequencies that are shown in FEMA's 1994 FIS and shows the updated numbers summarized in the 1996 LOMR (in parentheses). These are the minimum values that must be used for floodplain-management purposes in order for FEMA to recognize any improvements that modify the floodplain or for encroachments to be regulated in the floodplain.

Table 5.3-2 Summary of Discharges *(cfs)*				
Flooding Source	**10-year**	**50-year**	**100-year**	**500-year**
No. 1 Canyon	500 (254)	1,200(942)	1,650 (1,490)	3,100 (3,810)
No. 2 Canyon	600 (300)	1,450 (1,100)	1,950 (1,700)	3,700 (4,300)
Dry Gulch	140 (73)	300 (270)	410 (428)	760 (1,090)

Note: This table summarizes the discharges for a range of flood frequencies that are shown in FEMA's 1994 Flood Insurance Study and shows the updated numbers summarized in the 1996 FEMA Letter of Map Revision (in parentheses).

Exhibit 5.3-1 Revised Flood Hazard Zone for No. 1 and No. 2 Canyons (Northwest Hydraulics 1996)

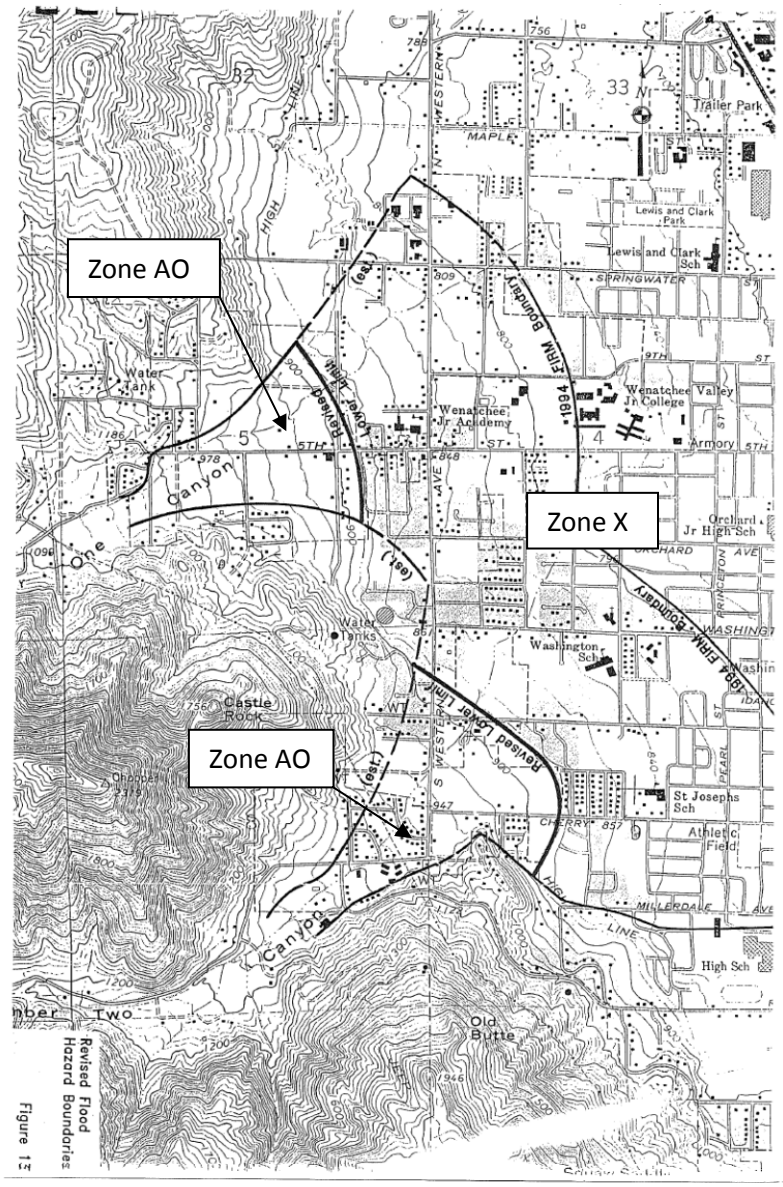
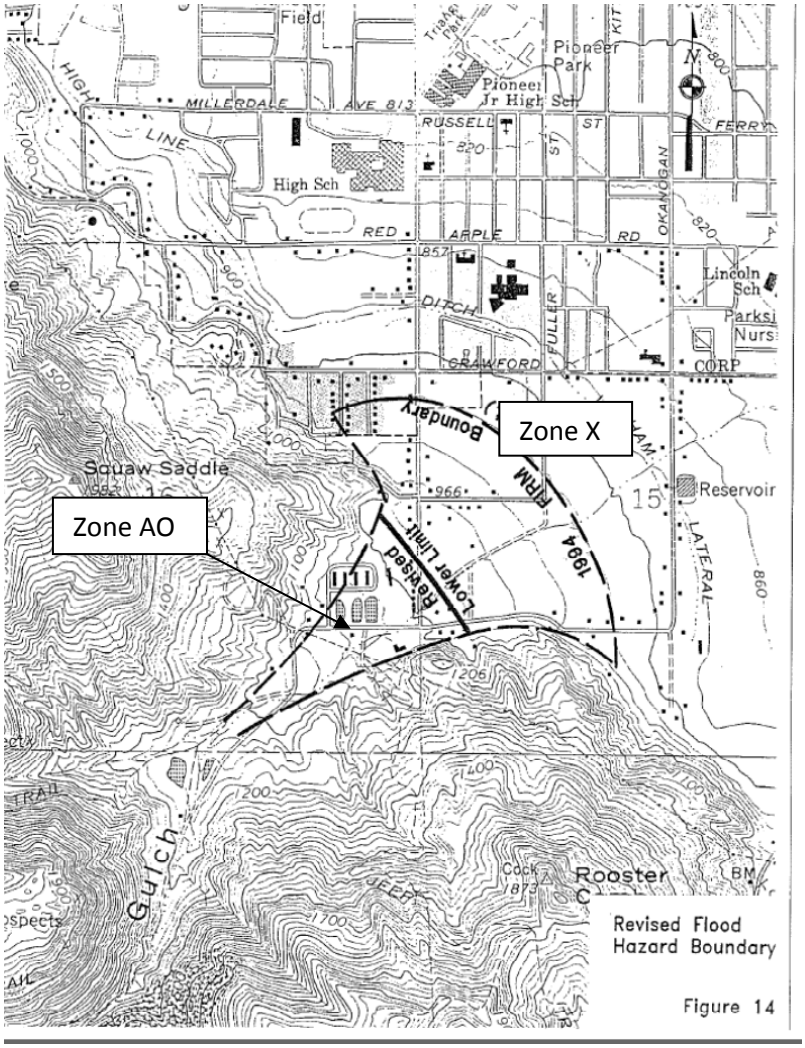


Exhibit 5.3-2 Revised Flood Hazard Zone for Dry Gulch (Northwest Hydraulics 1996)



Based on a review of the reports, No. 1 and No. 2 Canyons and Dry Gulch present significant risks to public property and safety due to flash flooding, mud flows, debris flows, and debris torrents. The reasons for these risks include:

- High hill slope gradient (greater than 40 percent) and friable slopes
- High rainfall intensity (greater than 1.25 inches/hour)
- Lack of vegetation (low interception rates)
- Land-use practices (historically not cultivated)
- Bare soils and shallow soils (there is evidence of rill erosion)
- Active erosion of tributaries (V-shaped profiles)

Estimates and conclusions related to mud flows, debris torrents, and sediment transport have been documented by Northwest Hydraulics (1996) for all three drainages. These conclusions are summarized below.

No. 1 Canyon

- Significant potential for future mud flows
- Sediment yield estimate (event-based) of 12 acre-feet/year
- Route and movement of alluvial fan is unknown
- Historic mud flows estimated 200 to 400 feet wide

No. 2 Canyon

- Mud flows in No. 2 Canyon of 3 to 5 feet high and about 1 foot at the canyon mouth
- Historic mud flows estimated greater than 400 feet wide
- Sediment yield estimate (event-based) of 20 acre-feet/year with a maximum of 40 acre-feet/year
- Significant potential for future mud flows
- Route and movement of alluvial fan is unknown

Dry Gulch

- Based on previous studies, Dry Gulch is not expected to produce a high sediment load due to a "partially functioning" dam upstream.[1]

5.4 Existing No. 1 and No. 2 Canyons and Dry Gulch Conveyance System

The City has established flow requirements (WCC 11.24.080, provided in Appendix H) for the two canyons and Dry Gulch as shown in Table 5.4-1.

Table 5.4-1
Flow Conveyance Requirements

No. 1 Canyon	Mouth to Columbia River	100 cfs
No. 2 Canyon	Mouth to Columbia River	100 cfs
Dry Gulch	Below Undammed Portion to Columbia River	150 cfs

The capacity of the existing No. 1 and No. 2 Canyons and Dry Gulch drainage systems varies throughout the city. Previous city policies have maintained separate drainage systems for urban and canyon flows, although some combined drainage systems do exist. The Canyons/Dry Gulch drainage systems within the city limits consist of a combination of open ditches and closed pipe systems.

The actual flow-conveyance capacity for each drainage is less along many parts of the conveyance system than the stated requirement for each drainage. The open ditch systems have not been regulated on private property, and problems occur annually in these ditches due to

[1] "Partially functioning" should be better understood. HDR suggests evaluating this dam for structural stability, effectiveness, and ability to resist overtopping. If this dam fails, it could cause greater peak flows and could release stored sediment during a flood. Based on this review, we recommend that the City include identified modifications in project development actions, as necessary. The City should also provide enough detention to detain peak flows to an amount that the downstream system can convey.

lack of maintenance. Where development has occurred along the drainage areas, individual developers have installed closed pipe systems per the City conveyance requirements.

No. 1 and No. 2 Canyons discharge flows into the urban system in a restricted drainage system along the western edge of the city, where rural low-density development transitions into higher-density urban development. Since the restricted drainage system in the urban area has not been maintained, there is a high probability that flows from a storm would leave the channel and flood the surrounding area until they are either dispersed into existing developments or ultimately enter the Wenatchee Reclamation District's High Line Canal (see Exhibit 5.3-1).

The Dry Gulch drainage system is located at the south end of Wenatchee in a less developed area. The City has been proactive in maintaining capacity along the drainage channel that conveys Dry Gulch flows to the Columbia River. This drainage system also consists of both open and closed conveyance systems. In the transitional area between the rural drainage and the urban conveyance system, local flooding might also occur due to a lack of inlet capacity as flows enter into the closed pipe system.

5.5 Flood Hazard Best Management Practices

Flood hazards can be mitigated using both structural and nonstructural best management practices (BMPs). Structural BMPs are facilities designed and constructed to mitigate the adverse impacts of the flood hazard. Typical structural BMPs include check dams, stilling basins, sabo structures, levees, and training channels, while nonstructural BMPs include warning systems, proper land use, education and public participation programs, and regulatory controls. Sabo structures are concrete or wire structures designed to capture large volumes of debris while letting flows pass. Training channels are systems designed to convert an actively migrating stream into a laterally stable channel in which channel erosion is reduced.


Sabo Check Dams (Concrete or Wire Structures)

When selecting an appropriate method for managing flood risk, the City must also consider regulatory requirements. If one of the objectives is to implement measures that will eliminate the Zone AO designation on the FEMA FIRMs, there are limited options that will accomplish this goal. Section 5.3 describes how FEMA views hazards associated with alluvial fans as a result of the sediment- and debris-laden flows and unique geographic characteristics of an active alluvial fan. In order for FEMA to recognize the flood-control measure as being adequate for revising the FIRMs, the measures must include a method for controlling the sediment and debris that is exiting the canyons, reduce the flow rates through storage to a flow rate that the downstream facilities can convey, and provide enough downstream erosion protection to the toe of the alluvial fan and through the city.

5.5.1 Structural Flood Hazard BMPs

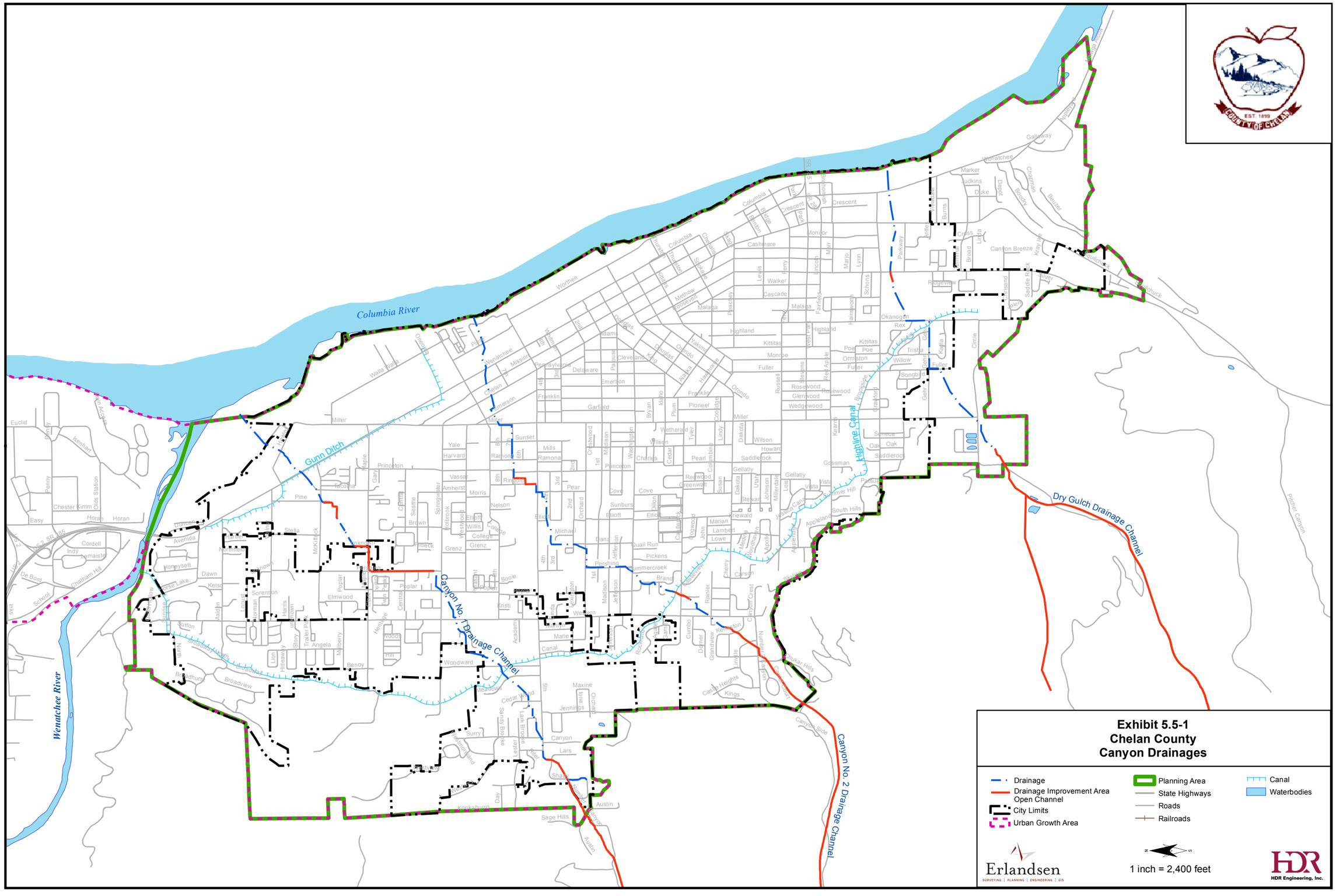
1. COE Study (1974). This study recommends the use of debris-control dams in No. 1 and No. 2 Canyons and large concrete conveyance structures to route the flows from the dams to the Columbia River. Total project construction costs were estimated at about $73 million (January 2009 updated cost). This concept is consistent with what FEMA would require for eliminating the alluvial fan flood zone. However, erosion protection of the channels from the outlet of the debris-control dam to the toe of the alluvial fan will also be required. The City would either need to demonstrate there is no erosion potential or provide erosion protection as necessary. Flows would also need to be metered out of the control structure and/or a hardened conveyance channel downstream to the point where flows enter the conveyance system in the city.
2. Chelan County Public Works (1977). This study proposed large, flat, grassy areas between 10 to 20 acres in area and 5 to 6 feet deep at the mouths of No. 1 and No. 2 Canyons. These areas could also be used for recreation. The study did not include cost estimates. While this concept, combined with structural measures needed to direct flow to these areas, might be effective at capturing the majority of the sediment reaching that point in the system, it would not remove the Zone AO designation on the FEMA FIRM, since flows could be directed by debris accumulation to a path that could bypass these facilities.
3. Munson Engineers Wenatchee Area Flood Hazard Report (1980). Munson Engineers proposed to construct debris dams in No. 1 and No. 2 Canyons and Dry Gulch and stilling basins in the developed areas. The estimated cost for these structures was about $8 million (January 2009 updated cost) but did not include real estate. HDR assumes that these facilities are smaller than those proposed by the COE because they were intended to capture only sediment and debris and would not have enough volume to decrease peak flows. Without enough volume to decrease peak flows and erosion-protection measures in the downstream channel, the floodplain as shown on the FEMA FIRM might be further reduced but would not be eliminated without adequate conveyance improvements. The necessary erosion-protection and conveyance improvements are not included in the Munson cost estimate. The cost of conveyance improvements through the urban area would be high due to the size of facilities needed, utility relocations, reconstruction of disturbed infrastructure, and right-of-way acquisition needs.
4. Hammond Collier, Wade, Livingstone Stormwater Management Plan (2000). Based on designs from the COE study and the Munson report and using new information from the COE Zintel Canyon Dam Project, this plan proposed the following:

    - Seven separate structures over the three basins, each with an estimated 100 acre-feet of storage. The proposed structures could include either complete retention of flows or could be used as detention facilities, which then could be connected to the city's drain system. This concept is similar to the concept that was proposed by the COE. This concept, together with erosion-control measures for the downstream channel, would be necessary to eliminate the Zone AO designation shown on the FEMA FIRM.
    - Estimates to construct the detention system were about $13 to $18 million plus an additional $6 million to upgrade the existing drain system (January 2009 updated cost). See Exhibit 5.5-1 for drainage system improvement areas.

- The city's current stormwater system isn't designed to handle flows above the 100- to 150-cfs threshold for Dry Gulch and the Canyons. The actual capacity is estimated to be even less than this. Estimated bulked (with sediment) maximum flows of 3,000 cfs would constitute a 20-fold increase in existing city stormwater flow capacity. Constructing conveyance facilities of this size in an already heavily urbanized area would be costly.

5.5.2 Non-structural Flood Hazard BMPs

1. Hazard Mapping – Identify areas of danger. This BMP is addressed through the FEMA FIS and the associated floodplain mapping on the FIRM, since that is the purpose of the FIS and the associated delineation of the floodplain. No. 1 and No. 2 Canyons and Dry Gulch are each shown on the FIRM and updated LOMR, and portions of the city are identified as Special Flood Hazard Areas (SFHA) as a result of flooding from these sources. These SFHA are identified on the FIRM and are updated on the 1996 LOMR as areas that are potentially subject to inundation by a 100-year flood.


Columbia River
Wenatchee River
Gunn Ditch
Canyon No. 1 Drainage Channel
Canyon No. 2 Drainage Channel
Highline Canal
Dry Gulch Drainage Channel
Exhibit 5.5-1
Chelan County
Canyon Drainages
Drainage
Drainage Improvement Area
Open Channel
City Limits
Urban Growth Area
Planning Area
State Highways
Roads
Railroads
Canal
Waterbodies
1 inch = 2,400 feet
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
HDR Engineering, Inc.

2. Land Use – Restrict or limit development in identified hazard areas. This BMP is addressed through the City's existing ordinances. Chapter 2.05, Flood Hazard Prevention, was adopted by the City as a requirement for participation in FEMA's NFIP. Through the provisions in this ordinance, the City regulates all development within the SFHA to reduce the potential for flood damages. In addition, the City has adopted Ordinance No. 2009-11, which deals with Resource Lands and Critical Area development, based on the Washington State Growth Management Act. This ordinance identifies Frequently Flooded Areas, which are defined as areas subject to a 1 percent or greater chance of flooding in any given year, and references the City's Flood Hazard Prevention ordinance for regulating all development in Frequently Flooded Areas. The City's existing Flood Hazard Prevention ordinance contains only the minimum provisions required by FEMA. If the City chooses to, it could develop and implement more-restrictive provisions, which would provide an additional degree of protection for future construction in the SFHA or areas outside the SFHA that might also be subject to potential damages from flooding and debris flows from No. 1 and No. 2 Canyons and Dry Gulch.
3. Insurance – Help those already in hazard areas. This BMP is also addressed through the City's participation in the NFIP by making federal flood insurance available for all residents (land owners as well as renters) with developed property in the city. In locations identified as being within an SFHA, lending institutions typically require the purchase of flood insurance before constructing a building and as a condition for obtaining any federally insured loan in an SFHA. In instances where the purchase of flood insurance is not mandated, anyone can purchase flood insurance for a building and its contents, whether or not the building is located within the identified SFHA. At the present time, there are 330 flood-insurance policies in place within the city. As noted in Section 5.3, the Zone X designation in Wenatchee is intended to represent areas subject to flooding during a 100-year storm with shallow depths. Although flood insurance is not mandatory in these areas, it would be prudent for property owners in the Zone X to also obtain flood insurance to insure against the risk to which they are exposed. Insurance costs for properties in Zone X are significantly less than in Zone AO (SFHA).

5.6 City Discussion and Recommendations

5.6.1 Debris and Flow Control Improvement Options

Runoff from the Canyons poses a significant risk to public property and safety. A number of studies have been conducted over the years. These studies have generally concluded that existing drainage facilities are not able to handle such storms and that some form of debris and flow control is recommended. The COE recommended the construction of debris-control dams and conveyance structures extending into the urban area. The County proposed debris control by providing open areas that could be used to store floodwater and debris during a large storm and used for recreational use the rest of the time. Munson Engineers suggested the use of channel storage within the canyons, debris dams, and stilling basins within the developed areas. Hammond Collier, Wade, Livingstone proposed a mitigation program that adapted elements from the COE and Munson Engineers and was similar in function to the COE Zintel Canyon Dam Project, which provides flood protection to the City of Kennewick.

Constructing such projects requires a significant investment. Based on our review of existing conditions and previous studies, HDR has identified two structural alternatives: (1) a debris basin

that controls only sediment and debris in the canyon above the apex of the alluvial fans with conveyance improvements designed to resist erosion through the alluvial fan and downstream urban area, or (2) detention basins in the canyon above the apex of the alluvial fans with sediment-capture features and enough storage volume and controls to reduce the peak flows from the basin to a flow rate conveyable by existing downstream facilities. Due to the potential cost of large conveyance facilities in the urbanized area, alternative 2 is likely to be the more cost-effective solution. Both of these alternatives could eliminate the Zone AO designation on the FEMA FIRM if the conveyance improvements extend to the river, provided this is the City's long-term goal.

As the City evaluates detention basin opportunities, it should seek to better understand the "partially functioning" condition of the Dry Gulch dam. HDR suggests evaluating the existing dam for structural stability, effectiveness, and ability to resist overtopping. If this dam fails, it could cause greater peak flows and could release stored sediment during a flood. Based on this review, we recommend that the City include identified modifications in project development actions, as necessary. The City should also provide enough detention to detain peak flows to an amount that the downstream system can convey.

5.6.2 Conveyance System Improvements

Additional incremental improvements can also be made to improve existing conditions based on the City's near- and long-term objectives. Downstream conveyance improvements are needed. These include both improvements to the existing conveyance systems and possibly diverting part of the No. 1 and No. 2 Canyons flow into the city's stormwater system.

It should be noted that flood events from the canyons are not expected to correspond with rain events within the urban area. Consequently, the existing conveyance system would be available to mitigate flooding from the canyons. Also, flooding from the canyons is expecting to result primarily in sediment and debris, which will be addressed by the improvements to the existing stormwater system, which will include sediment removal.

Based on the system analysis (see Chapter 6 of the City of Wenatchee Comprehensive Stormwater Plan), approximate flow rates of 28 cfs for No. 1 Canyon and 26 cfs for No. 2 Canyon could be conveyed through the existing stormwater system in addition to using the existing conveyance channels if they are upgraded to their flow-conveyance targets. These rates are based on the capacity of the urban collection system along the edge of the planning area.

The average capacity of the existing Dry Gulch closed conveyance system is about 80 cfs. Additional system improvements would be necessary to upgrade the conveyance system's capacity to handle these flows. The cost of upgrading the Dry Gulch conveyance system is less than the cost of improving conveyance below the canyons.

Additionally, HDR recommends that the City implement nonstructural BMPs to minimize risks to public property and safety from flood hazards.

5.6.3 Funding Options

The City has at least three options for initiating a study to evaluate structural alternatives and focus on the desired, most cost-effective approach for design and construction.

Option 1

Option 1 is to reinitiate discussions with the COE through one of the programs in its Civil Works Program: the general Civil Works Process and the Continuing Authorities Program (CAP).

The Civil Works Process requires both congressional authorization and appropriation for studies, design, and construction funding. The Civil Works Project process is often summarized by the COE as having 21 steps, as outlined in Appendix I. These steps integrate the congressional authorization and appropriations requirements with the administrative actions required for completion by the COE in cooperation with the nonfederal sponsor.

The CAP provides access to the COE to assist on a wide variety of technical problems associated with shoreline and stream bank erosion, navigation, flood damage reduction, and environmental restoration. This program is limited to $7 million for the federal share. The cost share is 65% federal and 35% non-federal. Appendix I provides a more detailed description of the requirements and steps for these two approaches.

Other COE programs also exist, such as Planning Assistance to States and Flood Plain Management Services. The Planning Assistance to States (Section 22) Program typically funds one project per state or tribe per year and generally cost from $20,000 to $150,000. Studies are cost shared with 50 percent of the costs furnished by a local sponsor and 50 percent by the COE. The Flood Plain Management Services program provides authority for the COE to use its technical expertise in floodplain management matters to help both public and private interests. On request, program services are provided to state, regional, and local governments, Native American tribes, and other non-federal public agencies without charge.

Option 2

Option 2 is to pursue a similar effort described for COE with the Natural Resources Conservation Service (NRCS). Additional information can be provided if the City wants to understand what this option might involve.

Option 3

Securing any federal funding is going to take time and significant coordination and communications. If the City is interested in trying to meet a shorter project development schedule, Option 3 might be appropriate. Option 3 is for the City and any local partnering agencies to seek Flood Control Assistance Account Program (FCAAP) funding for a flood hazard reduction technical study and then consider how to fund the project with state and local funding. Dedicated local revenue source(s) would be needed to support this option, such as a local improvement district (LID) as discussed in the City's 1999 Storm Water Management Plan. This can allow the City to meet the FEMA requirements or other more modest flood-hazard reduction goals without layering on the additional requirements and process that other federal agencies include in a joint effort. Often the federal options can result in increased project planning and design and construction costs and can extend the project development schedule.

One challenge with Option 3 is that FCAAP funding is limited for the state 2010–2011 biennium. Ecology might not be accepting any new applications during this state biennium budget period. FCAAP grant funding might not be available until 2012 or beyond (personal communication, Bev Huether, Ecology, June 1, 2009).

An additional funding option might be seeking FEMA funding by having the Canyon hazards identified in the Chelan County Hazard Mitigation Plan. With the projects identified in the

Hazard Mitigation Plan, the City can apply for funding a Hazard Mitigation Project to mitigate this flooding problem. Chelan County and the City of Wenatchee have an existing multi-jurisdictional Hazard Mitigation Plan that was approved by FEMA in February 2005. Hazard Mitigation Plans are required to be updated every 5 years, so the Plan will need to be updated by February 2010.

Applications for FEMA funding of Hazard Mitigation Plans or projects are filed through the Washington State Emergency Management Division during an open period for filing grant applications. Typically, grants for plans or projects are funded at 75% federal/state funding with a 25% local match.

Regardless the funding path chosen, HDR recommends that the City solidify its flood risk reduction goals and then develop some updated structural alternatives to meet these goals. Order-of-magnitude costs need to be identified before determining which funding approach is most suitable for the City's situation. HDR further recommends that the City coordinate closely with FEMA Region X staff on design criteria to meet federal flood-control requirements.

5.7 County Discussion and Recommendations

5.7.1 Debris and Flow Control Improvement Options

As discussed in Section 5.6.1, runoff from the Canyons poses a significant risk to public property and safety. Constructing improvement projects requires a significant investment. Based on our review of existing conditions and previous studies, Erlandsen has identified two structural alternatives: (1) a debris basin that controls only sediment and debris in the canyon above the apex of the alluvial fans with conveyance improvements designed to resist erosion through the alluvial fan and downstream into the urban area, or (2) detention basins in the canyon above the apex of the alluvial fans with sediment-capture features and enough storage volume and controls to reduce the peak flows from the basin to a flow rate conveyable by existing downstream facilities. Either of these alternatives will require the County and City to work together to develop the projects.

Due to the potential cost of large conveyance facilities in the urbanized area, alternative 2 is likely to be the more cost-effective solution. Both of these alternatives could eliminate the Zone AO designation on the FEMA FIRM if the conveyance improvements extend to the river, provided this is the County/City's long-term goal.

As the County/City evaluates detention basin opportunities, it should seek to better understand the "partially functioning" condition of the Dry Gulch dam. Erlandsen suggests evaluating the existing dam for structural stability, effectiveness, and ability to resist overtopping. If this dam fails, it could cause greater peak flows and could release stored sediment during a flood. Based on this review, we recommend that the County/City include identified modifications in project development actions, as necessary. The County/City should also provide enough detention to detain peak flows to an amount that the downstream system can convey.

5.7.2 Conveyance System Improvements

Additional incremental improvements can also be made to improve existing conditions within the County based on the City's near- and long-term objectives. Although these improvements within the City Limits do not provide any direct benefit to the County, they indirectly affect the sizing of any facilities constructed upstream of the City's conveyance system. Downstream

conveyance improvements are needed. These include both improvements to the existing conveyance systems and possibly diverting part of the No. 1 and No. 2 Canyons flow into the city's stormwater system. System improvements in both the County and the City should be coordinated such that design elements are developed across boundaries to ensure that the various design elements function in sequence.

It should be noted that flood events from the canyons are not expected to correspond with rain events within the urban area. Consequently, the City's existing conveyance system would be available to mitigate flooding from the canyons. Also, flooding from the canyons is expecting to result primarily in sediment and debris, which will be addressed by the improvements to the existing stormwater system, which will include sediment removal.

Based on the system analysis (see Chapter 6 of the City of Wenatchee Comprehensive Stormwater Plan), approximate flow rates of 28 cfs for No. 1 Canyon and 26 cfs for No. 2 Canyon could be conveyed through the existing stormwater system in addition to using the existing conveyance channels if they are upgraded to their flow-conveyance targets. These rates are based on the capacity of the urban collection system along the edge of the planning area.

The average capacity of the existing Dry Gulch closed conveyance system is about 80 cfs. Additional system improvements would be necessary to upgrade the conveyance system's capacity to handle these flows. The cost of upgrading the Dry Gulch conveyance system is less than the cost of improving conveyance below the canyons.

Additionally, Erlandsen recommends that the County implement nonstructural BMPs to minimize risks to public property and safety from flood hazards.

5.7.3 Funding Options

The County has at least three options for initiating a study to evaluate structural alternatives and focus on the desired, most cost-effective approach for design and construction. These alternatives will require direct coordination with the City.

Option 1

Option 1 is to reinitiate discussions with the COE through one of the programs in its Civil Works Program: the general Civil Works Process and the Continuing Authorities Program (CAP). This alternative is further discussed in Section 5.6.3.

Option 2

Option 2 is to pursue a similar effort described for COE with the Natural Resources Conservation Service (NRCS). Additional information can be provided if the County wants to understand what this option might involve.

Option 3

Securing any federal funding is going to take time and significant coordination and communications. If the County is interested in trying to meet a shorter project development schedule, Option 3 might be appropriate. Option 3 is for the County and any local partnering agencies to seek Flood Control Assistance Account Program (FCAAP) funding for a flood hazard reduction technical study and then consider how to fund the project with state and local funding. Dedicated local revenue source(s) would be needed to support this option, such as a local improvement district (LID). This can allow the County to meet the FEMA requirements or other more modest flood-hazard reduction goals without layering on the additional

requirements and process that other federal agencies include in a joint effort. Often the federal options can result in increased project planning and design and construction costs and can extend the project development schedule.

An additional funding option might be seeking FEMA funding by having the Canyon hazards identified in the Chelan County Hazard Mitigation Plan. With the projects identified in the Hazard Mitigation Plan, the County can apply for funding a Hazard Mitigation Project to mitigate this flooding problem. Chelan County and the City of Wenatchee have an existing multi-jurisdictional Hazard Mitigation Plan that was last updated in 2011. Hazard Mitigation Plans are required to be updated every 5 years, so the Plan will need to be updated by February 2016.

6 WATER QUALITY

6.1 Introduction

This section describes general water quality concerns based on the planning area information, lists the existing facilities with water quality treatment features, and summarizes BMPs that may be incorporated to protect water quality.

6.2 General Water Quality Concerns

Water quality is an important focus for the Study area since stormwater runoff from developed areas primarily discharges into the Wenatchee or Columbia Rivers and Squilchuck Creek. The areas surrounding Wenatchee are expected to have large increases in development, particularly in Sunnyslope. With development comes an increase in impervious area and potentially new sources of pollution, amplifying stormwater runoff while degrading its water quality.

6.2.1 Major Stormwater Pollutants and their Sources

There are a number of pollutants that may have an adverse effect on the receiving water body. A list of the major pollutants outlined in the SWMMEW is shown below.

Total Suspended Solids (TSS)
These are any type of particulates (eroded soil, heavy metals, etc.) that can increase turbidity and cause sedimentation of the receiving water body.

Oil and Grease
Are any type of oil, grease, or other hydrocarbons that may be conveyed into a water body.

Nutrients
The major nutrients of concern are phosphorus and nitrogen which could cause eutrophication of the receiving water body.

BOD
The Biochemical Oxygen Demand pollutants are any materials that are discharged that can be consume by bacteria and in the process, deplete oxygen in the water.

Toxic Organics
Examples given by Ecology for toxic organics include: pesticides, phenols, phthalates, and polynuclear aromatic hydrocarbons (PAHs)

Heavy Metals
Are metals that can negatively impact the ecosystem which includes lead, zinc, cadmium, and copper.

pH
This is a measurement of acidity or alkalinity that can negatively impact a receiving water body if the discharge has a different pH.

Bacteria and Viruses
Are any type of pathogen that is discharged.

The origin of a pollutant in a water body may come from either a “point” or “nonpoint” source. Point sources of pollution are locations where pollutants are discharged at a specific, concentrated location. For example, a point source of pollution would be the discharge pipe of a

wastewater treatment plant or the discharge of an industrial facility. Nonpoint source pollution is defined in the SWMMEW as, "Pollution that enters any waters of the state from any dispersed land based or water-based activities and does not result from discernible, confined, or discrete conveyances (Ecology, 2004)."

Table 6.2-1 lists many typical nonpoint sources of pollution and the pollutants that are commonly associated with different land-use types. Table 6.2-2 provides estimated concentrations and load estimates for pollutants present in stormwater runoff.

Table 6.2-1
Land Uses and Associated Nonpoint Source Pollutants

Land Use	Nutrients	Oils/ Grease	Toxic Compounds	Sediment	Organic Materials	Pathogens/ Bacteria
Residential Development						
Clearing and Grading	x	x		x	x	x
Construction	x	x	x	x		
Roof Wash-off	x		x	x		
Yard Debris	x				x	x
Lawn and Landscape Runoff	x		x	x	x	x
Riparian Vegetation Removal	x			x		
Septic Systems	x		x		x	x
Commercial						
Automotive Shops	x	x	x			
Car and Truck Washes	x	x	x			
Landscaping and Nurseries	x		x	x	x	
Restaurants	x	x			x	
Shopping Centers	x	x	x		x	
Industrial						
Concrete Batch Plant		x		x		
Swim Pool Manufacturing			x			
High-Tech Manufacturing			x			
Agriculture						
Irrigation	x		x	x	x	
Livestock Grazing	x			x	x	x
Manure Disposal	x			x	x	x
Crop Production	x		x	x	x	
Other Sources						
Transportation	x	x	x			
Hazardous Spills	x	x	x		x	x
Illicit Connections	x	x	x		x	x
Landfills	x	x	x		x	x

Source: McGuiness, et al. 1994

Table 6.2-2 Water Quality Characteristics of Runoff from Residential and Commercial Areas[1]			
Constituent	**Average Residential or Commercial Site Concentration**	**Weighted Mean Residential or Commercial Site Concentration**	**Nationwide Urban Runoff Program Recommendations for Load Estimates**
Total Suspended Solids (TSS)	239 mg/l	180 mg/l	180 to 548 mg/l
Biochemical Oxygen Demand (BOD)	12 mg/l	12 mg/l	12 to 19 mg/l
Chemical Oxygen Demand (COD)	94 mg/l	82 mg/l	82 to178 mg/l
Total Phosphorus	0.50 mg/l	0.42 mg/l	0.42 to 0.88 mg/l
Soluble Phosphorus	0.15 mg/l	0.15 mg/l	0.15 to 0.28 mg/l
Total Kjehldahl Nitrogen	2.30 mg/l	1.90 mg/l	1.90 to 4.18 mg/l
NO2 +3 - N	1.40 mg/l	0.86 mg/l	0.86 to 2.20 mg/l
Total Copper	53 µg/l	43 µg/l	43 to118 µg/l
Total Lead	238 µg/l	182 µg/l	182 to 443 µg/l
Total Zinc	353 µg/l	202 µg/l	202 to 633 µg/l

1. Developed from results of the Nationwide Urban Runoff Program (EPA 1983)

The pollutants that are typically found in runoff generated off of roadways may contain suspended solids, oil/grease, polynuclear aromatic hydrocarbons (PAHs), lead, copper, zinc, cadmium and other heavy metals. These contaminants are deposited onto roads through vehicle use such as the wearing down of car breaks and dripping of oil from the engine. Additionally, road maintenance operations such as applying road salts or anti-icers add contaminants.

In addition to the pollutants generated from roads, runoff from commercial and business areas can also contain pollutants generated by residential or industrial areas, depending on which businesses are present. For example, an automotive shop could generate oil and grease in runoff, while a nursery may result in a higher amount of sediment in stormwater runoff. Some home-based businesses also have the potential of generating polluted discharges. Public education and outreach may be most effective with home-based businesses.

Residential areas generate the same pollutants as road runoff along with herbicides, pesticides, nutrients (from fertilizers and animal wastes), and bacteria, viruses, and other pathogens (from animal wastes) (Ecology 2004). Rural residential areas might generate more viruses and other pathogens due to the higher prevalence of animals, whereas high-density residential areas that include multifamily homes would be anticipated to generate a higher concentration of petroleum in storm runoff. Sediment erosion from residential areas is mostly a concern during construction periods before land cover or vegetation is established.

Industrial areas generate stormwater runoff that contains heavy metals, sediments, and human-made organic pollutants including phthalates, PAHs, and other petroleum hydrocarbons

6.2.2 Total Maximum Daily Load Requirements

A TMDL (total maximum daily load) is the maximum amount of pollutant that a water body can receive without exceeding water quality standards. In Washington State, TMDL also refers to the

planning process in which water bodies that do not meet water quality standards are studied and strategies to reduce pollutants are developed and implemented. EPA approved in 2009 the Ecology developed TMDL for pH and dissolved oxygen (DO) in the Wenatchee River (Ecology 2009). In the Wenatchee River, one of the main pollutants that affects the pH and DO levels is phosphorus. A large amount of interest has been placed on reducing phosphorus loadings from discharges into the River.

A TMDL exists on the Columbia River for total dissolved gas (TDG). According to Ecology, this TMDL sets TDG loading capacities and allocations for the Columbia River, primarily affecting fish passage at Columbia River dams (Ecology 2008). EPA also began efforts on a temperature TMDL for the Columbia River but suspended this effort "to allow necessary discussions and information exchange" (Ecology 2009b).

6.2.3 National Pollutant Discharge Elimination System Requirements

To comply with CWA regulations, Chelan County, City of Wenatchee, City of East Wenatchee, and Douglas County have joined together to create a joint stormwater program. In 1999, the EPA introduced Phase II of the NPDES program, which requires a permit for stormwater discharges to certain MS4s and construction sites greater than 1 acre of land. In Washington State, Ecology administers the NPDES program on behalf of the EPA.

The WVSTAC was formed as a cooperative effort to address the requirements of the permit and to collaborate on regional stormwater issues. The committee, which consists of agency representatives from Chelan County, the City of Wenatchee, City of East Wenatchee and Douglas County was formed under an interlocal agreement among the jurisdictions.

6.3 Potential Pollutant Loadings

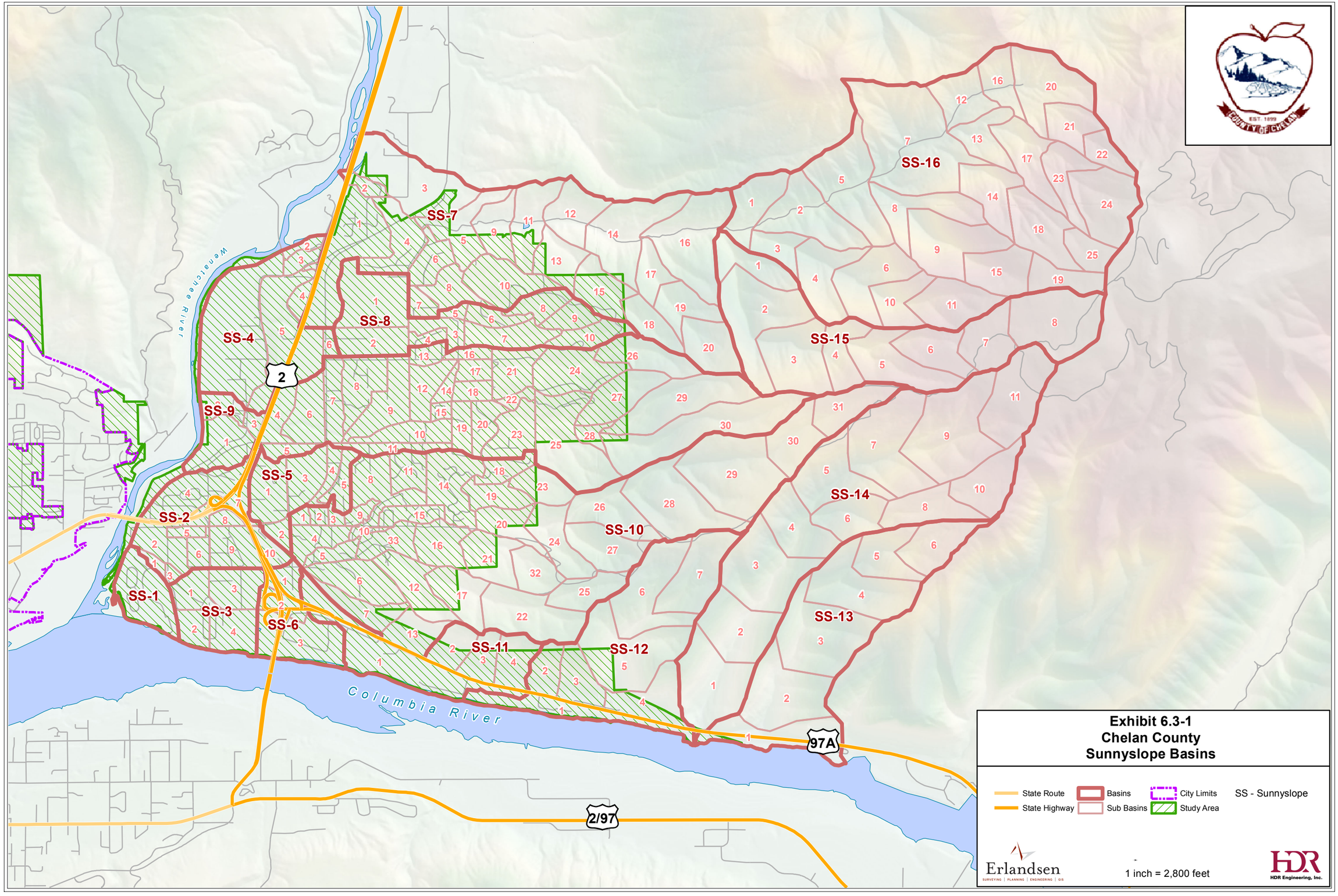
Currently, it is not required for the County to actively monitor and sample stormwater outfalls for water quality. Therefore, estimates on the water quality of the Study areas will have to be made based on the potential pollutant loading associated with land use. The pollutants that are generally associated with a type of land use are shown in Table 6.2-1 and Table 6.2-2.

6.3.1 Sunnyslope

The basins used for Sunnyslope can be divided into three areas in terms of land use, development, and topography. (Exhibit 6.3-1) The first set of basins in Section 6.3.1.1 are basins found in the Olds Station Area which is mostly developed and will not see a major change in land use in the planned future. The second set of basins in Section 6.3.1.2 are basins that have been mostly developed but will see a change in land use as well as an increase in density in the planned future. Finally, the third set of basins in Section 6.3.1.3 is basins that are undeveloped and will remain as undeveloped or as spaced, rural residential into the planned future.

6.3.1.1 Basins SS-1, 2, 3, 6, 11

These basins form the area known as Olds Station and an industrial area along the banks of the Columbia River. The area is fairly developed and the existing development conforms to the future zoning plan for the area. Therefore placement of a water quality facility may be constricted to whatever land is still available.


SS-16
SS-7
SS-8
SS-4
SS-9
SS-5
SS-2
SS-1
SS-3
SS-6
SS-11
SS-12
SS-15
SS-14
SS-10
SS-13
2
97A
2/97
Wenatchee River
Columbia River
Exhibit 6.3-1
Chelan County
Sunnyslope Basins
State Route
State Highway
Basins
Sub Basins
City Limits
Study Area
SS - Sunnyslope
1 inch = 2,800 feet
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
HDR Engineering, Inc.

Olds Station has gravity mains that convey stormwater to discharge points in the Columbia and Wenatchee Rivers. There are only a few water quality treatment facilities upstream of these outfalls. An oil and water separator exists before the discharge into the Columbia River near Euclid Avenue. Other privately owned oil and water separators exist in various parking lots. There are also two storage basins found in the area summarized in Table 6.4-1. The northwest portion of Olds Station is part of the North Wenatchee Business District and is mostly commercial development with a number of large parking facilities. Some of the pollutants associated with this type of land use are sediments, nutrients, oils/grease, and heavy metals. The remainder of Olds Station and most of basin SS-11 is developed as industrial. Depending on the type of operations occurring at these sites, some of the pollutants that may be contributed include sediments, oil/grease, and toxic organics.

One outfall from this area discharges into the Wenatchee River. Because of the established TMDL for the Wenatchee River, care will need to be taken to prevent pollutants that could deteriorate acceptable levels of dissolved oxygen and pH. BMPs that are efficient in removing phosphorus may need to be utilized if phosphorus levels are high enough in the discharging runoff.

6.3.1.2 Basins SS-4, 5, 7, 8, 9, 10

These basins form the area that will see the greatest growth in the next several decades. Most of the areas in these basins are currently light residential, grassland, or orchard. The types of pollutants that are normally associated with this type of land use are sediments and nutrients. However, the development plan for the area transitions the existing land use into single family residential, high density residential, and commercial zones. The increase in development will create a higher percentage of impervious area as well as increasing the number of major roads with higher traffic volumes. Therefore water quality treatment facilities will need to be completed to accommodate the future increase in stormwater runoff and degradation of the runoff's water quality. New landscaped areas may generate sources of sediments and nutrients while additional traffic in the area may create a source of oil/grease and heavy metals. It may be anticipated that a higher concentration oil/grease and heavy metals may occur in the area around the intersection of East Street and School Street which has the potential to be a high density area within Sunnyslope.

A few gravity stormwater systems already exist in the area along portions of East Street, School Street, Crestview Road, and Burch Mountain Road, where stormwater enters the mains via catch basins. However, the majority of the area within the basins drains via unmaintained, grass-lined channels. The channels then convey stormwater to discharge points in the Columbia River or the High Line Irrigation Ditch. A number of storage basins also exist in the area and are summarized in Table 6.4-1. Many of the storage basins were constructed to handle flows for specific residential areas as part of the neighborhood development.

This area has three existing discharges into the Wenatchee River. Because of the established TMDL for the river, care will need to be taken to prevent pollutants that could deteriorate acceptable levels of dissolved oxygen and pH. BMPs that are efficient in removing phosphorus may need to be utilized if phosphorus levels are high enough in the discharging runoff.

6.3.1.3 Basins SS-12, 13, 14, 15, 16

These basins consist of the steeper sloped, undeveloped area found in the northern portion of Sunnyslope. Currently, water quality is not an issue for these basins and there are no existing facilities or conveyance systems for stormwater. Land use remains as natural scrubland

consisting of sagebrush and native grasses and runoff follows natural intermittent streams located at canyon bottoms that drain toward the lower elevations of Sunnyslope.

The majority of the area has been zoned for rural residential with 20 acre lots. New development may increase runoff and stormwater pollution but not near to the effect of the lower elevations of Sunnyslope. When developed into rural residential, the increase in landscaped area may introduce sediments and nutrients into runoff. An increase in livestock kept in the area may also introduce pathogens into stormwater.

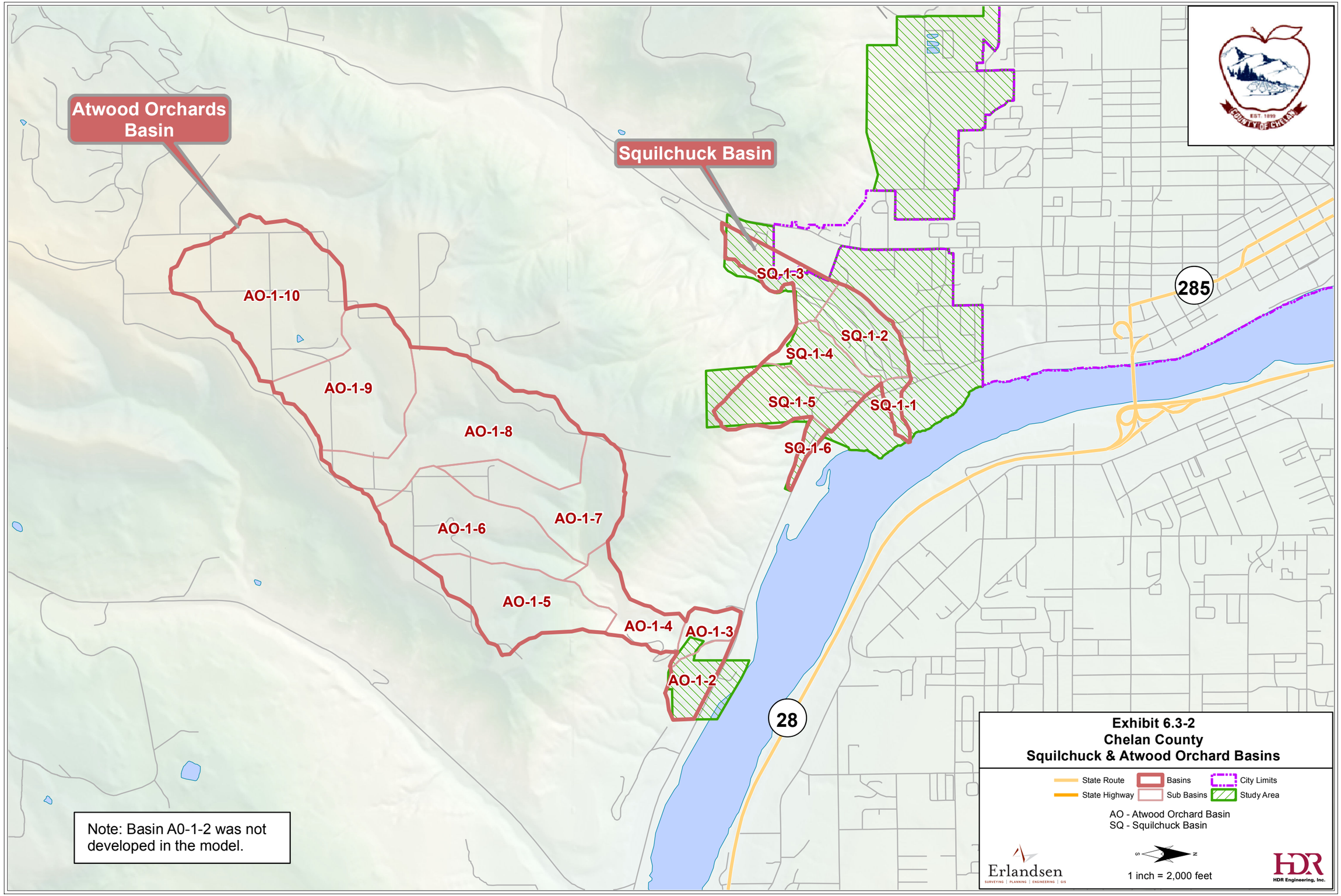
6.3.2 Squilchuck

The land use in the basin is currently residential, grassland, orchard or light industrial. (Exhibit 6.3-2) Though zoned as high density residential, the existing residential development is mostly a densely packed mobile home development. There are no established treatment or conveyance methods found in the basin. Runoff generated in the basin drain into Squilchuck Creek which discharges into the Columbia River. The zoning in the basin suggests that the open space and orchards may be developed into rural residential and that existing high density residential areas could be further developed. With a decrease in natural grassland and an increase in residential area, there may be an increase in sediments and nutrients that are associated with landscaped area. Livestock that might be found in a rural residential setting can also contribute pathogens into runoff. The light industrial areas may create oil and grease pollutants depending on their operation.

6.3.3 Atwood Orchards

The land use in the basin is currently either orchard or natural grassland. (Exhibit 6.3-2) There are currently no established treatment or conveyance methods found in the basin. Runoff that is generated drains into natural intermittent channels that merge and discharge into the Columbia River. Zoning in the area will have the remaining natural grassland be developed into additional commercial agricultural land or into rural residential.

The large number of orchards found in the area may contribute sediments, nutrients, and pesticides into stormwater and livestock that might be found in a rural residential setting may add pathogens. With the rural setting that will be maintained in the area, it may be beneficial to use a public education and outreach program to educate about stormwater pollution prevention as a BMP rather than constructing a facility.


Atwood Orchards Basin
Squilchuck Basin
AO-1-10
AO-1-9
AO-1-8
AO-1-7
AO-1-6
AO-1-5
AO-1-4
AO-1-3
AO-1-2
SQ-1-3
SQ-1-2
SQ-1-4
SQ-1-5
SQ-1-1
SQ-1-6
285
28
Note: Basin A0-1-2 was not developed in the model.
Exhibit 6.3-2
Chelan County
Squilchuck & Atwood Orchard Basins
State Route
State Highway
Basins
Sub Basins
City Limits
Study Area
AO - Atwood Orchard Basin
SQ - Squilchuck Basin
1 inch = 2,000 feet
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HDR
HDR Engineering, Inc.

6.4 Existing Facilities

The existing facilities (public and private) found in the Study area are storage basins and an oil and water separator. The storage basins typically rely on infiltration and evaporation for managing stormwater. Only when the capacity of the storage basin is exceeded will they discharge via surface flow. The storage basins provide some water quality treatment through settling of suspended solids and filtration of pollutants if stormwater is infiltrated. The majority of the basin facilities were built during construction of neighborhoods created in newer areas of Sunnyslope and typically only intercept stormwater from its associated development. Information on the existing facilities' capacity and location are summarized in Table 6.4-1.

Table 6.4-1
Existing Stormwater Facilities in Study Area

Basin	Facility	Facility Name Location	Type of Facility	Approx. Capacity (cu.ft.)
SS-2	12	Penny Road Olds Station Road	Storage Basin	386,300
SS-3		Euclid Separator Euclid Avenue	Oil and Water Separator	N/A
SS-7	9	Warm Springs Warm Springs Canyon Road and American Fruit Road	Storage Basin	6,700
SS-7	8	Sunridge Sunridge Lane and American Fruit Road	Storage Basin	500
SS-7	8	Sunridge Sunridge Lane and American Fruit Road	Storage Basin	3,100
SS-7	3	Viewmont Estates Lovell Road and American Fruit Road	Storage Basin	14,000
SS-8	4	Crestview Estates II American Fruit Road	Storage Basin	600
SS-9	2	Crestview Estates I Crestview Road and American Fruit Road	Storage Basin	11,300
SS-9	7	Sunnyslope Meadows Knowles Road	Storage Basin	4,600
SS-9	10	Mountain Brook III Knowles Road	Storage Basin	3,400
SS-9	6	Meadow Brook Lilly Lane	Storage Basin	22,000
SS-9	1	Mountain Brook II Elizabeth Court	Storage Basin	15,800
SS-9	1	Mountain Brook II Elizabeth Court	Storage Basin	21,300
SS-9	1	Mountain Brook II Elizabeth Court	Storage Basin	37,100
SS-9	14	Sun Valley Estates Sun Valley Lane	Storage Basin	34,000
SS-10	5	Mountain Brook I Rolling Hills Lane and Stoney Brook Lane	Storage Basin	7,400

Table 6.4-2 Continued Existing Stormwater Facilities in Study Area				
Basin	**Facility**	**Facility Name Location**	**Type of Facility**	**Approx. Capacity (cu.ft.)**
SS-10	5	Mountain Brook I Rolling Hills Lane and Stoney Brook Lane	Storage Basin	19,500
SS-10	11	WSDOT US-97 and Ohme Garden Road	Storage Basin	106,800
SS-10	13	Cascade Crest Dianna Way	Storage Basin	300

Basins identified on Exhibit 6.3-1 with facilities identified in Exhibit 3.6-1.

6.5 Best Management Practices

The SWMMEW describes a number of practices and designs that can be employed to lessen the impact of pollutants on water quality. Ecology describes these as Best Management Practices (BMPs). There are three main categories for BMPs: source control, water quality treatment, and flow control.

Source control BMPs are designed to prevent pollution from ever being introduced into stormwater, water quality treatment BMPs are designed to remove existing pollutants from stormwater; and flow control BMPs are designed to control the rate, frequency, and/or flow duration of stormwater runoff which, if left uncontrolled, may cause damage downstream(Ecology, 2004).

This section will describe some of the BMPs recommended by Ecology for each of the categories that the County can utilize in managing stormwater. Detailed descriptions on the design and implementation of these BMPs may be found in the SWMMEW and the EPA Phase II Menu of BMPs.

The National Menu of Stormwater Best Management Practices[1] for Stormwater Phase II was first released in October 2000. EPA expects to update this menu as new information and technologies become available. At the State level, the BMP list is further refined to reflect technologies approved in the State of Washington.[2]

6.5.1 Source Control BMPs

Catch Basins

Catch basins are inlets to the stormwater system that typically have a grate to prevent larger debris from entering and a sump below the invert of the lowest pipe where sediment and debris may settle and collect. Ongoing maintenance needs to be performed to remove any accumulated solids.

Oil and Water Separators

[1] EPA, National Menu of Stormwater Best Management Practices, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/)
[2] Department of Ecology, Approved as Equivalent to Existing Technologies, (http://www.ecy.wa.gov/programs/wq/stormwater/newtech/EQUIVALENT.html)

Oil and water separators typically come in a baffle type or a coalescing plate type configuration and are at sites that have a high potential for release oil or grease. Separators are generally not well suited for regionalized or basin-level stormwater management.

Construction Site BMPs

A large amount of construction is expected to occur in Sunnyslope while the area develops which will introduce new stormwater issues, particularly with erosion. A number of BMPs can be implemented to contain pollution and runoff generated by construction which includes: preserving natural vegetation, limiting construction area, controlling offsite flowrates, sediment collectors, soil stabilization, and proper handling of construction materials and wastes.

6.5.2 Water Quality BMPs

The following are water quality BMPs that are outlined in the SWMMEW.

Infiltration and Bioinfiltration

These include infiltration ponds, infiltration trenches, infiltration swales, and bio-infiltration swales. These BMPs remove pollutants by entrapping stormwater into a depression and infiltrating it through the soil.

Biofiltration

These include biofiltration swales and vegetated filter strips. Pollutants are removed using vegetation that increases filtration, sedimentation, soil sorption and plant uptake. This type of BMP is able to remove a majority of suspended solids and to some extent heavy metals, phosphorus, pesticides, and oil/grease.

Subsurface Infiltration

Stormwater runoff is conveyed into a subsurface structure, such as a drywell, where it then infiltrates as groundwater using the vadose zone of the soil to remove pollutants. This type of BMP is regulated by the Underground Injection Control (UIC) program established by Ecology. If used, care needs to be taken to prevent contamination of critical aquifers.

Wetpool and Dryponds

These include wetponds, large wetponds, extended detention dry ponds, wet vaults, and stormwater treatment wetlands. Wetponds, also known as retention ponds, have a permanent pool of water that assist in removing suspended solids and to some extent heavy metals, phosphorus, and hydrocarbons. Large wetponds are similar to basic wetponds except for their large size to increase pollutant removal efficiency. Extended detention dry ponds are similar to a standard flow control detention pond except that it has a detention of at least 24 hours which allows for the settling of pollutants. Wet vaults are underground facilities that have a permanent pool of water that allow for the settling of suspended solids. Finally, stormwater treatment wetlands are shallow man-made ponds that use biological processes to provide water quality treatment that can remove suspended solids, heavy metals, pesticides, and hydrocarbons, and to some extent phosphorus.

Because of the arid environment of the area around Wenatchee, any BMP that requires a permanent pool of water would be unfavorable. From this group of BMPs, extended detention dry ponds would be the most favorable for the climate.

Sand Filtration

Sand filter basins percolate stormwater through a layer of sand to remove pollutants. They typically require a pre-treatment method before the sand filtration, such as a settling basin, to remove larger particles that could clog the filter bed. Sand filters can be used to remove suspended solids and to a lesser degree, heavy metals, phosphorus and oil/grease. Though a preferred method of treatment in arid regions, sand filters may experience issues in a cold environment when not installed as a subsurface vault making them less desirable. These include frost heave and frozen ground considerations.

Evaporation Pond

Evaporation ponds are basins that do not discharge stormwater by any means except for evaporation. They are used when surface discharge and infiltration are not viable options. This provides water quality treatment by evaporating water and leaving behind any contaminants it was carrying.

6.5.3 Flow Control BMPs

Detention Facilities

Detention facilities are structures that are designed to temporarily store surface water runoff and then release the water at a controlled rate. Underground storage tanks, pond storage areas, and enlarged channels and canals are examples of detention facilities. Detention facilities can also include water quality treatment by incorporating bio-filtration swales, filters, sedimentation basins, and wetponds.

Retention Facilities

Retention facilities are structures that are designed to store surface water runoff without releasing the water beyond the structure. Stored water is then subject to infiltration, evaporation, transportation, or reuse. Evaporation ponds, surface depressions, infiltration drywells, trenches, and ponds are examples of retention facilities.

Subsurface Infiltration

Subsurface infiltration systems are facilities that discharge stormwater directly into the ground, including drywells, pipe or french drains, and drain fields (Ecology 2004). Subsurface infiltration is subject to the Underground Injection Control (UIC) rule.

6.5.4 Emerging Technologies

Ecology provides guidance in the SWMMEW about emerging technologies that, although they have not been fully evaluated, appear to remove a desirable level of stormwater pollutants. In addition, Ecology keeps an updated list of approved emerging technologies on its website along with the technologies' application criteria and performance limits. Examples of emerging technologies include media filters, amended sand filters, catch basin inserts, manufactured storm drain structures, and high-efficiency street sweepers (Ecology 2004).

6.6 Underground Injection Control (UIC) Program

The UIC Program was established by Congress and is administered in the State of Washington by the Department of Ecology to prevent the degradation and pollution of groundwater that could be used as a source of drinking water. As part of the program, all UIC wells in the County are required to be registered with Ecology. UIC wells are defined by as, "a well that is used to

discharge fluids into the subsurface. A UIC well is one of the following: (1) A bored, drilled or driven shaft, or dug hole whose depth is greater than the largest surface dimension; (2) an improved sinkhole; or (3) a subsurface fluid distribution system (WAC 173-218-030)," and are commonly referred to as drywells.

By February 3, 2011, Ecology required all UIC wells to be registered and by February 3, 2013 all wells will have been required to complete a well assessment. The assessment determines whether a UIC well negatively impacts groundwater and if a water quality retrofit needs to be added.

Any new UIC wells constructed within the County will need to be aware of the guidelines established by Ecology which includes meeting the non-endangerment standard. New wells can meet this standard by using a presumptive approach where if a UIC well follows guidelines established by Ecology, it is presumed that the well treats stormwater to an acceptable level. New wells could also use the demonstrative approach where a site-specific analysis is conduced that demonstrates the well complies with groundwater quality standards.

6.7 NPDES Phase II Permit Reissuance

The County is permitted under the NPDES Phase II stormwater permit for Eastern Washington to discharge stormwater. The permit was issued on January 17, 2007 with modifications that came into effect on June 17, 2009. However, the permit expires February 15, 2012. At that time a new NPDES Phase II Permit will be issued that may have different requirements than the current permit. The County should be aware that modifications may have to be implemented to accommodate changes to the discharge permit. One such change could be a requirement to monitor stormwater discharges.

7 CAPITAL IMPROVEMENTS

7.1 Introduction

This section develops improvements required to address both structural deficiencies and conveyance/erosion problem areas within the Study area. Recommended projects were developed based upon modeling deficiencies, historical records, discussions with staff and the County Commissioners.

Hydraulic modeling for the Study area was completed for the Sunnyslope, Squilchuck and Atwood Orchard basins as part of this study. Runoff originating in No. 1 Canyon, No. 2 Canyon and Dry Gulch is further discussed in Chapter 5 as several modeling efforts have been completed on the Canyons. The extensive inventory work required to accurately model the Canyons is outside the scope of work for this project.

The project information presented below is intended to assist in the planning process. The items need to be addressed as part of final design.

- Partnering opportunities
- Detailed drainage channel mapping
- Easement acquisition
- Property acquisition
- Final hydraulic modeling
- Infiltration testing
- Operation and Maintenance considerations

7.2 Project Costs

Costs for the projects were developed based upon 2010 and 2011 historical bid information for the Wenatchee Area. Project bid tabulations were reviewed for projects completed for Eastmont School District, City of Cashmere and WSDOT. From these and other representative projects that were used as a basis, individual unit costs were extracted to determine an average construction cost for each of the different materials that would be used in a given project. For those costs where no local information was available, material suppliers were contacted to obtain pipe and structure costs for the various large-diameter components since these items are not typically used in project in the north-central Washington area. Paving and trenching costs are based on county requirements for trench patch sections that were average into a linear-foot cost based on the diameter of the pipe and anticipated trench patch width. Structure costs were further developed as individual structure costs inclusive of all installation costs and were assumed to be located every 300-feet along the length of the pipe. Appendix J includes structure and pipeline cost information. Appendix J also includes detailed cost information for each of the projects described in Section 7.3.

Limited information is available on the cost per unit to maintain and operate drainage infrastructure elements. Based upon costs estimated for maintaining ditches and facilities in Western Washington, Table 7.2-1 outlines those costs that were used in development project estimates.

Table 7.2-1 Drainage Maintenance Costs		
Type of Structure	Activity	Cost per Unit
Culverts	Clean Culvert using Vactor Truck Hand Clean Culvert	$25.00 each $75.00 each
Catch Basins	Clean catch Basin	$55.00 each
Drainage Ditches	Perform Ditch Maintenance	$3.00 per foot

Source: Lake Whatcom Comprehensive Stormwater Plan (2006). Costs adjusted for inflation.

7.3 Projects

Projects within the Study area are summarized below with detailed estimates provided in Appendix J. Exhibit 7.3-1 further outlines those projects in north of Wenatchee with Exhibit 7.3-2 outlining those projects south of the Wenatchee River.

The projects were classified according to the following classifications:

- EP – Eagle Rock Project Area
- MP – Maintenance Project
- CP – Conveyance Project
- DP – Detention Project

Each project is outlined as follows:

Project Number	Individual project number
Project Summary	Description of project
Project Objective	What issue will the project correct
Design Event	Rainfall event
Projected Flows	Flows developed during hydraulic modeling
Projected Volume	Storage volume developed during hydraulic modeling
Roadway Classification	Federal Functionality Classification for the roadway
Estimate	Cost estimate for the project
Location	Location of the project

7.3.1 Eaglerock Drainage Improvements

Project Number	EP-1
Project Summary	Clean and inspect roadside drainage ditches, driveway culverts and roadway crossing culverts. Disturbed ditches will be hydroseeded to minimize future erosion.
Project Objective	The Eaglerock area has a history of drainage issues. Chelan County performs yearly maintenance on these systems, but minor improvements are needed to minimize the need for yearly maintenance. Improvements to roadside conveyance systems will improve conveyance, minimize erosion potential and ensure that existing culverts are functional and clean.

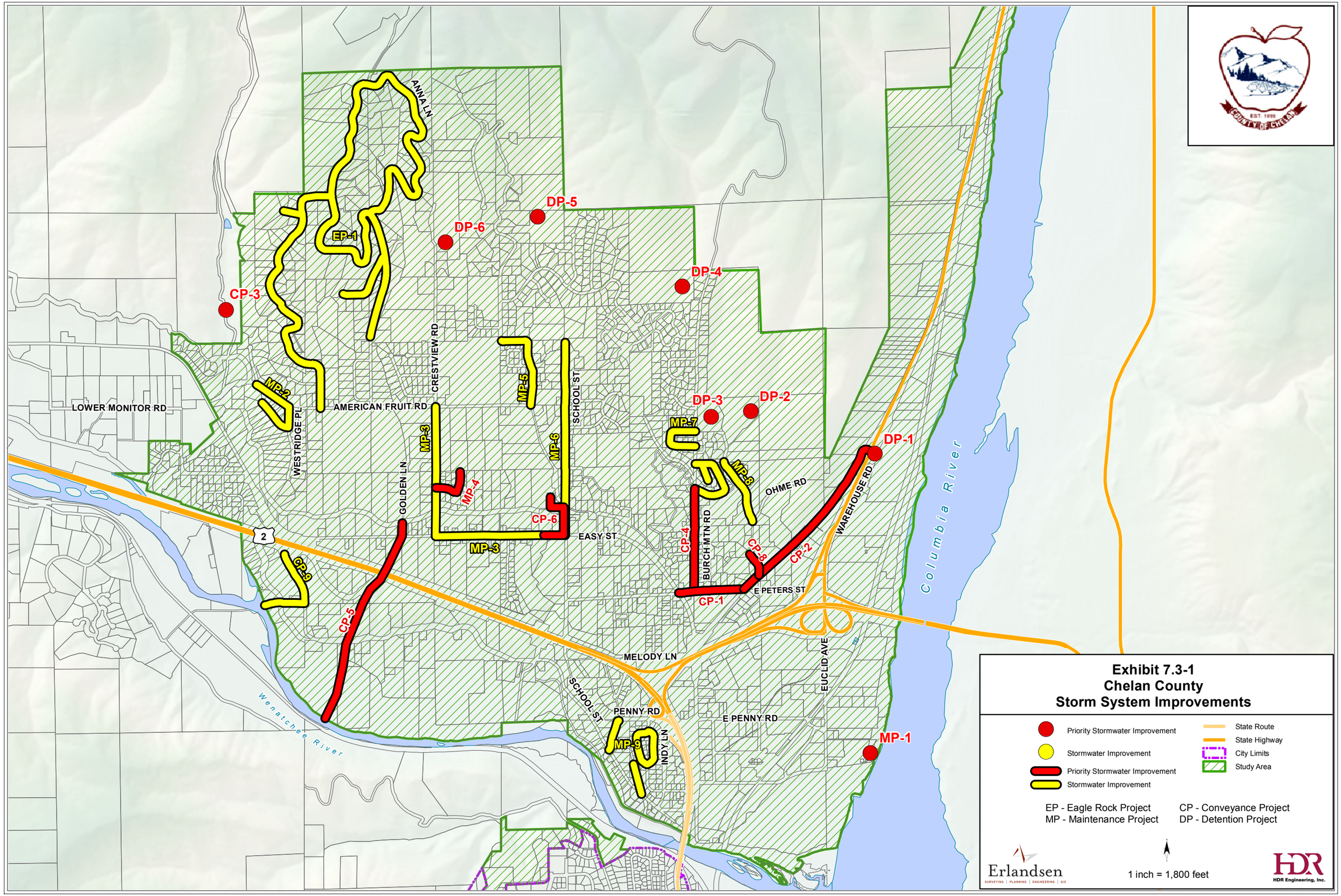

ANNA LN
EP-1
DP-5
DP-6
DP-4
CP-3
CRESTVIEW RD
MP-5
SCHOOL ST
DP-3
DP-2
MP-7
DP-1
MP-2
LOWER MONITOR RD
AMERICAN FRUIT RD
WESTRIDGE PL
MP-8
MP-6
GOLDEN LN
MP-4
OHME RD
WAREHOUSE RD
CP-6
EASY ST
MP-3
CP-4
BURCH MTN RD
CP-3
CP-5
CP-2
E PETERS ST
CP-1
Columbia River
MELODY LN
EUCLID AVE
SCHOOL ST
PENNY RD
E PENNY RD
MP-9
INDY LN
MP-1
Wenatchee River
2
Exhibit 7.3-1
Chelan County
Storm System Improvements
Priority Stormwater Improvement
Stormwater Improvement
Priority Stormwater Improvement
Stormwater Improvement
State Route
State Highway
City Limits
Study Area
EP - Eagle Rock Project
MP - Maintenance Project
CP - Conveyance Project
DP - Detention Project
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
1 inch = 1,800 feet
HDR
HDR Engineering, Inc.

Exhibit 7.3-2
Chelan County
Storm System Improvements

<all other values>
Canyon Improvement Projects
Stormwater Improvement
State Route
State Highway
City Limits
Study Area

CP - Conveyance Project

1 inch = 3,600 feet

Erlandsen SURVEYING | PLANNING | ENGINEERING | GIS

HDR Engineering, Inc.

CP-10
CP-57
NUMBER 2 CANYON RD
NUMBER 1 CANYON RD
RITCHER CANYON RD
SQUILCHUCK RD
CIRCLE ST
GEHR ST
CRAWFORD ST
RED APPLE RD
SKYLINE DR
MILLERDALE AVE
CHERRY ST
CASTLEROCK AVE
WASHINGTON ST
ORCHARD AVE
5TH ST
9TH ST
SPRINGWATER AVE
MAPLE ST
MCKITTRICK ST
WALNUT ST
S WESTERN AVE
N WESTERN AVE
S MILLER ST
N MILLER ST
STEVENS ST
LYNN ST
OKANOGAN AVE
METHOW ST
S MISSION ST
VIEWDALE AVE
S CHELAN AVE
S WENATCHEE AVE
N CHELAN AVE
N MISSION ST
N WENATCHEE AVE
285
2
28
NW Columbia Ave
NW Cascade Ave
NW Boston Ave
NW Alan Ave
Sunset Hwy
NE Hadley St
N Baker Ave
19th St NW
19th St NE
20th St NE
27th St NW
27th St NE
28th St NW
28th St NE
Wenatchee River

Design Event	25 Year
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Local Access
Estimate	$184,700
Location	West Eaglerock Drive, West Eaglerock Place, April Drive, Anna Lane, Rue Jolie Lane and Mountain Vista Drive

7.3.2 Peters Street Conveyance Improvements

Project Number	CP-1
Project Summary	Install new regional and localized collection system. Existing pipe will need to be upsized to convey flows from Burch Mountain Road. If the proposed detention structures DP-1 and DP-2 are constructed, pipe size can be reduced. It is anticipated that improvements would be made concurrently with roadway improvements.
Project Objective	Peters Street lacks a formal drainage system to collect and route stormwater. Runoff in this area is detained in roadside low areas or it flows across the Chelan County Maintenance Yard on its way to WSDOT ROW. Proposed improvements will construct a formal collection and conveyance system with ultimate routing to an infiltration system.
Design Event	25 Year
Projected Flows	15 cfs (Dependent upon upstream storage development)
Roadway Classification	Urban Local Access
Estimate	$420,000
Location	Peters Street between Easy Street and Ohme Garden Road

7.3.3 Ohme Garden Road

Project Number	CP-2
Project Summary	The existing roadside ditches do not have sufficient capacity to collect and route flows from the Ohme Garden Basin to the Goodfellow Infiltration System. Install new regional and local collection system. Pipe will need to be upsized to convey flows from Burch Mountain Road. If detention structures DP-1 and DP-2 are constructed, pipe size can be reduced. It is anticipated that this project will be completed concurrently with the reconstruction of the roadway. Work to separate overflows from the Wenatchee Reclamation District irrigation canal will also need to be considered.
Project Objective	The objectives of the project are to provide localized collection and conveyance for upstream flows. Currently the area does not have a formal collection system but roadside ditches do provide some collection. Existing Greater Wenatchee Irrigation District system overflows will need to be separated out of the storm system.

	Improvements will need to be completed prior to upstream improvements.
Design Event	25 Year
Project Flows	30 cfs (Dependent upon upstream storage development)
Roadway Classification	Urban Collector
Estimate	$1,013,000
Location	Ohme Garden Road between Peters Street and SR 97A

7.3.4 Warm Springs Culvert Improvements

Project Number	CP-3
Project Summary	The existing culvert on Warm Springs Road is undersized and needs to be upsized to minimize flooding issues identified in the model.
Project Objective	Improve flow characteristics of the culvert, improve inlet and outlet conditions which will minimize flooding upstream of the culvert during high flow conditions.
Design Event	25 Year
Projected Flows	57 cfs
Roadway Classification	Urban Local Access
Estimate	$68,500
Location	Culvert crossing on Warm Springs Road north of American Fruit Road

7.3.5 Burch Mountain Road Storm Improvements

Project Number	CP-4
Project Summary	The existing pipes do not have sufficient capacity to collect and route flows in the existing piping network. Install new regional and local collection system. Pipe will need to be upsized to convey flows from Burch Mountain Road. If detention structures DP-1 and DP-2 are constructed, pipe size can be reduced. It is anticipated that this project will be completed concurrently with repaving of Burch Mountain Road to minimize construction costs.
Project Objective	Increase pipe size to improve flow capacities for both localized collection and upstream conveyance conditions. Improvements will prevent surcharging conditions once upstream improvements are completed.
Design Event	25 Year
Projected Flows	12 cfs (Dependent upon upstream storage development)
Roadway Classification	Urban Collector
Estimate	$310,500
Location	Burch Mountain Road north of Peters Street and south of Mari Lane

7.3.6 Golden Lane Conveyance Improvements

Project Number	CP-5
Project Summary:	Work entails constructing a new drainage system through or around the existing downstream orchard. System will utilize existing piping under SR 2. Exact location of the piping will need to be developed with landowners prior to construction to minimize impacts to existing operations. Work will include a crossing under the Wenatchee Reclamation District canal.
Project Objective	Develop drainage system for drainage that was altered during past farming activities. Project will entail development of new system that will ultimately cross under SR 2 in an existing culvert, a canal and numerous private parcels with flows discharging into the Wenatchee River.
Design Event	25 Year
Projected Flows	16 cfs
Roadway Classification	No Classification
Estimate	$490,000
Location	South of Easy Street across Highway 2 to Wenatchee River

7.3.7 School Street Conveyance Improvements

Project Number	CP-6
Project Summary	Work includes construction of a new intake basin with overflow to bypass flows around the Wenatchee Reclamation District (District) facility. Work includes crossing under the existing canal with the new bypass system connecting into the existing outfall system south of the District's facilities. The new overflow will be constructed in School and Easy Streets.
Project Objective	Develop drainage system that will convey flows around a natural drainage that has been filled in during road construction and inert waste disposal operations. Project will reestablish a drainage way that will ultimately covey flows into the Wenatchee River.
Design Event	25 Year
Projected Flows	2.6 cfs
Roadway Classification	Urban Collector
Estimate	$480,500
Location	Northwest of the intersection of Easy Street and School Street

7.3.8 Boodry Street Conveyance Improvements

Project Number	CP-7
Project Summary	Project is to develop a localized collection system to collect and convey water from Boodry Street with a discharge into the existing system located in South Wenatchee Avenue.
Project Objective	Development of a new conveyance system which will develop a collection system for a localized area currently lacking a formal system. Discharge from the system will ultimately flow into Squilchuck Creek. The system will also be a prime candidate for a water quality facility given the undeveloped property in the area.
Design Event	25 Year
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Local Access
Estimate	$542,000
Location	Boodry Street west of the intersection of South Wenatchee Avenue

7.3.9 Ohme Garden Routing Improvements

Project Number	CP-8
Project Summary	The project includes construction of a new local collection system that is connected into project CP-4. Specific design elements will need to include a review of flow routing in the area as the existing system has difficult directional changes that have the potential to cause downstream flooding if the system fails. Work will have to follow project CP-3.
Project Objective	Develop collection system for area that has the potential to impact a commercial area.
Design Event	25 Year
Projected Flows	7.5 cfs
Roadway Classification	Urban Local Access
Estimate	$160,000
Location	Ohme Road north of Ohme Garden Road

7.3.10 Love Lane Routing Improvements

Project Number	CP-9
Project Summary	The project includes development and construction of a localized routing and collection system. The existing system has been impacted by development in the area with runoff impacting downstream properties. This area was not modeled and an analysis will need to be completed to develop required pipe sizes.

Project Objective	Develop collection system for area that has the potential to impact a commercial area.
Design Event	25 Year
Projected Flows	7.5 cfs
Roadway Classification	Urban Local Access
Estimate	$244,500
Location	Lower Sunnyslope Road, Love Lane and Sleepy Hollow Road

7.3.11 No. 1, No.2 Canyons and Dry Gulch

Project Number	CP-10
Project Description	Work includes acquiring property along with development of new stilling basins and development of a conveyance system that ultimately discharges into the Columbia River. Improvements within the canyons should include: • Establish and maintain slope vegetation as a source control; • Development of formal conveyance systems along the bottom of the drainages that are designed to minimize erosion during flow events; • Development of stilling basins at strategic locations in the canyon reaches to provide areas for debris offloading with a focus on maintenance access; • Development of regional facilities at the interface between the County and City. Regional facilities will serve to provide a final point of debris removal prior to the discharge of flows into the City's existing urban collection system. These facilities should be designed as a mixed use facility given the large size of the facilities. A mixed use facility would combine public use during non-storm periods with detention provided during larger storm events. • Urban improvements to improve conveyance within the existing storm system within the City.
Project Objective	Develop stilling basins and a conveyance system that ultimately discharges into the Columbia River. The project will need to include development of funding alternatives such as implementation of a Flood Control District by the County. All projects will need to be coordinated with the City due to the discharge of storm runoff into the City's urban collection system.
Design Event	Further Evaluation Required
Projected Flows	Further Evaluation Required
Roadway Classification	Urban Local Access and Rural Local Access
Location	No. 1, No.2 Canyons; Dry Gulch
Estimate	Further Evaluation Required

7.3.12 Columbia Outfall Improvements

Project Number	MP-1
Project Description	Work entails cleaning and reshaping the existing outfall, installation of outfall protection and hydroseeding of all disturbed surfaces.
Project Objective	Minimize erosion, reduce yearly maintenance and improve the existing discharge into the Columbia River.
Design Event	25 Year
Projected Flows	20 cfs
Roadway Classification	NA
Estimate	$132,500
Location	East of Euclid Avenue near Apple Capital Recreation Loop Trail

7.3.13 Westridge Place Maintenance Improvements

Project Number	MP-2
Project Summary	Clean and inspect roadside drainage ditches, driveway culverts and culverts. Disturbed ditches will be seeded to minimize future erosion.
Project Objective	Improve drainage characteristics of the existing roadside ditches to reduce flooding issues.
Design Event	NA
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Local Access
Estimate	$18,400
Location	Westpoint Place, Westridge Place and American Fruit Road

7.3.14 Crestview Maintenance Improvements

Project Number	MP-3
Project Summary	Clean and inspect roadside drainage ditches, driveway culverts and conveyance culverts. Disturbed ditches will be seeded to minimize future erosion.
Project Objective	Improve drainage characteristics of the existing roadside ditches and structures to reduce flooding issues.
Design Event	NA
Projected Flows	8.4 cfs
Roadway Classification	Urban Collector (Crestview Road) and Urban Minor Arterial (Easy Street)
Location	$20,200
Location	Crestview Road between Easy Street and American Fruit Road Easy Street between Crestview Road and School Street

7.3.15 Alpine Drive Maintenance Improvements

Project Number	MP-4
Project Summary	Clean and inspect roadside drainage ditches, driveway culverts and roadway crossing culverts. Disturbed ditches will be seeded to minimize future erosion.
Project Objective	Improve drainage characteristics of the existing roadside ditches to reduce flooding issues.
Design Event	NA
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Local Access
Estimate	$22,000
Location	Alpine Drive east of Crestview Street

7.3.16 Knowles Road Maintenance Improvements

Project Number	MP-5
Project Summary	Clean and inspect roadside drainage ditches, driveway culverts and roadway crossing culverts. Increase ditch capacity to increase flow capacity. Disturbed ditches will be seeded to minimize future erosion.
Project Objective	Improve drainage characteristics and increase capacity of the existing roadside ditches to reduce flooding issues.
Design Event	NA
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Collector
Estimate	$65,800
Location	Knowles Road north of American Fruit Road

7.3.17 School Street Maintenance Improvements

Project Number	MP-6
Project Summary	Clean and inspect roadside drainage ditches, driveway culverts and roadway crossing culverts. Construct ditches in areas without conveyance systems. Disturbed ditches will be seeded to minimize future erosion.
Project Objective	Improve drainage characteristics of the existing roadside ditches to reduce flooding issues.
Design Event	NA
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Collector and Urban Local Access
Estimate	$60,000

Location	School Street north of Melody Lane

7.3.18 Mari Lane Area Maintenance Improvements

Project Number	MP-7
Project Summary	Clean and inspect roadside drainage ditches, driveway culverts and roadway crossing culverts. Disturbed ditches will be seeded to minimize future erosion.
Project Objective	Improve drainage characteristics of the existing roadside ditches to reduce flooding issues.
Design Event	NA
Estimate	$30,000
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Local Access
Location	Mari Lane east of Burch Mountain Road

7.3.19 McMullan Road Maintenance Improvements

Project Number	MP-8
Project Summary	Remove existing curb, gutter and sidewalk that was installed in a rural area and construct roadside ditch for runoff conveyance.
Project Objective	Remove existing pedestrian safety issue and improve drainage characteristics of the existing roadside ditches to reduce flooding issues.
Design Event	25 Year
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Local Access
Estimate	$80,700
Location	McMullan Road north of Ohme Road

7.3.20 Chatham Hill Conveyance Improvements

Project Number	MP-9
Project Summary	Project includes making repairs to the existing collection system. Existing catch basins need to be evaluated for settlement issues, roadside curbs reviewed for conveyance issues and work includes cleaning the existing collection system structures and pipes.
Project Objective	Clean and repair existing structures, pipes and roadside curbs to ensure runoff can enter collection system. Minimize yearly maintenance.
Design Event	NA
Estimate	$56,800
Projected Flows	Less than 2 cfs
Roadway Classification	Urban Collector and Urban Local Access

Location	Indy Lane and Penny Road from Chatham Hill Road to LeMaster Avenue

7.3.21 Goodfellow Outfall Improvements

Project Number	DP-1
Project Summary	Work includes acquiring property along with development of new infiltration pond for the discharge out of the Ohme Garden Basin. The existing outfall lacks a defined pond structure. The old gravel pit will support infiltration of stormwater alleviating the need to construct a direct discharge to the Columbia River.
Project Objective	Develop infiltration system that can handle runoff from the Ohme Garden Basin. This system will need to be developed prior to development of other upstream system which will ultimately discharge into the final pond.
Design Event	100 Year for property purchase and 25 year for initial storage element
Projected Volume	700,000 cf (Dependent upon upstream storage)
Roadway Classification	NA
Estimate	$1,441,000
Location	East of Warehouse Way near Stemilt along the west bank of the Columbia River

7.3.22 Ohme Garden Basin No. 1

Project Number	DP-2
Project Summary	Work includes acquiring property along with development of a new stilling basin. This structure will minimize impacts to downstream property and collection systems by minimizing flows to downstream systems and preventing debris flows that have the potential to originate in the undeveloped land of Burch Mountain. This facility can be developed in stages depending on the availability of resources and funds to construct the project although it is recommended that the County acquire property in order to construct a facility sized for a 100 year storm event once completed.
Project Objective	Develop stilling basin to provide means for removing first flush debris and reduce flows before it has the chance to impact downstream systems. Obtain property that provides an opportunity to expand system as development funds are obtained.
Design Event	100 Year for property purchase and 25 year for initial storage element
Projected Volume	194,950 cf
Roadway Classification	NA
Estimate	$486,500
Location	Northeast of the termini of McMullan Road

7.3.23 Ohme Garden Basin No. 2

Project Number	DP-3
Project Summary	Work includes acquiring property along with development of a new stilling basin. This structure will minimize impacts to downstream property and collection systems by minimizing flows to downstream systems and preventing debris flows that have the potential to originate in the undeveloped land of Burch Mountain. This facility can be developed in stages depending on the availability of resources and funds to construct the project although it is recommended that the County acquire property in order to construct a facility sized for a 100 year storm event once completed.
Project Objective	Develop stilling basin to provide means for removing first flush debris and reduce flows before it has the chance to impact downstream systems. Obtain property that provides an opportunity to expand system as development funds are obtained.
Design Event	100 Year for property purchase and 25 year for initial storage element
Projected Volume	114,250 cf
Roadway Classification	NA
Estimate	$370,000
Location	Northwest of the termini of McMullan Road

7.3.24 Ohme Garden Basin No. 3

Project Number	DP-4
Project Summary	Work includes acquiring property along with development of a new stilling basin. This structure will minimize impacts to downstream property and collection systems by minimizing flows to downstream systems and preventing debris flows that have the potential to originate in the undeveloped land of Burch Mountain. This facility can be developed in stages depending on the availability of resources and funds to construct the project although it is recommended that the County acquire property in order to construct a facility sized for a 100 year storm event once completed.
Project Objective	Develop stilling basin to provide means for removing first flush debris and reduce flows before it has the chance to impact downstream systems. Obtain property that provides an opportunity to expand system as development funds are obtained.
Design Event	100 Year for property purchase and 25 year for initial storage element
Projected Volume	180,800 cf
Roadway Classification	NA
Estimate	$547,500
Location	West of Burch Mountain Road and north of Morning Wind Lane

7.3.25 Central Basin – Basin No. 1

Project Number	DP-5
Project Summary	Work includes acquiring property along with development of a new stilling basin. This structure will minimize impacts to downstream property and collection systems by minimizing flows to downstream systems and preventing debris flows that have the potential to originate in the undeveloped land of Burch Mountain. This facility can be developed in stages depending on the availability of resources and funds to construct the project although it is recommended that the County acquire property in order to construct a facility sized for a 100 year storm event once completed.
Project Objective	Develop stilling basin to provide means for removing first flush debris and reduce flows before it has the chance to impact downstream systems. Obtain property that provides an opportunity to expand system as development funds are obtained.
Design Event	100 Year for property purchase and 25 year for initial storage element
Projected Volume	94,500 cf
Roadway Classification	NA
Estimate	$422,500
Location	North of Elizabeth Court

7.3.26 Central Basin – Basin No. 2

Project Number	DP-6
Project Description	Work includes acquiring property along with development of a new stilling basin. This structure will minimize impacts to downstream property and collection systems by minimizing flows to downstream systems and preventing debris flows that have the potential to originate in the undeveloped land of Burch Mountain. This facility can be developed in stages depending on the availability of resources and funds to construct the project although it is recommended that the County acquire property in order to construct a facility sized for a 100 year storm event once completed.
Project Objective	Develop stilling basin to provide means for removing first flush debris and reduce flows before it has the chance to impact downstream systems. Obtain property that provides an opportunity to expand system as development funds are obtained.
Design Event	100 Year for property purchase and 25 year for initial storage element
Projected Volume	40,280 cf
Roadway Classification	NA
Location	North of Crestview Drive
Estimate	$262,600

7.4 Capital Funding Sources

7.4.1 Chelan County Stormwater Utility

In January 2008 Chelan County adopted a stormwater utility to manage stormwater needs in developing areas around Wenatchee. All developed properties containing impervious surfaces (impervious surface includes rooftops and paved areas) are charged a service fee. The service area does not include properties within the city of Wenatchee. These fees are billed on a yearly basis and property owners receive an invoice from the Chelan County Treasurers Office. In 2012 the County collected $330,000 in stormwater utility fees of which 60% ($198,000) is dedicated to capital improvements.

This fee has been developed to provide the County with means for maintaining existing systems and ultimately making minor improvements to the system. This funding source is not sufficient to develop major capital projects, but the funds may be used as a matching source for other funding programs. The County will need to continually evaluate the stormwater utility rates to determine if fees collected provide sufficient funds to provide financing for capital projects identified in this project.

7.4.2 Chelan County Roadway Projects

Funding for county roadway projects originates from various federal and state programs. Given that roadways generate stormwater runoff and stormwater improvements are an integral element to roadway projects, the County should evaluate all projects to determine if storm system improvements need to be upgrade in order to address regional stormwater issues. In these instances, the County could draw upon its stormwater utility funds to provide funding for upsizing pipes to handle regional issues.

7.4.3 Public Works Trust Fund Loans

The Public Works Trust Fund Board is authorized by state statute (RCW 43.155) to loan money to counties, cities, and special purpose districts to repair, replace, or create domestic water systems, sanitary sewer systems, storm drainage systems, roads, streets, solid waste and recycling facilities, and bridges.

These funds are broken down into preconstruction and construction activities. Construction activities focus on the activities that repair, replace or create a facility. Preconstruction activities include but are not limited to right-of-way acquisition, design work, engineering, permit acquisition, environmental review, cultural and historic resource and public notification.

Construction Loan applications are typically due in July with a loan limit of $10,000,000 per biennium with interest rates varying between 0.5 percent and 2 percent depending on local match. Loan terms are limited to the life of the project or twenty years. Preconstruction loan applications are accepted on a monthly basis depending on the availability of funding.

7.4.4 Centennial Clean Water Grant, State Revolving Fund Loan and Stormwater Retrofit

The United States Congress established the Clean Water State Revolving Fund (CWSRF) as part of the Clean Water Act (CWA) Amendments of 1987. The EPA offers states capitalization grants each year according to a formula established in the CWA. The capitalization grants are required to be matched with 20 percent state funds and are added to payments of principal and interest from previous loans. The combined funds are loaned out to eligible public bodies and repaid to

the CWSRF with interest. This means that the CWSRF continues to revolve and grow and more money becomes available to fund water quality projects. Today, the majority of the fund consists of repaid principal and interest.

The Centennial Clean Water Fund grants are available to hardship communities for up to $5 million and non-hardship communities up to $500,000. These applications are typically due by the first of December. Stormwater retrofit funding is also available for projects up to $500,000 but these projects require a 25% local match.

7.4.5 Municipal General Obligation Bond

A Municipal Bond is a common method of financing capital improvements for local governments that is secured by a state or local government's pledge to use tax revenues to repay bond holders. These bonds are a viable alternative for funding County projects.

Most general obligation pledges at the local government level include a pledge to levy a property tax to meet debt service requirements, in which case holders of general obligation bonds have a right to compel the borrowing government to levy that tax to satisfy the local government's obligation. Because property owners are usually reluctant to risk losing their holding due to unpaid property tax bills, credit rating agencies often consider a general obligation pledge to have very strong credit quality and frequently assign them investment grade ratings. If local property owners do not pay their property taxes on time in any given year, a government entity is required to increase its property tax rate by as much as is legally allowable in a following year to make up for any delinquencies. In the interim between the taxpayer delinquency and the higher property tax rate in the following year, the general obligation pledge requires the local government to pay debt service coming due with its available resources.

7.4.6 Community Development Block Grant Funds (CDBG)

Community Development Block Grant (CDBG) General Purpose Grants are made available annually through a competitive application process to assist Washington State small cities, towns and counties in carrying out significant community and economic development projects that principally benefit low-and moderate income persons. These funds are available to counties with less than 200,000 population that are non-entitlement jurisdiction or are not participants in a HUD urban county entitlement consortium. The County might want to consider using these funds for improvement to the public storm sewer system in low-income areas of the county.

7.4.7 Flood Control District

The purpose of a flood control district (District) is to protect life and property, preserve public health and conserve and develop natural resources. The county has the ability to form a district that would cover No. 1 Canyon, No. 2 Canyon and Dry Gulch to enable the District to levy and secure additional funding that would be utilized to make upgrades to drainage facilities in these areas. In accordance with Washington State statues, the county engineer is responsible to participate in the formation of the District.

7.4.8 Army Corps of Engineers Funding Opportunities

Chapter 5 and Appendix I describe the Corp's funding opportunities and eligibility requirements.

8 OLDS STATION DRAINAGE SYSTEM

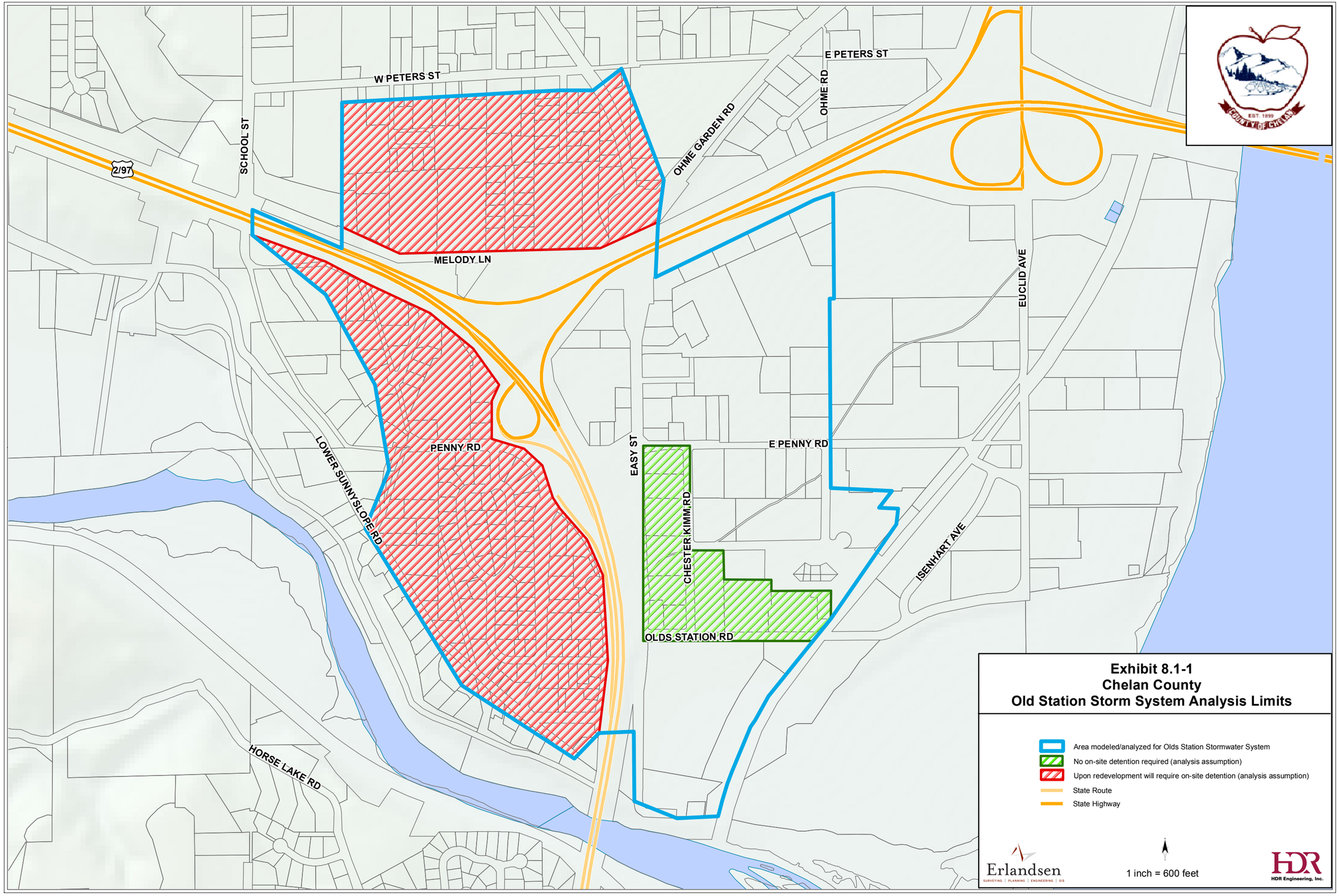
8.1 Olds Station Collection System History

The history of the Olds Station Collection system as depicted herein is based on documents provided by Chelan County. The Olds Station area currently consists of industrial, commercial and residential developments and is bordered on the south by the Wenatchee River and the Columbia River on the east. Wenatchee Avenue is a major roadway cutting through the western portion of the area and State Highway 2/97 is the predominant border to the north. Prior to the development in the past few decades, the area contained mostly orchards. As the land use for the Olds Station area changed to include more impervious cover, more and more runoff was adversely affecting the County's roads, particularly Penny Road. Early stormwater management consisted primarily of piping runoff to drywells or other limited infiltration systems. Siltation over time reduced the infiltration rate of these existing systems further limiting their capacity.

In 1990, a collection and conveyance system was constructed by WSDOT to receive runoff generated within the Highway 2 right-of-way, along Easy Street and at the lower end of the Sunnyslope area. The discharge point for stormwater accumulated in this system was a swale south of Olds Station Road on property owned by the Port of Chelan County. Stormwater that did not infiltrate within the swale (that ran along the west side of the BNRR tracks) would flow into the Wenatchee River via a small outfall. Over time, sediment collected in the swale reducing the infiltration capacity significantly.

Large events in 1994 overwhelmed some of these systems resulting in flooding. For example, the old Kmart Shopping Center (now the Gateway Cinema Complex) drains to an infiltration / retention pond near the south edge of the property. The overflow from the pond discharged through a pipe that conveys it to a structure on the shoulder of Penny Road where it surcharged adding to flooding along Penny Road and to the south. Various agencies (Chelan County, the Port of Chelan County, and the Washington State Department of Transportation - WSDOT,) cooperated to examine future drainage needs for the Olds Station area. A comprehensive stormwater management plan was developed in August 1995 to address this quickly developing region. The plan, prepared by RH2 Columbia Engineering, P.S., included the following:

- Capacity evaluation of the existing stormwater systems (Exhibit 8.1-1)
- Hydrologic and hydraulic analysis
- Recommendations for
    - stormwater standards and guideline policies
    - system improvements (Columbia River discharge system, pipe upsizing, provide detention at undeveloped sites, and a regional conveyance system with two alternative alignments)
    - water quality issues (oil water separators and sediment removal)
    - on-site systems versus a regional system (discussion)
    - maintenance
- Estimate of construction costs
- Potential funding options.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EASY ST
CHESTER KIMM RD
ISENHART AVE
LOWER SUNNYSLOPE RD
OLDS STATION RD
HORSE LAKE RD
Exhibit 8.1-1
Chelan County
Old Station Storm System Analysis Limits
Area modeled/analyzed for Olds Station Stormwater System
No on-site detention required (analysis assumption)
Upon redevelopment will require on-site detention (analysis assumption)
State Route
State Highway
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
1 inch = 600 feet
HDR
HDR Engineering, Inc.

8.2 West Alignment

The October 1997 Olds Station Storm Drainage Modeling and Design Report prepared by RH2 Columbia Engineering evaluated the west alignment of the Olds Station Stormwater System, an area covering approximately 200 acres. The report, prepared for the County, was completed as part of the design of storm drainage improvements along Horan and Olds Station Roads and included the cooperation of the Port of Chelan County and the WSDOT. It further stated in the report, "The Port of Chelan County has agreed to take the lead in construction of the remainder of the collection system, sedimentation pond and river outflow that will serve Port properties and other commercial properties in the Olds Station area. Chelan County will financially participate in the design and construction of the sedimentation pond and outfall."

In general the area serviced by the west alignment includes Olds Station Road (west of the BNRR tracks); and the area bordered by Easy Street on the east, Chatham Hill Road on the south, School Street on the west and Peters Street West on the north. Chester Kimm Road is also part of this alignment and located in the southeastern portion of the service area.

Several different storm hydrographs were used to estimate stormwater runoff and included the 6 hour 25 year (WSDOT), 6 hour 100 year (WSDOT), and 24 hour 25 year SCS Type II design storm events. Assumptions for the model included:

- The Sunnyslope area (north of Hwy 2/97) was modeled as pre-developed with 10 percent impervious area and upon redevelopment would require on-site detention. This area was estimated to cover approximately 46.1 acres.
- The area west of the interchange of Hwy 2/97 and North Wenatchee Avenue was modeled as residential with up to 1.8 units per acre and upon redevelopment would require on-site detention. This area was estimated to cover approximately 71.5 acres. The interchange was also included in the existing conditions.
- The areas bounded by East Penny Road, Chester Kimm Road and Easy Street; and along the north edge of Olds Station Road were modeled requiring no on-site detention and were fully developed with 90 percent impervious surfacing. This area was estimated to cover approximately 20.6 acres.
- The storm system improvements would begin on Easy Street (just north of Olds Station Road) and outflow into the proposed Port of Chelan County's Stormwater System located along the west side of the BNRR tracks.

The report indicated that the peak discharge rate for the design events (at the outlet of the system) was 104 cfs, 214 cfs and 78 cfs for the 6 hour 25 year (WSDOT), 6 hour 100 year (WSDOT), and 24 hour 25 year SCS Type II storm events, respectively. A flow volume of 164,000 cubic feet at the outlet was noted for the 6 hour 25 year event. The report did not include the area east of Chester Kimm Road and portions of the basin north of Penny Road and west of the BNRR tracks.

Design guidelines were provided in the report that cover flows, alignment, pipe size and materials, and minimum grade. A backwater analysis considering the 6 hour 25 year Ecology event showed that there is a surcharge potential at the intersection of Horan Road and Olds Station Road and that all other locations were at least six inches below the proposed structure rim elevations. For the 100 year event, the backwater analysis summary indicated that surcharging would likely occur along both Horan Road and Olds Station Road. Report recommendations suggested that field flow data be recorded and calibrated with the model to obtain greater accuracy with future models. An additional recommendation proposed installing higher than normal curbs to increase the carrying capacity of the roadway, specifically along Horan and Olds Station Roads.

8.3 East Alignment

The east alignment includes the remainder of the conveyance system that is not contained in the west alignment described above. It extends from the main 72-inch concrete conveyance pipe near the BNRR crossing at Olds Station road northeast along the west side of the tracks, then changes to a northwesterly direction to the collection system servicing Technology Center Way, Penny Road (east of Technology Center Way) and potential overflows from the retail development where Gateway Cinema is located.

RH2 had mapped the existing stormwater systems as part of their 1995 Comprehensive Stormwater Management Plan. Their summary figure (Figure 3.1 in 1995 Report) depicting the Olds Station Area Existing Storm Systems, indicates that the stormwater system in Penny Road (consisting of interconnected catch basins and manholes) was continuous from Chester Kimm Avenue to much of the Euclid Avenue. The report further comments that a direct discharge line to the Columbia River was constructed in 1993 to handle overflows from the Penny/Euclid collection system. More recent work shows that the Penny Road collection system is not continuous. There two segments that are separated near the intersection with Technology Center Way which was constructed subsequent to 1995. The westernmost segment is part of the Olds Station east alignment. The eastern segment continues to contribute to the flows that are directed toward the Columbia River as does the infrastructure that exists in Euclid and the east end of Olds Station Road.

It is our understanding that Forsgren Associates, Inc. worked on the evaluation/design of the east alignment of the collection system, the sedimentation pond and river outflow for the Port of Chelan County around the time that RH2 was working on the West Alignment. Since the two systems were to be joined, a common approach was sought. Discussions over the effective impervious area, precipitation events, DOT subcatchment delineation, culvert sizes and other differences of opinion/methodology resulted in a separate modeling of the Olds Station area that was conducted by Aqua Terra Consultants. It was this last analysis that was used to size the collection system in Technology Center Way that completed the East Alignment connecting Penny Road to the main conveyance line and the large settling basin for the system.

8.4 Design Considerations

Aqua Terra's analysis reflected effective impervious area values as specified by the SWMM manual. Their evaluation included SCS Type II 24 hour storm event and Washington State Department of Ecology (Ecology) short duration storm for Region 1 methodologies with the idea

that the more conservative method (highest peaks) would be used for design. The model included all areas that would foreseeably contribute to the planned stormwater system. All culverts were assumed to be properly sized so that no surcharging would occur and the widths for each DOT subcatchment were adjusted to better reflect their actual widths.

The results of the modeling are presented in a report dated July 17, 1998 and were used to size the settling basin and determine the 25 and 100- year peak flood events. Peak diversion flow into the basin was calculated using the 6-month peak flow (6 month six hour precipitation event for Ecology and 6 month 24 hour precipitation event for SCS) and was shown as the maximum flow rate that can be diverted to the basin. The peak flows were 29.6 cfs using Ecology criteria and 30.1 cfs with the SCS criteria. A holding time of 36 hours within the basin was the desired goal. Using the 6 month events, the holding times ranged from 7.3 to 38.8 hours.

Culverts within the conveyance system were analyzed to determine if surcharging existed as a result of the peak flows estimated by 25 year and 100 year Ecology storm events. Recommendations for upsizing 15 culverts located in various parts of the system (DOT, Port, County, diversion structure, by-pass pipe, inlet to pond and outlet to river) were included in the report and the recommended pipe upsizings were listed for both 25 year and 100 year events to prevent surcharging. In some cases, the specified upsize would accommodate either of the storm events, in others the 100 year event required a larger diameter pipe than the 25 year event.

The Olds Station area was analyzed for both Ecology and SCS methodologies using 25 year and 100 year storm events to determine peak flow rates and volumes. The results of this analysis are listed in the following tables:

PEAK FLOW	Ecology	SCS
25-year storm		
Inflow to pond (cfs)	29.6	29.7
Outfall to river (cfs)	282.5	137.0
100-year storm		
Inflow to pond (cfs)	29.7	29.7
Outfall to river (cfs)	405.0	194.1

VOLUME	Ecology	SCS
25-year storm		

Inflow to pond (cf)	161,000	802,000
Outfall to river (cf)	470,000	1,340,00
<u>100-year storm</u>		
Inflow to pond (cf)	192,000	947,000
Outfall to river (cf)	651,000	1,710,00

8.5 Mainline Conveyance and Settling Basin

Construction plans for Port of Chelan County Olds Station Regional Stormwater Project , dated September, 1999, were prepared by Forsgren. The plans show:

- Approximately 3400 feet of conveyance pipe ranging in diameter from 24 to 72 inches,
- 12 manholes/catch basins,
- The connection to the existing stormwater system in Olds Station Road,
- A 14-foot square diversion structure with an internal weir that diverts lower flows to the settling basin and allows high flows to continue toward the Wenatchee River,
- An approximately 380,000 cubic foot settling basin with an outlet control structure (96" diameter manhole connected to the mainline with a 30-inch pipe), the top/inlet/rim for the structure is set ±8 feet above the bottom of the basin. The structure also includes a 7-inch diameter control orifice located with the invert set 12 inches above the pond bottom. Based on the dimensions shown, the base area of the basin is ±33,257 square feet with 2:1 H:V side-slopes and the overall depth of the basin is ±14 feet at the south end and ±22 feet at the north end. An overall storage of 821,064 can be calculated assuming the 14-foot depth and excluding the access ramps.
- A stilling basin / outflow to the Wenatchee River

Subsequent to the construction, a survey was conducted by Erlandsen in 2010 that indicates that the base area is ±30,634 square feet. The outlet structure rim is set 7.43 feet above the base elevation of 636.51 providing approximately 369,327 cubic feet of storage. The overall depth of the basin is 14.78 feet which would allow for a total of over one million cubic feet of storage should the outlet structure fail.

The survey also mapped the stormwater conveyance systems locating structures and recording pipe types, sizes and grades.

8.6 Olds Station Drainage System Recommendations

The following recommendations should be considered for future development within the Olds Station drainage basin and for connections to the Olds Station Regional Stormwater System:

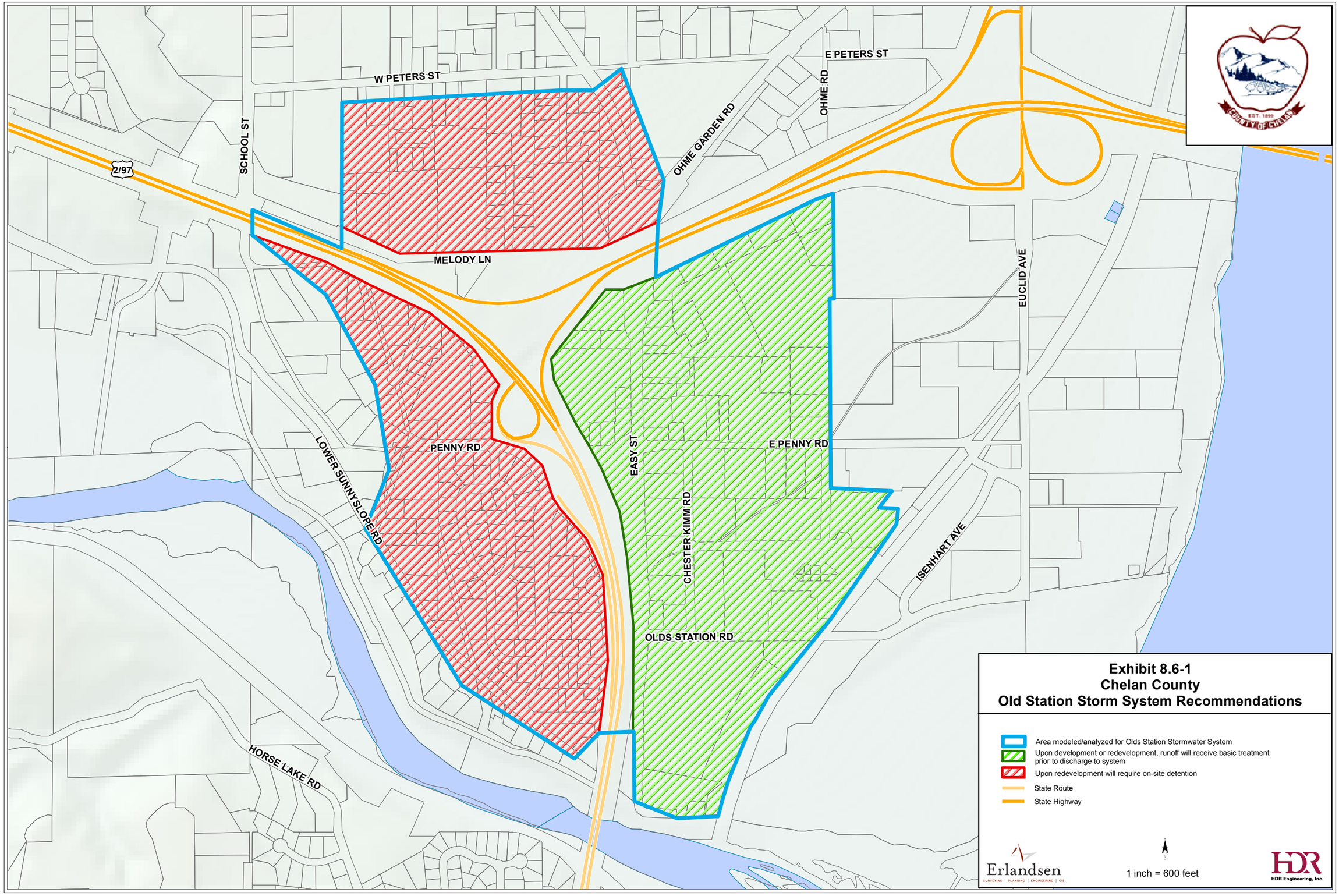
- Stormwater runoff from any new development (or redevelopment) that will be connected to the regional system should receive basic treatment prior to discharge to the system. Basic treatment facilities, per the Ecology's SWMMEW, are intended to remove 80 percent of total suspended solids. The water quality design storm is the 6 month, 24 hour event.

- Areas that are designated to require detention as part of redevelopment should maintain this designation.

- At a minimum, annual maintenance should be required on all private systems that are connected to the regional system. Periodic maintenance throughout the system will significantly reduce sedimentation in the large settling basin.

- Periodic maintenance should be completed on all components within the public portion of the system.

(The areas for the first two recommendations are delineated in Exhibit 8.6-1.)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EASY ST
CHESTER KIMM RD
LOWER SUNNYSLOPE RD
ISENHART AVE
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HORSE LAKE RD
Exhibit 8.6-1
Chelan County
Old Station Storm System Recommendations
Area modeled/analyzed for Olds Station Stormwater System
Upon development or redevelopment, runoff will receive basic treatment prior to discharge to system
Upon redevelopment will require on-site detention
State Route
State Highway
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
1 inch = 600 feet
HDR
HDR Engineering, Inc.

9 Miscellaneous documents

9.1 SEPA Checklist

WAC 197-11-960 Environmental Checklist

ENVIRONMENTAL CHECKLIST

Purpose of checklist:

The State Environmental Policy Act (SEPA), chapter 43.21C RCW, requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. An environmental impact statement (EIS) must be prepared for all proposals with probable significant adverse impacts on the quality of the environment. The purpose of this checklist is to provide information to help you and the agency identify impacts from your proposal (and to reduce or avoid impacts from the proposal, if it can be done) and to help the agency decide whether an EIS is required.

Instructions for applicants:

This environmental checklist asks you to describe some basic information about your proposal. Governmental agencies use this checklist to determine whether the environmental impacts of your proposal are significant, requiring preparation of an EIS. Answer the questions briefly, with the most precise information known, or give the best description you can.

You must answer each question accurately and carefully, to the best of your knowledge. In most cases, you should be able to answer the questions from your own observations or project plans without the need to hire experts. If you really do not know the answer, or if a question does not apply to your proposal, write "do not know" or "does not apply." Complete answers to the questions now may avoid unnecessary delays later.

Some questions ask about governmental regulations, such as zoning, shoreline, and landmark designations. Answer these questions if you can. If you have problems, the governmental agencies can assist you.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Use of checklist for nonproject proposals:

Complete this checklist for nonproject proposals, even though questions may be answered "does not apply." IN ADDITION, complete the SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS (part D).

For nonproject actions, the references in the checklist to the words "project," "applicant," and "property or site" should be read as "proposal," "proposer," and "affected geographic area," respectively.

1) BACKGROUND

a) Name of proposed project, if applicable:
2012 Greater Wenatchee Area Stormwater Comprehensive Plan

b) Name of applicant:
Chelan County

c) Address and phone number of applicant and contact person:
c/o Jason Detamore, Stormwater Program Manager
316 Washington, Suite 402
Wenatchee, WA 98801
Phone: (509) 667-6415

d) Date checklist prepared:
April 20, 2012

e) Agency requesting checklist:
Chelan County

f) Proposed timing or schedule (including phasing, if applicable):
Chelan County is developing a comprehensive stormwater plan. Implementation of the proposed plan will be phased.

g) Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.
The 2012 plan provides a foundation for future infrastructure improvements. The 2012 schedule of capital improvements will be evaluated and may be reprioritized based upon current needs and available funding as the County's Operation is updated. Environmental review, as applicable, will occur at the time capital projects are specifically proposed and at the design and permitting process.

h) List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

Additional environmental and cultural investigations will be required for capital improvements proposed by the 2012 Comprehensive Plan.

i) Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.
There are no other applications pending for governmental approvals of other proposals directly affecting this proposal. In the future, individual projects related to the 2012 Plan may require governmental approvals. Such required approvals will be sought, as applicable, for the individual projects prior to construction. Because this proposal is a non-project action - a comprehensive stormwater plan covering service to a large geographical area – other unrelated public or private proposals and government approvals may be pending that could affect the project.

j) List any government approvals or permits that will be needed for your proposal, if known.
Future construction projects will require county and other agency review and approval prior to construction.

k) Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The proposal is a non-project action involving the approval of the 2012 Greater Wenatchee Area Stormwater Management Plan. The 2012 Plan serves as a tool to assist the County in making the best use of available resources.

l) Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The County is located in North Central Washington. The plan covers areas, within the County, but around the County of Wenatchee. The project area is further defined as the Chelan County Stormwater Utility Service Area.

2) ENVIRONMENTAL ELEMENTS

a) Earth

i) General description of the site (circle one): **Flat, rolling, hilly**, steep slopes, mountainous, other.

The proposal is a non-project action. More specific information regarding the site will be determined during project level environmental review.

ii) What is the steepest slope on the site (approximate percent slope)?

The proposal is a non-project action. More specific information regarding steep slopes will be determined during project level environmental review.

iii) What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

The proposal is a non-project action. More specific information regarding soil types will be determined during project level environmental review.

iv) Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

The proposal is a non-project action. More specific information regarding unstable soils will be determined during project level environmental review.

v) Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

The proposal is a non-project action. Filling and/or grading activity could occur in association with future capital improvement and/or O&M projects. This issue will be addressed for each water system project, as applicable.

vi) Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

The proposal is a non-project action. More specific information on the potential of erosion occurring will be determined during environmental review and permitting of individual projects.

vii) About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

The proposal is a non-project action. The amount of impervious surfaces resulting from the construction of capital projects will be identified during design and environmental review when individual projects are proposed. All future projects will comply with applicable stormwater requirements.

viii) Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

The proposal is a non-project action. Measures to reduce or control erosion will be identified during design, permitting and environmental review of individual projects. All future projects will comply with applicable stormwater and other regulatory requirements.

b) Air

i) What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, and industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.

The proposal is a non-project action. This issue will be addressed for each water system project, as applicable.

ii) Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

The proposal is a non-project action. This issue will be addressed for each water system project, as applicable.

iii) Proposed measures to reduce or control emissions or other impacts to air, if any:

The proposal is a non-project action. This issue will be addressed for each water system project, as applicable.

c) Water

i) Surface

(1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

The proposal is a non-project action. Specific information on surface water bodies located near individual stormwater projects will be determined during project environmental review.

(2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

The proposal is a non-project action. Specific information on surface water bodies located near individual stormwater projects will be determined during project environmental review.

(3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

Not Applicable.

(4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

Not Applicable.

(5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

The proposal is a non-project action. Specific information on floodplains located near individual stormwater projects will be determined during project environmental review.

(6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

The proposal is a non-project action involving the approval of the 2012 Plan by Chelan County. Individual capital projects contained in the 2012 Plan may result in the discharge of waste materials to surface waters. Information regarding the discharge of waste materials will occur during project level environmental review. All projects will comply with jurisdictions' waste discharge regulations, where applicable.

ii) Ground:

(1) Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.

The proposal is a non-project action involving the approval of the 2012 Plan by Chelan County.

(2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals . . . ; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

Not Applicable.

(iii) Water runoff (including stormwater):

(1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

The proposal is a non-project action. More specific information on the potential for runoff and the identification of receiving waters, if present, will be determined during environmental review and permitting of individual projects. All projects will comply with stormwater runoff regulations, where applicable.

(2) Could waste materials enter ground or surface waters? If so, generally describe.

The proposal is a non-project action. The construction of capital improvements as recommended in the 2012 Plan could temporarily discharge waste materials, which will be controlled with project and site-specific best management practices and other project-specific mitigation measures.

(iv) Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

The proposal is a non-project action. The construction of capital improvements as recommended in the 2012 Plan could temporarily discharge materials during the construction period. Project and site-specific best management practices and other project-specific mitigation measures will be implemented during the construction period.

d) Plants

i) Check or circle types of vegetation found on the site:

- **deciduous tree**: alder, maple, aspen, other
- **evergreen tree**: fir, cedar, pine, other
- **shrubs**
- **grass**
- **pasture**
- **crop or grain**
- wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other

The proposal is a non-project action addressing water service to a large geographical area. Information that is more specific will be determined during project level environmental review.

ii) What kind and amount of vegetation will be removed or altered?

The proposal is a non-project action. More specific information will be determined during project level environmental review. The majority of the construction and maintenance activities conducted by County will occur in improved rights-of-way or newly constructed rights-of-way and will, therefore, result in minimal removal of vegetation.

iii) List threatened or endangered species known to be on or near the site.

The proposal is a non-project action addressing stormwater. More specific information in regards to the presence of threatened or endangered vegetation will be determined during project level environmental review.

iv) Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

The proposal is a non-project action. More specific information will be determined during individual project design, permitting and environmental review.

e) Animals

i) Circle any birds and animals which have been observed on or near the site or are known to be on or near the site:

- **birds**: hawk, heron, eagle, songbirds, other:
- **mammals**: deer, bear, elk, beaver, other:
- **fish**: bass, salmon, trout, herring, shellfish, other:

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

ii) List any threatened or endangered species known to be on or near the site.

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

iii) Is the site part of a migration route? If so, explain.

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

iv) Proposed measures to preserve or enhance wildlife, if any:

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

f) Energy and natural resources

i) What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Current County facilities use electricity, natural gas and/or petroleum. The programs and future projects contained in the 2012 Plan are not anticipated to require any major increases in regional long-term energy use.

ii) Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

Not Applicable.

iii) What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

g) Environmental health

i) Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste that could occur as a result of this proposal? If so, describe.

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

(1) Describe special emergency services that might be required.

Not Applicable.

(2) Proposed measures to reduce or control environmental health hazards, if any:

The proposal is a non-project action. The County implements an operations and maintenance program to prevent environmental health hazards from occurring. Protocols for control and disposal of hazardous materials associated with individual projects will be evaluated during environmental review of individual projects.

ii) Noise

(1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

The proposal is a non-project action. More specific information on potential sources of noise that may affect specific projects will be determined during environmental review and permitting of individual projects.

(2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

The proposal is a non-project action. Noise impacts associated with construction activity could occur as specific recommended projects are constructed. The County will evaluate project and site-specific impacts and propose appropriate mitigation measures, when necessary, during environmental review and permitting for individual stormwater projects.

(3) Proposed measures to reduce or control noise impacts, if any:

The proposal is a non-project action. The County will evaluate project and site specific impacts and propose appropriate mitigation measures, when necessary, during environmental review and permitting for individual stormwater projects.

h) Land and shoreline use

i) What is the current use of the site and adjacent properties?

The proposal is a non-project action. More specific information on current uses of individual sites will be determined during project-level environmental review.

ii) Has the site been used for agriculture? If so, describe.

The proposal is a non-project action. More specific information on current uses of individual sites will be determined during project-level environmental review.

iii) Describe any structures on the site.

The proposal is a non-project action. The County will evaluate project and site specific impacts and propose appropriate mitigation measures, when necessary, during environmental review and permitting for individual stormwater projects.

iv) Will any structures be demolished? If so, what?

The proposal is a non-project action. More specific information on current uses of individual sites will be determined during project-level environmental review.

v) What is the current zoning classification of the site?

The proposal is a non-project action involving the approval of the 2012 Plan. Zoning within the project site varies.

vi) What is the current comprehensive plan designation of the site?

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

vii) If applicable, what is the current shoreline master program designation of the site?

The proposal is a non-project action. Specific information on the status of the designation of individual sites as covered by an individual jurisdictions'' shoreline master program will occur during design, permitting and project-level environmental review.

viii) Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

The area served by County contains environmentally sensitive areas. The projects recommended in the 2012 Plan could affect environmentally sensitive areas and would, therefore, be subject to local critical areas regulations. Critical areas can include geologic and seismic hazards, flood prone areas, riparian corridors, wetlands, fish and wildlife habitat conservation areas, and abandoned landfills and mines. Critical areas are mapped by the local jurisdiction. The presence of potential critical areas and site-specific impacts and mitigation will be evaluated when projects are reviewed under future SEPA and permitting.

ix) Approximately how many people would reside or work in the completed project?

Not Applicable.

x) Approximately how many people would the completed project displace?

It is anticipated that implementation of the 2012 Plan will not result in the displacement of any people. Potential displacement impacts and any necessary mitigation measures will be evaluated during future design and environmental review when individual projects are pursued.

xi) Proposed measures to avoid or reduce displacement impacts, if any:

Not Applicable.

xii) Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The proposal is a non-project action involving the approval of the 2012 Plan by Chelan County. The 2012 Plan demonstrates how the County will control stormwater within its service area into the future based upon the comprehensive plan land use designations established by individual land use authorities. Growth and development patterns established by individual jurisdictions have been considered.

i) Housing

i) Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

The proposal is a non-project action. The implementation of the 2012 Plan will not result in the additional of housing units available to the general public.

ii) Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

Not Applicable.

iii) Proposed measures to reduce or control housing impacts, if any:

Not Applicable.

j) Aesthetics

i) What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

ii) What views in the immediate vicinity would be altered or obstructed?

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

iii) Proposed measures to reduce or control aesthetic impacts, if any:

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

k) Light and glare

i) What type of light or glare will the proposal produce? What time of day would it mainly occur?

The proposal is a non-project action. Implementation of the 2012 Plan is not anticipated to result in the introduction of new major sources of light or glare.

ii) Could light or glare from the finished project be a safety hazard or interfere with views?

Not Applicable.

iii) What existing off-site sources of light or glare may affect your proposal?

None

iv) Proposed measures to reduce or control light and glare impacts, if any:

Lighting requirements will be determined during design and will comply with current lighting standards associated with the applicable jurisdiction's development regulations.

l) Recreation

i) What designated and informal recreational opportunities are in the immediate vicinity?

The proposal is a non-project action. The existence of recreational opportunities will be identified during project specific environmental review.

ii) Would the proposed project displace any existing recreational uses? If so, describe.

The implementation of the water projects recommended in the 2012 Plan will not result in the displacement of any existing recreational uses.

iii) Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

Not Applicable.

m) Historic and cultural preservation

i) Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

The proposal is a non-project action. The existence of sites of historical significance will be identified during project specific environmental review.

ii) Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

Not Applicable.

iii) Proposed measures to reduce or control impacts, if any:

Not Applicable.

n) Transportation

i) Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

ii) Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

iii) How many parking spaces would the completed project have? How many would the project eliminate?

The proposal is a non-project action. Information regarding parking spaces associated with stormwater projects will be identified during project-specific design, permitting and environmental review.

iv) Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

v) Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

The proposal is a non-project action. Additional information will be developed during environmental review of specific stormeater improvement projects.

vi) How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

Future projects anticipated under the proposed plan will generate minimal traffic during operation, if any.

vii) Proposed measures to reduce or control transportation impacts, if any:

Construction of projects will include mitigation measures to reduce short-term impacts on affected roadways and other transportation facilities.

o) Public services

i) Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.

Not Applicable.

ii) Proposed measures to reduce or control direct impacts on public services, if any.

Not Applicable.

p) Utilities

i) Circle utilities currently available at the site: **electricity**, natural gas, **water, refuse service**, **telephone**, sanitary sewer, **septic system**, other.

The proposal is a non-project action. Specific information on utilities available at individual sites will be determined during project level design, permitting and environmental review.

ii) Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

3) SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature of Proponent/Applicant:

Date Submitted:

D. SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS

(Do not use this sheet for project actions.)

Because these questions are very general, it may be helpful to read them in conjunction with the list of the elements of the environment.

When answering these questions, be aware of the extent the proposal or the types of activities likely to result from the proposal, would affect the item at a greater intensity or at a faster rate than if the proposal were not implemented. Respond briefly and in general terms.

a) How would the proposal be likely to increase discharge to water; emissions to air; production, storage, or release of toxic or hazardous substances; or production of noise?
   Capital improvement projects and/or maintenance projects proposed in the 2012 Plan may result in temporary construction equipment exhaust, dust and noise.

b) Proposed measures to avoid or reduce such increases are:
   This issue will be addressed for each capital improvement project and/or maintenance project during individual project permitting and environmental review.

c) How would the proposal be likely to affect plants, animals, fish or marine life?
   Capital improvement projects and/or maintenance projects proposed in the 2012 Plan will generally occur in already distributed areas, such as rights-of way, therefore minimal effects on species are expected.

d) Proposed measures to protect or conserve plants, animals, fish or marine life are:
   This issue will be addressed for each capital improvement project and/or maintenance project during individual project permitting and environmental review.

e) How would the proposal be likely to deplete energy or natural resources?
   Not Applicable

f) Proposed measures to protect or conserve energy and natural resources are:
   The proposal is a non-project action addressing stormwater to a large geographical area. Information that is more specific would be determined during project level environmental review.

g) How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?
   This issue will be addressed for each capital improvement project and/or maintenance project during individual project permitting and environmental review.

h) Proposed measures to protect such resources or to avoid or reduce impacts are:
   The County will implement utility maintenance activities will be carried out consistent with the federally approved "Regional Road Maintenance Endangered Species Act Program Guidelines".

i) How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?

The 2012 Plan is consistent with and supports implementation of applicable individual jurisdictions' adopted comprehensive land use plans.

j) Proposed measures to avoid or reduce shoreline and land use impacts are:
Not Applicable.

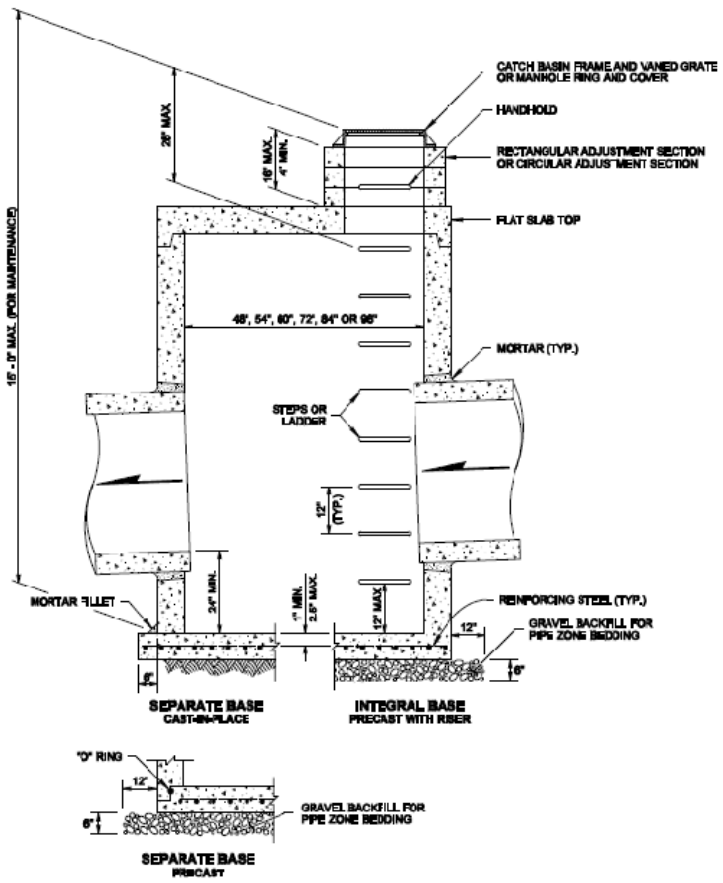
k) How would the proposal be likely to increase demands on transportation or public services and utilities?
The 2012 Plan is consistent with and supports implementation of applicable individual jurisdictions' adopted comprehensive land use plans.

l) Proposed measures to reduce or respond to such demand(s) are:
Under the 2012 Plan, the County will continue to implement a conservation program.

m) Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.
Not Applicable.

APPENDIX A

Figure 1



NOTES

1. No steps are required when height is 4' or less.
2. The bottom of the precast catch basin may be sloped to facilitate cleaning.
3. The rectangular frame and grate may be installed with the flange up or down. The frame may be cast into the adjustment section.
4. Knockouts shall have a wall thickness of 2" minimum to 2.5" maximum. Provide a 1.5" minimum gap between the knockout wall and the outside of the pipe. After the pipe is installed, fill the gap with joint mortar in accordance with Standard Specification 9-04.3.

CATCH BASIN DIMENSIONS

CATCH BASIN DIAMETER	WALL THICKNESS	BASE THICKNESS	MAXIMUM KNOCKOUT SIZE	MINIMUM DISTANCE BETWEEN KNOCKOUTS	BASE REINFORCING STEEL in^2/ft. IN EACH DIRECTION	
					SEPARATE BASE	INTEGRAL BASE
48"	4"	6"	36"	8"	0.23	0.15
54"	4.5"	8"	42"	8"	0.19	0.19
60"	5"	8"	48"	8"	0.25	0.25
72"	6"	8"	60"	12"	0.35	0.24
84"	8"	12"	72"	12"	0.39	0.29
96"	8"	12"	84"	12"	0.39	0.29

PIPE ALLOWANCES

CATCH BASIN DIAMETER	PIPE MATERIAL WITH MAXIMUM INSIDE DIAMETER				
	CONCRETE	ALL METAL	CPSSP ①	SOLID WALL PVC ②	PROFILE WALL PVC ③
48"	24"	30"	24"	27"	30"
54"	30"	36"	30"	27"	36"
60"	36"	42"	36"	36"	42"
72"	42"	54"	42"	36"	48"
84"	54"	60"	54"	36"	48"
96"	60"	72"	60"	36"	48"

① Corrugated Polyethylene Storm Sewer Pipe (Std. Spec. 9-05.20)
② (Std. Spec. 9-05.12(1))
③ (Std. Spec. 9-05.12(2))

CATCH BASIN TYPE 2

STANDARD PLAN B-10.20-00

SHEET 1 OF 1 SHEET

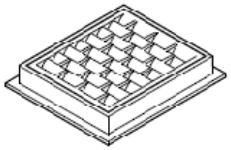
APPROVED FOR PUBLICATION

Harold J. Peterseo 06-01-06

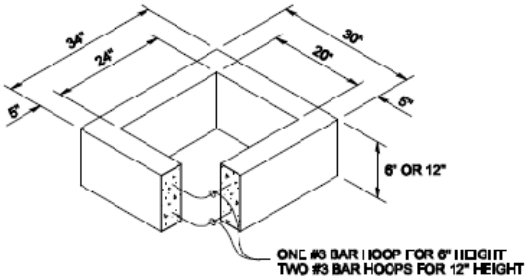
STATE DESIGN ENGINEER DATE

Washington State Department of Transportation

Figure 2



FRAME AND VANED GRATE



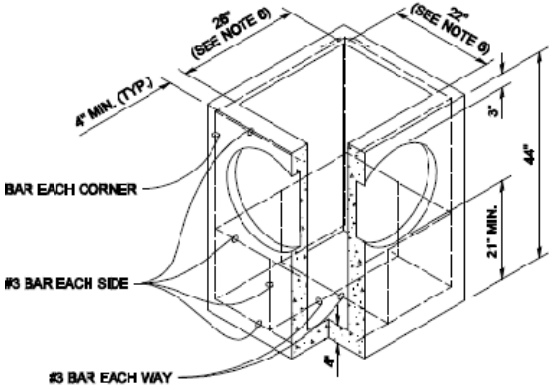
RECTANGULAR ADJUSTMENT SECTION

PIPE ALLOWANCES	
PIPE MATERIAL	MAXIMUM INSIDE DIAMETER
REINFORCED OR PLAIN CONCRETE	12"
ALL METAL PIPE	15"
CPSSP * (STD SPEC. 9-05.20)	12"
SOLID WALL PVC (STD SPEC. 9-05.12(1))	15"
PROFILE WALL PVC (STD SPEC. 9-05.12(2))	15"

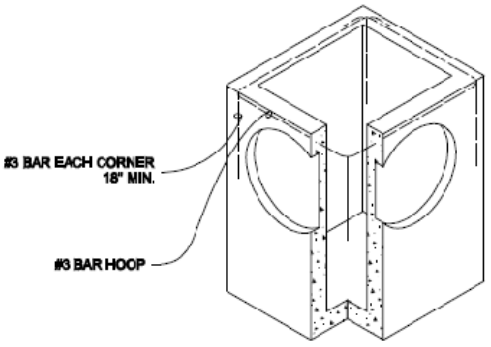
* CORRUGATED POLYETHYLENE STORM SEWER PIPE

NOTES

1. As acceptable alternatives to the rebar shown in the **PRECAST BASE SECTION**, fibers (placed according to the Standard Specifications), or wire mesh having a minimum area of 0.12 square inches per foot shall be used with the minimum required rebar shown in the **ALTERNATIVE PRECAST BASE SECTION**. Wire mesh shall not be placed in the knockouts.
2. The knockout diameter shall not be greater than 20". Knockouts shall have a wall thickness of 2" minimum to 2.5" maximum. Provide a 1.5" minimum gap between the knockout wall and the outside of the pipe. After the pipe is installed, fill the gap with joint mortar in accordance with Standard Specification 9-04.3.
3. The maximum depth from the finished grade to the lowest pipe invert shall be 5'.
4. The frame and grate may be installed with the flange up or down. The frame may be cast into the adjustment section.
5. The Precast Base Section may have a rounded floor, and the walls may be sloped at a rate of 1:24 or steeper.
6. The opening shall be measured at the top of the precast base section.
7. All pickup holes shall be grouted full after the basin has been placed.

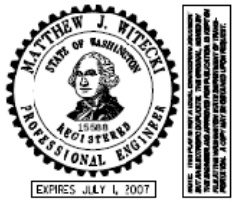


PRECAST BASE SECTION



SEE NOTE 1

ALTERNATIVE PRECAST BASE SECTION



CATCH BASIN TYPE 1

STANDARD PLAN B-5.20-00

SHEET 1 OF 1 SHEET

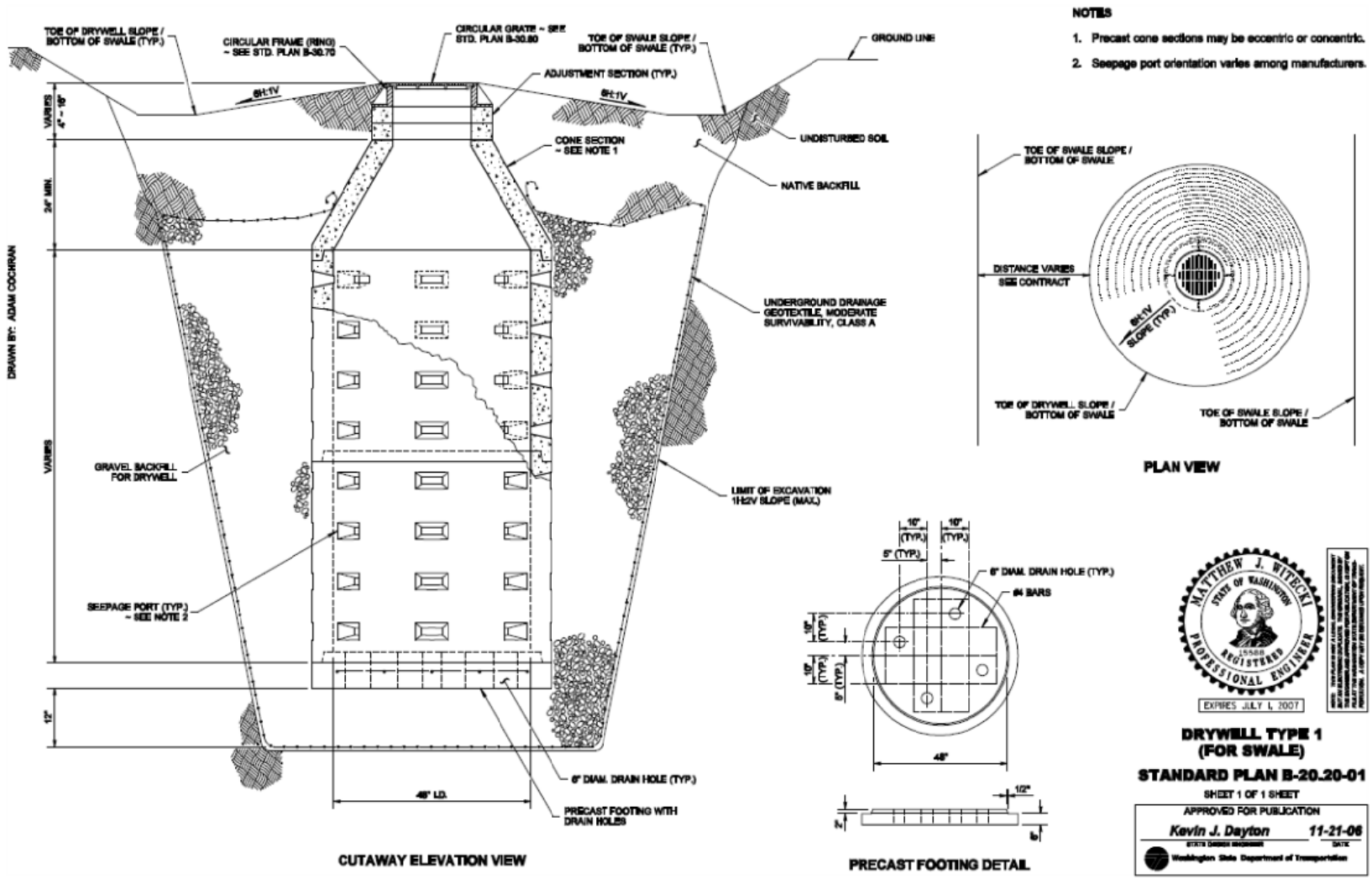
APPROVED FOR PUBLICATION

Harold J. Peterfeso *06-01-06*

STATE DESIGN ENGINEER — DATE

Washington State Department of Transportation

Figure 3


NOTES
1. Precast cone sections may be eccentric or concentric.
2. Seepage port orientation varies among manufacturers.
TOE OF DRYWELL SLOPE / BOTTOM OF SWALE (TYP.)
CIRCULAR FRAME (RING) ~ SEE STD. PLAN B-30.70
CIRCULAR GRATE ~ SEE STD. PLAN B-30.80
TOE OF SWALE SLOPE / BOTTOM OF SWALE (TYP.)
GROUND LINE
ADJUSTMENT SECTION (TYP.)
6H:1V
CONE SECTION ~ SEE NOTE 1
UNDISTURBED SOIL
NATIVE BACKFILL
UNDERGROUND DRAINAGE GEOTEXTILE, MODERATE SURVIVABILITY, CLASS A
GRAVEL BACKFILL FOR DRYWELL
LIMIT OF EXCAVATION 1H:2V SLOPE (MAX.)
SEEPAGE PORT (TYP.) ~ SEE NOTE 2
6" DIAM. DRAIN HOLE (TYP.)
48" I.D.
PRECAST FOOTING WITH DRAIN HOLES
VARIES 4" ~ 18"
24" MIN.
VARIES
12"
DRAWN BY: ADAM COCHRAN
CUTAWAY ELEVATION VIEW
TOE OF SWALE SLOPE / BOTTOM OF SWALE
DISTANCE VARIES SEE CONTRACT
6H:1V SLOPE (TYP.)
TOE OF DRYWELL SLOPE / BOTTOM OF SWALE
TOE OF SWALE SLOPE / BOTTOM OF SWALE
PLAN VIEW
10" (TYP.)
10" (TYP.)
5" (TYP.)
6" DIAM. DRAIN HOLE (TYP.)
#4 BARS
48"
1/2"
PRECAST FOOTING DETAIL
MATTHEW J. WITTECKI
STATE OF WASHINGTON
15568
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES JULY 1, 2007
DRYWELL TYPE 1 (FOR SWALE)
STANDARD PLAN B-20.20-01
SHEET 1 OF 1 SHEET
APPROVED FOR PUBLICATION
Kevin J. Dayton
11-21-06
STATE DESIGN ENGINEER
DATE
Washington State Department of Transportation

APPENDIX B

RUSLE2 Related Attributes

Chelan County Area, Washington (Parts of Chelan and Kittitas Counties)

Map symbol and soil name	Pct. of map unit	Hydrologic group	Kf	T factor	Representative value		
					% Sand	% Silt	% Clay
25:							
Pits, gravel	100	---	---	---	---	---	---
Ad:							
Alluvial land	100	B	.32	5	65.2	27.3	7.5
Be:							
Beverly	100	B	.37	3	65.2	27.3	7.5
Bf:							
Beverly	100	B	.32	3	65.2	27.3	7.5
BkC:							
Bjork	100	C	.43	3	29.1	53.4	17.5
BkD:							
Bjork	100	C	.43	3	29.1	53.4	17.5
BkE:							
Bjork	100	C	.43	3	29.1	53.4	17.5
BkF:							
Bjork	100	C	.43	3	29.1	53.4	17.5
BoF2:							
Bjork	90	C	.43	3	29.1	53.4	17.5
BrC:							
Brief	100	B	.32	4	67.8	23.7	8.5
BuA:							
Burch	100	B	.37	5	64.6	26.9	8.5
BuB:							
Burch	100	B	.37	5	64.6	26.9	8.5
BuC:							
Burch	100	B	.37	5	64.6	26.9	8.5
BuD:							
Burch	100	B	.37	5	64.6	26.9	8.5
BuE:							
Burch	100	B	.37	5	64.6	26.9	8.5

RUSLE2 Related Attributes

Chelan County Area, Washington (Parts of Chelan and Kittitas Counties)

Map symbol and soil name	Pct. of map unit	Hydrologic group	Kf	T factor	Representative value		
					% Sand	% Silt	% Clay
BvA:							
Burch	100	B	.43	5	45.7	41.8	12.5
BvB:							
Burch	100	B	.43	5	45.7	41.8	12.5
BvC:							
Burch	100	B	.43	5	45.7	41.8	12.5
BvD:							
Burch	100	B	.43	5	45.7	41.8	12.5
CaA:							
Cashmere	100	B	.32	5	68.5	24.0	7.5
CaB:							
Cashmere	100	B	.32	5	68.5	24.0	7.5
CaC:							
Cashmere	100	B	.32	5	68.5	24.0	7.5
CaD:							
Cashmere	100	B	.32	5	68.5	24.0	7.5
CcA:							
Cashmont	100	B	.24	5	67.4	23.6	9.0
CcB:							
Cashmont	100	B	.24	5	67.4	23.6	9.0
CdC:							
Cashmont	100	B	.28	5	67.4	23.6	9.0
CdD:							
Cashmont	100	B	.28	5	67.4	23.6	9.0
CeD:							
Cashmont	100	B	.24	5	67.4	23.6	9.0
CrD:							
Colockum	100	B	.43	5	30.4	55.6	14.0
CtE:							
Colockum	100	B	.43	5	30.4	55.6	14.0

RUSLE2 Related Attributes

Chelan County Area, Washington (Parts of Chelan and Kittitas Counties)

Map symbol and soil name	Pct. of map unit	Hydrologic group	Kf	T factor	Representative value		
					% Sand	% Silt	% Clay
CwB:							
Cowiche	100	B	.49	2	30.1	54.9	15.0
CwC:							
Cowiche	100	B	.49	2	30.1	54.9	15.0
CwD:							
Cowiche	100	B	.49	2	30.1	54.9	15.0
CwE:							
Cowiche	100	B	.49	2	30.1	54.9	15.0
CwF:							
Cowiche	100	B	.49	2	30.1	54.9	15.0
EfB:							
Ellisforde	100	B	.32	5	63.5	26.5	10.0
ElC:							
Ellisforde	100	B	.49	5	14.2	71.8	14.0
ErF:							
Entiat	90	D	.32	2	68.2	23.8	8.0
MaA:							
Malaga	100	B	.37	2	63.5	26.5	10.0
PhB:							
Peshastin	100	B	.49	3	45.7	41.8	12.5
PhC:							
Peshastin	100	B	.49	3	45.7	41.8	12.5
PlD:							
Peshastin	100	B	.49	3	45.7	41.8	12.5
PlE:							
Peshastin	100	B	.49	3	45.7	41.8	12.5
PoB:							
Pogue	100	B	.32	3	65.2	27.3	7.5
PrB:							
Pogue	100	B	.37	3	65.2	27.3	7.5

RUSLE2 Related Attributes

Chelan County Area, Washington (Parts of Chelan and Kittitas Counties)

Map symbol and soil name	Pct. of map unit	Hydrologic group	Kf	T factor	Representative value		
					% Sand	% Silt	% Clay
PrD:							
Pogue	100	B	.37	3	65.2	27.3	7.5
Rh:							
Riverwash	100	D	---	---	---	---	---
Rk:							
Rock outcrop	60	D	---	---	---	---	---
Lithic Xerorthents	30	D	.32	1	33.8	58.7	7.5
Ro:							
Rock outcrop	100	D	---	---	---	---	---
Te:							
Terrace escarpments	100	A	.32	5	79.2	15.8	5.0
VaD:							
Varelum	100	B	.32	4	30.4	55.6	14.0
WeA:							
Wenatchee	100	C	.49	5	30.1	54.9	15.0
WeB:							
Wenatchee	100	C	.49	5	30.1	54.9	15.0
YaF:							
Yaxon	100	B	.43	5	30.4	55.6	14.0

RUSLE2 Related Attributes

This report summarizes those soil attributes used by the Revised Universal Soil Loss Equation Version 2 (RUSLE2) for the map units in the selected area. The report includes the map unit symbol, the component name, and the percent of the component in the map unit. Soil property data for each map unit component include the hydrologic soil group, erosion factors Kf for the surface horizon, erosion factor T, and the representative percentage of sand, silt, and clay in the surface horizon.

Component Text

Chelan County Area, Washington (Parts of Chelan and Kittitas Counties)

Map unit: 25 - Gravel pits

Component: Pits, gravel

Text kind/Category: Nontechnical description/GENSOIL

Generated brief soil descriptions are created for major soil components. The Pits is a miscellaneous area.

Map unit: Ad - Alluvial land

Component: Alluvial land

Text kind/Category: Nontechnical description/GENSOIL

The Alluvial land component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on terraces, flood plains. The parent material consists of alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is occasionally flooded. It is not ponded. A seasonal zone of water saturation is at 36 inches during January, February, March, April, May, June. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 3w. Irrigated land capability classification is 3w. This soil does not meet hydric criteria.

Map unit: Be - Beverly fine sandy loam

Component: Beverly

Text kind/Category: Nontechnical description/GENSOIL

The Beverly component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on terraces. The parent material consists of alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 36 inches during January, February, March, April, May. Organic matter content in the surface horizon is about 1 percent. This component is in the R008XY501WA Sandy 9-15 Pz ecological site. Nonirrigated land capability classification is 3w. Irrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: Bf - Beverly gravelly fine sandy loam

Component: Beverly

Text kind/Category: Nontechnical description/GENSOIL

The Beverly component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on terraces. The parent material consists of alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 36 inches during January, February, March, April, May. Organic matter content in the surface horizon is about 1 percent. This component is in the R008XY501WA Sandy 9-15 Pz ecological site. Nonirrigated land capability classification is 3s. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: BkC - Bjork silt loam, 8 to 15 percent slopes

Component: Bjork

Text kind/Category: Nontechnical description/GENSOIL

The Bjork component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on hillslopes, uplands. The parent material consists of residuum from schist, gneiss or sandstone with loess in the upper part. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY101WA Dry Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: BkD - Bjork silt loam, 15 to 25 percent slopes

Component: Bjork

Text kind/Category: Nontechnical description/GENSOIL

The Bjork component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on hillslopes, uplands. The parent material consists of residuum from schist, gneiss or sandstone with loess in the upper part. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY101WA Dry Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: BkE - Bjork silt loam, 25 to 45 percent slopes

Component: Bjork

Text kind/Category: Nontechnical description/GENSOIL

The Bjork component makes up 100 percent of the map unit. Slopes are 25 to 45 percent. This component is on hillslopes, uplands. The parent material consists of residuum from schist, gneiss or sandstone with loess in the upper part. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY101WA Dry Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: BkF - Bjork silt loam, 45 to 65 percent slopes

Component: Bjork

Text kind/Category: Nontechnical description/GENSOIL

The Bjork component makes up 100 percent of the map unit. Slopes are 45 to 65 percent. This component is on hillslopes, uplands. The parent material consists of residuum from schist, gneiss or sandstone with loess in the upper part. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY101WA Dry Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Map unit: BoF2 - Bjork-Rock outcrop complex, 25 to 65 percent slopes, eroded

Component: Bjork

Text kind/Category: Nontechnical description/GENSOIL

The Bjork component makes up 90 percent of the map unit. Slopes are 25 to 65 percent. This component is on hillslopes, uplands. The parent material consists of residuum from schist, gneiss or sandstone with loess in the upper part. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY101WA Dry Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Map unit: BrC - Brief gravelly sandy loam, 8 to 15 percent slopes

Component: Brief

Text kind/Category: Nontechnical description/GENSOIL

The Brief component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on terraces, alluvial fans. The parent material consists of alluvium derived from igneous, metamorphic and sedimentary rock. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: BuA - Burch fine sandy loam, 0 to 3 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3c. Irrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: BuB - Burch fine sandy loam, 3 to 8 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: BuC - Burch fine sandy loam, 8 to 15 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: BuD - Burch fine sandy loam, 15 to 25 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: BuE - Burch fine sandy loam, 25 to 45 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 25 to 45 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 6e. Irrigated land capability classification is 7e. This soil does not meet hydric criteria.

Map unit: BvA - Burch loam, 0 to 3 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3c. Irrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: BvB - Burch loam, 3 to 8 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: BvC - Burch loam, 8 to 15 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: BvD - Burch loam, 15 to 25 percent slopes

Component: Burch

Text kind/Category: Nontechnical description/GENSOIL

The Burch component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on terraces. The parent material consists of alluvium derived from sandstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: CaA - Cashmere sandy loam, 0 to 3 percent slopes

Component: Cashmere

Text kind/Category: Nontechnical description/GENSOIL

The Cashmere component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on alluvial fans, terraces. The parent material consists of glaciofluvial deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3c. Irrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: CaB - Cashmere sandy loam, 3 to 8 percent slopes

Component: Cashmere

Text kind/Category: Nontechnical description/GENSOIL

The Cashmere component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on alluvial fans, terraces. The parent material consists of glaciofluvial deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: CaC - Cashmere sandy loam, 8 to 15 percent slopes

Component: Cashmere

Text kind/Category: Nontechnical description/GENSOIL

The Cashmere component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on alluvial fans, terraces. The parent material consists of glaciofluvial deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: CaD - Cashmere sandy loam, 15 to 25 percent slopes

Component: Cashmere

Text kind/Category: Nontechnical description/GENSOIL

The Cashmere component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on alluvial fans, terraces. The parent material consists of glaciofluvial deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: CcA - Cashmont sandy loam, 0 to 3 percent slopes

Component: Cashmont

Text kind/Category: Nontechnical description/GENSOIL

The Cashmont component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on hillslopes, alluvial fans, terraces. The parent material consists of alluvium, glaciofluvial deposits or ablation till. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3s. Irrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: CcB - Cashmont sandy loam, 3 to 8 percent slopes

Component: Cashmont

Text kind/Category: Nontechnical description/GENSOIL

The Cashmont component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on hillslopes, alluvial fans, terraces. The parent material consists of alluvium, glaciofluvial deposits or ablation till. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: CdC - Cashmont gravelly sandy loam, 8 to 15 percent slopes

Component: Cashmont

Text kind/Category: Nontechnical description/GENSOIL

The Cashmont component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on hillslopes, alluvial fans, terraces. The parent material consists of alluvium, glaciofluvial deposits or ablation till. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: CdD - Cashmont gravelly sandy loam, 15 to 25 percent slopes

Component: Cashmont

Text kind/Category: Nontechnical description/GENSOIL

The Cashmont component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on hillslopes, alluvial fans, terraces. The parent material consists of alluvium, glaciofluvial deposits or ablation till. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: CeD - Cashmont stony sandy loam, 0 to 25 percent slopes

Component: Cashmont

Text kind/Category: Nontechnical description/GENSOIL

The Cashmont component makes up 100 percent of the map unit. Slopes are 0 to 25 percent. This component is on hillslopes, alluvial fans, terraces. The parent material consists of alluvium, glaciofluvial deposits or ablation till. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 4s. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: CrD - Colockum silt loam, 15 to 25 percent slopes

Component: Colockum

Text kind/Category: Nontechnical description/GENSOIL

The Colockum component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on hillslopes, mountain slopes. The parent material consists of colluvium from sandstone or basalt with loess and volcanic ash in the upper part. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY102WA Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 3 percent.

Map unit: CtE - Colockum bouldery silt loam, 25 to 45 percent slopes

Component: Colockum

Text kind/Category: Nontechnical description/GENSOIL

The Colockum component makes up 100 percent of the map unit. Slopes are 25 to 45 percent. This component is on hillslopes, mountain slopes. The parent material consists of colluvium from sandstone or basalt with loess and volcanic ash in the upper part. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY102WA Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 25 percent.

Map unit: CwB - Cowiche silt loam, 3 to 8 percent slopes

Component: Cowiche

Text kind/Category: Nontechnical description/GENSOIL

The Cowiche component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on hillslopes. The parent material consists of residuum weathered from metamorphic and sedimentary rock with loess. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY102WA Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: CwC - Cowiche silt loam, 8 to 15 percent slopes

Component: Cowiche

Text kind/Category: Nontechnical description/GENSOIL

The Cowiche component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on hillslopes. The parent material consists of residuum weathered from metamorphic and sedimentary rock with loess. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY102WA Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: CwD - Cowiche silt loam, 15 to 25 percent slopes

Component: Cowiche

Text kind/Category: Nontechnical description/GENSOIL

The Cowiche component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on hillslopes. The parent material consists of residuum weathered from metamorphic and sedimentary rock with loess. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY102WA Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: CwE - Cowiche silt loam, 25 to 45 percent slopes

Component: Cowiche

Text kind/Category: Nontechnical description/GENSOIL

The Cowiche component makes up 100 percent of the map unit. Slopes are 25 to 45 percent. This component is on hillslopes. The parent material consists of residuum weathered from metamorphic and sedimentary rock with loess. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY103WA Cool Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: CwF - Cowiche silt loam, 45 to 65 percent slopes

Component: Cowiche

Text kind/Category: Nontechnical description/GENSOIL

The Cowiche component makes up 100 percent of the map unit. Slopes are 45 to 65 percent. This component is on hillslopes. The parent material consists of residuum weathered from metamorphic and sedimentary rock with loess. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY103WA Cool Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Map unit: EfB - Ellisforde fine sandy loam, 3 to 8 percent slopes

Component: Ellisforde

Text kind/Category: Nontechnical description/GENSOIL

The Ellisforde component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on lake terraces. The parent material consists of loess over lacustrine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 10 percent.

Map unit: ElC - Ellisforde silt loam, 8 to 15 percent slopes

Component: Ellisforde

Text kind/Category: Nontechnical description/GENSOIL

The Ellisforde component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on lake terraces. The parent material consists of loess over lacustrine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 10 percent.

Map unit: ErF - Entiat-Rock outcrop complex, 25 to 65 percent slopes

Component: Entiat

Text kind/Category: Nontechnical description/GENSOIL

The Entiat component makes up 90 percent of the map unit. Slopes are 25 to 65 percent. This component is on hillslopes. The parent material consists of resdiuum from granite with loess and volcanic ash. Depth to a root restrictive layer, bedrock, paralithic, is 12 to 20 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY501WA Sandy 9-15 Pz ecological site. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Map unit: MaA - Malaga gravelly fine sandy loam, 0 to 3 percent slopes

Component: Malaga

Text kind/Category: Nontechnical description/GENSOIL

The Malaga component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on terraces. The parent material consists of glacial outwash. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is somewhat excessively drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. This component is in the R008XY501WA Sandy 9-15 Pz ecological site. Nonirrigated land capability classification is 6s. Irrigated land capability classification is 3s. This soil does not meet hydric criteria.

Map unit: PhB - Peshastin loam, 3 to 8 percent slopes

Component: Peshastin

Text kind/Category: Nontechnical description/GENSOIL

The Peshastin component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on terraces. The parent material consists of till and outwash with a component of loess and volcanic ash in the surface. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY101WA Dry Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 10 percent.

Map unit: PhC - Peshastin loam, 8 to 15 percent slopes

Component: Peshastin

Text kind/Category: Nontechnical description/GENSOIL

The Peshastin component makes up 100 percent of the map unit. Slopes are 8 to 15 percent. This component is on terraces. The parent material consists of till and outwash with a component of loess and volcanic ash in the surface. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY101WA Dry Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 10 percent.

Map unit: PlD - Peshastin stony loam, 0 to 25 percent slopes

Component: Peshastin

Text kind/Category: Nontechnical description/GENSOIL

The Peshastin component makes up 100 percent of the map unit. Slopes are 0 to 25 percent. This component is on terraces. The parent material consists of till and outwash with a component of loess and volcanic ash in the surface. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY201WA Dry Stony 9-15 Pz ecological site. Nonirrigated land capability classification is 4s. Irrigated land capability classification is 4e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 10 percent.

Map unit: PlE - Peshastin stony loam, 25 to 45 percent slopes

Component: Peshastin

Text kind/Category: Nontechnical description/GENSOIL

The Peshastin component makes up 100 percent of the map unit. Slopes are 25 to 45 percent. This component is on terraces. The parent material consists of till and outwash with a component of loess and volcanic ash in the surface. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY201WA Dry Stony 9-15 Pz ecological site. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 10 percent.

Map unit: PoB - Pogue fine sandy loam, 3 to 8 percent slopes

Component: Pogue

Text kind/Category: Nontechnical description/GENSOIL

The Pogue component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on terraces. The parent material consists of glacial outwash. Depth to a root restrictive layer, strongly contrasting textural stratification, is 20 to 40 inches. The natural drainage class is somewhat excessively drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY501WA Sandy 9-15 Pz ecological site. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: PrB - Pogue gravelly fine sandy loam, 3 to 8 percent slopes

Component: Pogue

Text kind/Category: Nontechnical description/GENSOIL

The Pogue component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on terraces. The parent material consists of glacial outwash. Depth to a root restrictive layer, strongly contrasting textural stratification, is 20 to 40 inches. The natural drainage class is somewhat excessively drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY501WA Sandy 9-15 Pz ecological site. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: PrD - Pogue gravelly fine sandy loam, 15 to 25 percent slopes

Component: Pogue

Text kind/Category: Nontechnical description/GENSOIL

The Pogue component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on terraces, escarpments. The parent material consists of glacial outwash. Depth to a root restrictive layer, strongly contrasting textural stratification, is 20 to 40 inches. The natural drainage class is somewhat excessively drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY501WA Sandy 9-15 Pz ecological site. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: Rh - Riverwash

Component: Riverwash

Text kind/Category: Nontechnical description/GENSOIL

Generated brief soil descriptions are created for major soil components. The Riverwash is a miscellaneous area.

Map unit: Rk - Rock land

Component: Rock outcrop

Text kind/Category: Nontechnical description/GENSOIL

Generated brief soil descriptions are created for major soil components. The Rock outcrop is a miscellaneous area.

Component: Lithic Xerorthents

Text kind/Category: Nontechnical description/GENSOIL

The Lithic Xerorthents component makes up 30 percent of the map unit. Slopes are 8 to 30 percent. This component is on hillslopes. The parent material consists of residuum. Depth to a root restrictive layer, bedrock, lithic, is 5 to 12 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: Ro - Rock outcrop

Component: Rock outcrop

Text kind/Category: Nontechnical description/GENSOIL

Generated brief soil descriptions are created for major soil components. The Rock outcrop is a miscellaneous area.

Map unit: Te - Terrace escarpments

Component: Terrace escarpments

Text kind/Category: Nontechnical description/GENSOIL

Generated brief soil descriptions are created for major soil components. The Terrace escarpments is a miscellaneous area.

Map unit: VaD - Varelum silt loam, 15 to 25 percent slopes

Component: Varelum

Text kind/Category: Nontechnical description/GENSOIL

The Varelum component makes up 100 percent of the map unit. Slopes are 15 to 25 percent. This component is on mountain slopes. The parent material consists of residuum from sandstone with a minor amount of loess and volcanic ash in the surface. Depth to a root restrictive layer, bedrock, paralithic, is 40 to 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: WeA - Wenatchee silt loam, 0 to 3 percent slopes

Component: Wenatchee

Text kind/Category: Nontechnical description/GENSOIL

The Wenatchee component makes up 100 percent of the map unit. Slopes are 0 to 3 percent. This component is on terraces. The parent material consists of alluvium with a minor amount of loess and volcanic ash in the surface. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3s. Irrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: WeB - Wenatchee silt loam, 3 to 8 percent slopes

Component: Wenatchee

Text kind/Category: Nontechnical description/GENSOIL

The Wenatchee component makes up 100 percent of the map unit. Slopes are 3 to 8 percent. This component is on terraces. The parent material consists of alluvium with a minor amount of loess and volcanic ash in the surface. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: YaF - Yaxon silt loam, 45 to 65 percent slopes

Component: Yaxon

Text kind/Category: Nontechnical description/GENSOIL

The Yaxon component makes up 100 percent of the map unit. Slopes are 45 to 65 percent. This component is on hillslopes, uplands. The parent material consists of residuum from sandstone with loess. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. This component is in the R008XY102WA Loamy 9-15 Pz ecological site. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Component Text

This report provides a means for the customer to print out text notes that are stored in the underlying soil survey database for map unit components of the selected map units. When the report is initiated, the customer is presented with a choice list of type(s) of text notes stored. The customer must select one type at a time for the report to finish.

APPENDIX C

Table 1
Squilchuck Modeling Input Parameters for Existing Conditions.

Name	Area (ac)	Curve Number	Time of Concentration (min)
sd05302	47.9	76	14
sd05303	59.8	85	11
sd05304	11.8	85	22
sd05305	47.7	81	11
sd05306	70.8	81	9
sd05307	9.5	88	5

Table 2
Atwood Orchard Modeling Input Parameters for Existing Conditions.

Name	Area (ac)	Curve Number	Time of Concentration (min)
sd05258	224.3	73	37
sd05257	155.4	71	30
sd05255	229.3	70	22
sd05007	118.4	71	16
sd05006	115.5	71	15
sd05259	56.4	77	7
sd05260	34.8	71	17
sd05263	24.2	73	15
sd05262	136.9	72	28

Table 3
Sunnyslope Modeling Input Parameters for Existing Conditions.

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd03185	1	23.9	94	5
sd03260	1	23.9	77	12
sd03265	1	39.4	76	26
sd03279	1	54.7	73	25
sd03506	1	7.2	89	3
sd03510	1	44.3	87	43
sd03515	1	9.5	97	4
sd03519	1	40.8	88	6
sd03519	2	10.5	98	5

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd03535	1	45.0	98	8
sd03538	1	17.4	89	4
sd03544	1	5.6	88	5
sd03555	1	33.5	88	12
sd03558	1	47.4	87	6
sd03560	1	48.1	90	9
sd03567	1	27.1	88	5
sd03579	1	70.1	75	17
sd03581	1	88.7	88	7

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd03583	1	23.2	88	4
sd03587	1	35.4	75	2
sd03590	1	7.6	75	42
sd03590	2	25.7	81	5
sd03590	3	45.8	83	5
sd03590	4	16.6	86	40
sd03597	1	6.9	75	2
sd03598	1	6.1	75	4
sd03609	1	37.3	81	25
sd04003	1	16.9	75	5
sd04004	1	16.5	74	4
sd04005	1	18.2	69	6
sd04007	1	8.2	69	4
sd04008	1	26.4	69	9
sd04010	1	42.3	82	6
sd04013	1	11.6	75	4
sd04505	1	184.2	68	6
sd05004	1	39.7	85	31
sd05008	1	57.4	70	7
sd05009	1	47.3	79	7
sd05012	1	72.0	74	7
sd05013	1	57.0	69	8
sd05016	1	84.9	81	9
sd05017	1	60.6	69	6
sd05018	1	116.3	80	10
sd05019	1	33.8	72	10
sd05021	1	66.9	84	8
sd05021	2	64.8	87	7
sd05023	1	62.4	69	6
sd05025	1	47.3	73	7
sd05026	1	58.4	71	9
sd05027	1	119.9	69	8
sd05029	1	59.2	69	7
sd05030	1	40.4	70	13
sd05032	1	50.6	69	11
sd05033	1	17.4	69	10
sd05034	1	36.2	76	5
sd05040	1	33.9	64	26
sd05042	1	16.3	81	5

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05043	1	23.8	70	15
sd05045	1	39.9	69	39
sd05049	1	60.9	66	41
sd05050	1	14.6	63	9
sd05052	1	128.7	65	7
sd05053	1	34.9	68	10
sd05056	1	99.4	74	6
sd05059	1	22.6	69	3
sd05060	1	146.7	89	10
sd05061	1	29.4	79	7
sd05063	1	44.5	78	6
sd05065	1	44.1	69	7
sd05070	1	94.5	79	6
sd05072	1	49.1	76	7
sd05074	1	67.3	78	9
sd05076	1	34.0	79	9
sd05079	1	78.4	76	10
sd05082	1	62.4	76	10
sd05084	1	44.3	79	11
sd05086	1	63.1	76	8
sd05088	1	101.9	75	12
sd05090	1	48.8	72	8
sd05091	1	83.9	69	8
sd05092	1	75.9	69	7
sd05093	1	33.5	69	8
sd05095	1	63.5	79	8
sd05098	1	59.3	76	6
sd05100	1	88.3	71	9
sd05101	1	50.8	70	9
sd05104	1	98.4	69	14
sd05106	1	130.1	69	7
sd05107	1	46.6	69	9
sd05108	1	107.3	72	10
sd05109	1	40.2	69	9
sd05110	1	54.5	71	12
sd05112	1	63.8	71	10
sd05115	1	60.1	69	8
sd05117	1	75.7	69	9
sd05119	1	58.1	69	9

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05122	1	59.2	69	10
sd05125	1	148.1	69	10
sd05127	1	123.7	69	9
sd05129	1	70.1	69	10
sd05131	1	64.1	69	15
sd05135	1	154.0	75	11
sd05137	1	135.8	75	7
sd05139	1	89.1	70	12
sd05141	1	62.2	69	9
sd05144	1	63.4	69	8
sd05146	1	58.7	69	13
sd05149	1	112.0	69	10
sd05151	1	137.1	76	8
sd05154	1	113.7	84	10
sd05155	1	76.8	69	9
sd05157	1	124.1	75	8
sd05158	1	91.7	77	7
sd05163	1	89.1	69	8
sd05164	1	106.8	69	7
sd05168	1	134.4	75	9
sd05173	1	149.7	69	12
sd05176	1	106.6	69	11
sd05177	1	13.9	69	13
sd05179	1	36.1	68	11
sd05180	1	46.4	68	7
sd05182	1	23.5	75	4
sd05184	1	73.1	75	7
sd05185	1	63.5	72	3
sd05186	1	41.1	69	8
sd05187	1	56.4	69	9
sd05188	1	49.3	71	8
sd05192	1	48.0	69	9
sd05194	1	96.2	69	9
sd05197	1	59.9	71	9
sd05198	1	37.2	75	12
sd05198	1	32.8	75	12
sd05199	1	63.9	86	25
sd05200	1	45.8	71	21
sd05201	1	60.9	71	8

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05202	1	129.8	70	14
sd05203	1	52.1	69	10
sd05204	1	120.4	69	9
sd05207	1	97.7	69	8
sd05209	1	225.7	74	11
sd05211	1	24.8	73	10
sd05212	1	46.2	68	5
sd05214	1	48.1	73	10
sd05215	1	68.1	74	35
sd05217	1	34.5	70	9
sd05219	1	55.7	69	9
sd05221	1	9.6	55	9
sd05223	1	19.4	76	2
sd05225	1	60.5	69	23
sd05226	1	75.0	79	9
sd05227	1	123.1	79	10
sd05228	1	108.1	76	16
sd05229	1	68.8	69	11
sd05230	1	38.5	69	11
sd05232	1	7.3	75	8
sd05233	1	12.7	69	4
sd05235	1	62.1	69	6
sd05237	1	30.4	68	40
sd05240	1	26.6	68	6
sd05267	1	11.3	75	6
sd05271	1	29.5	73	6
sd05279	1	54.7	73	4
sd05280	1	11.0	69	4
sd05281	1	9.7	68	4
sd05282	1	50.8	71	34
sd05283	1	129.1	70	3
sd05284	1	9.7	70	5
sd05285	1	16.1	64	11
sd05286	1	16.9	60	5
sd05287	1	91.2	73	39
sd05288	1	8.8	75	28
sd05289	1	60.9	68	7
sd05290	1	54.1	77	11
sd05291	1	14.6	97	4

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05292	1	22.5	98	3
sd05293	1	8.5	75	3
sd05294	1	25.5	75	5
sd05295	1	36.8	83	6
sd05296	1	34.5	84	6

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05297	1	44.9	83	7
sd05298	1	35.2	83	6
sd05299	1	47.7	83	6
sd05300	1	128.5	63	27
sd05301	1	81.1	98	58

Table 4
Squilchuck Modeling Input Parameters for Future Conditions.

Name	Area (ac)	Curve Number	Time of Concentration (min)
sd05302	47.9	76	14
sd05303	59.8	85	11
sd05304	11.8	85	22
sd05305	47.7	79	11
sd05306	70.8	80	9
sd05307	9.5	88	5

Table 5
Atwood Orchard Modeling Input Parameters for Future Conditions.

Name	Area (ac)	Curve Number	Time of Concentration (min)
sd05258	224.2	73	37
sd05257	155.4	71	30
sd05255	229.3	70	22
sd05007	118.4	71	16
sd05006	115.5	71	15
sd05259	56.4	77	7
sd05260	34.8	65	17
sd05263	24.2	71	15
sd05262	136.9	72	28

Table 6
Sunnyslope Modeling Input Parameters for Future Conditions.

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd03185	1	23.9	94	5
sd03260	1	23.9	78	12
sd03265	1	39.4	76	26
sd03267	1	54.7	76	25
sd03506	1	7.2	89	3
sd03510	1	44.3	87	43
sd03515	1	9.5	97	4
sd03519	1	40.8	88	6
sd03519	2	10.5	98	5
sd03535	1	45.0	98	8
sd03538	1	17.4	89	4
sd03544	1	5.6	88	5
sd03555	1	33.5	88	12
sd03558	1	47.4	87	6
sd03560	1	48.1	90	9
sd03567	1	27.1	88	5
sd03579	1	70.1	75	17
sd03581	1	88.7	88	7
sd03583	1	23.2	88	4
sd03587	1	35.4	75	2
sd03590	1	45.8	83	42
sd03590	2	25.7	82	5
sd03590	3	16.6	86	5
sd03590	4	7.6	75	40
sd03597	1	6.9	75	2
sd03598	1	6.1	75	4
sd03609	1	37.3	85	25
sd04003	1	16.9	75	5
sd04004	1	16.5	75	4
sd04005	1	18.2	75	6
sd04007	1	8.2	75	4
sd04008	1	26.4	69	9
sd04010	1	42.3	84	6
sd04012	1	32.8	75	4
sd04013	1	11.6	75	6
sd04505	1	184.2	68	31
sd05004	1	39.7	83	7

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05008	1	57.4	70	7
sd05009	1	47.3	79	8
sd05012	1	72.0	74	9
sd05013	1	57.0	69	6
sd05016	1	84.9	81	10
sd05017	1	60.6	69	10
sd05018	1	116.3	80	8
sd05019	1	33.8	72	7
sd05021	1	66.9	87	6
sd05021	2	64.8	87	7
sd05023	1	62.4	69	9
sd05025	1	47.3	73	8
sd05026	1	58.4	71	8
sd05027	1	119.9	69	13
sd05029	1	59.2	69	11
sd05030	1	40.4	68	10
sd05032	1	50.6	69	5
sd05033	1	17.4	75	26
sd05034	1	36.2	76	5
sd05040	1	33.9	79	15
sd05042	1	16.3	82	39
sd05043	1	23.8	69	41
sd05045	1	39.9	75	9
sd05049	1	60.9	66	7
sd05050	1	14.6	61	10
sd05052	1	128.7	66	6
sd05053	1	34.9	69	3
sd05056	1	99.4	74	10
sd05059	1	22.6	69	7
sd05060	1	146.7	89	6
sd05061	1	29.4	79	7
sd05063	1	44.5	78	6
sd05065	1	44.1	69	7
sd05070	1	94.5	79	9
sd05072	1	49.1	76	9
sd05074	1	67.3	78	10
sd05076	1	34.0	79	10

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05079	1	78.4	76	11
sd05082	1	62.4	76	8
sd05084	1	44.3	79	12
sd05086	1	63.1	76	8
sd05088	1	101.9	75	8
sd05090	1	48.8	72	7
sd05091	1	83.9	69	8
sd05092	1	75.9	69	8
sd05093	1	33.5	69	6
sd05095	1	63.5	79	9
sd05098	1	59.3	76	9
sd05100	1	88.3	70	14
sd05101	1	50.8	66	7
sd05104	1	98.4	63	9
sd05106	1	130.1	66	10
sd05107	1	46.6	69	9
sd05108	1	107.3	72	12
sd05109	1	40.2	69	10
sd05110	1	54.5	70	8
sd05112	1	63.8	71	9
sd05115	1	60.1	69	9
sd05117	1	75.7	69	10
sd05119	1	58.1	49	10
sd05122	1	59.2	52	9
sd05125	1	148.1	63	10
sd05127	1	123.7	69	15
sd05129	1	70.1	6	11
sd05131	1	64.1	69	7
sd05135	1	154.0	75	12
sd05137	1	135.8	45	9
sd05139	1	89.1	66	8
sd05141	1	62.2	69	13
sd05144	1	63.4	69	10
sd05146	1	58.7	69	8
sd05149	1	112.0	69	10
sd05151	1	137.1	62	9
sd05154	1	113.7	60	8
sd05155	1	76.8	69	7
sd05157	1	124.1	75	8

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05158	1	91.7	77	7
sd05163	1	89.1	69	9
sd05164	1	106.8	69	12
sd05168	1	134.4	78	11
sd05173	1	149.7	55	13
sd05176	1	106.6	62	11
sd05177	1	13.9	69	7
sd05179	1	36.1	68	4
sd05180	1	46.4	70	7
sd05182	1	23.5	77	3
sd05184	1	73.1	75	8
sd05185	1	63.5	76	9
sd05186	1	41.1	69	8
sd05187	1	56.4	69	9
sd05188	1	49.3	71	9
sd05192	1	48.0	69	9
sd05194	1	96.1	69	12
sd05197	1	59.9	71	12
sd05198	1	37.2	75	25
sd05199	1	63.9	71	21
sd05200	1	45.8	71	8
sd05201	1	60.9	71	12
sd05202	1	129.8	70	10
sd05203	1	52.1	69	9
sd05204	1	120.4	69	8
sd05207	1	97.7	69	11
sd05209	1	225.7	74	10
sd05211	1	24.8	75	5
sd05212	1	46.2	68	10
sd05214	1	48.1	75	35
sd05215	1	68.1	74	9
sd05217	1	34.5	67	9
sd05219	1	55.7	69	9
sd05221	1	9.6	54	2
sd05223	1	19.4	75	23
sd05225	1	60.5	65	9
sd05226	1	75.0	79	10
sd05227	1	123.1	79	16
sd05228	1	108.1	79	11

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05229	1	68.8	71	11
sd05230	1	38.5	68	8
sd05232	1	7.3	75	4
sd05233	1	12.7	75	6
sd05235	1	62.1	76	40
sd05237	1	30.4	68	6
sd05240	1	26.6	68	6
sd05267	1	11.3	75	6
sd05271	1	29.5	75	4
sd05280	1	11.0	75	4
sd05281	1	9.7	68	4
sd05282	1	50.8	85	34
sd05283	1	129.1	70	3
sd05284	1	9.7	70	5
sd05285	1	16.1	64	11
sd05286	1	16.9	60	5
sd05287	1	91.2	75	39

Name	Sub-catchment	Area (ac)	Curve Number	Time of Concentration (min)
sd05288	1	8.8	75	29
sd05289	1	60.9	66	7
sd05290	1	54.1	80	11
sd05291	1	14.6	97	4
sd05292	1	22.5	98	3
sd05293	1	8.5	75	3
sd05294	1	25.5	75	5
sd05295	1	36.8	85	6
sd05296	1	34.5	87	6
sd05297	1	44.9	87	7
sd05298	1	35.2	89	6
sd05299	1	47.7	90	6
sd05300	1	128.5	64	27
sd05301	1	81.1	98	58

APPENDIX D

TOTAL SURFACE RUNOFF FOR EXISTING CONDITIONS

Squilchuck						
			2 Yr. Storm	10 Yr. Storm	25 Yr. Storm	100 Yr. Storm
Name	Basin	Area (ac)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)
sd05306	1	70.8	25,140	108,699	145,460	121,826
sd05302	1	48.0	6,752	47,377	67,234	256,142
sd05303	1	59.8	37,733	126,745	163,335	50,647
sd05304	1	11.8	7,461	25,062	32,296	163,294
sd05305	1	47.7	16,976	73,400	98,223	241,823
sd05307	1	9.5	8,712	25,152	31,608	47,619

Atwood Orchard						
			2 Yr. Storm	10 Yr. Storm	25 Yr. Storm	100 Yr. Storm
Name	Basin	Area (ac)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)
sd05006	1	115.5	3,223	64,409	99,373	201,510
sd05258	1	224.3	13,929	161,121	239,391	462,063
sd05257	1	155.4	4,468	89,299	137,776	279,382
sd05255	1	229.3	3,870	116,338	183,440	382,349
sd05007	1	118.4	3,299	65,936	101,731	206,290
sd05259	1	56.4	9,776	60,775	85,116	151,353
sd05260	1	34.8	991	19,811	30,566	61,981
sd05263	1	24.2	1,491	17,252	25,632	49,474
sd05262	1	137.0	5,975	87,937	133,027	262,953

Sunnyslope						
			2 Yr. Storm	10 Yr. Storm	25 Yr. Storm	100 Yr. Storm
Name	Basin	Area (ac)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)
sd03185	1	23.9	44958	99,808	119,617	166,835
sd03260	1	23.9	4,169	25,918	36,299	64,546
sd03265	1	39.4	5,507	38,640	54,835	99,360
sd03279	1	54.7	3,391	39,219	58,270	112,471
sd03506	1	7.2	7,219	19,887	24,787	36,853
sd03510	1	44.3	36,018	109,062	138,171	210,888
sd03515	1	9.5	23,972	46,818	54,789	73,513
sd03519	1	40.8	37,291	107,600	135,202	203,651
sd03519	2	10.5	29,644	55,376	64,276	85,109
sd03535	1	45.0	127,616	238,394	276,707	366,394
sd03538	1	17.4	18,117	49,907	62,206	92,486
sd03544	1	5.6	5,261	15,179	19,073	28,729
sd03555	1	33.5	30,917	89,209	112,093	168,842
sd03558	1	47.4	38,904	117,800	149,241	227,784
sd03560	1	48.1	56,407	148,572	183,717	269,647
sd03567	1	27.1	24,215	69,870	87,793	132,240
sd03579	1	70.1	7,772	62,720	90,276	166,857
sd03581	1	88.7	81,192	234,272	294,369	443,398
sd03583	1	23.2	21,354	61,615	77,420	116,616
sd03587	1	35.4	3,855	31,106	44,772	82,753
sd03590	1	45.8	21,965	82,931	108,826	175,568
sd03590	2	25.7	9,234	39,927	53,430	88,827
sd03590	3	16.6	11,615	36,993	47,262	73,110
sd03590	4	7.6	839	6,772	9,748	18,017
sd03597	1	7.0	750	6,054	8,714	16,107
sd03598	1	6.1	677	5,466	7,867	14,540
sd03609	1	37.3	13,371	57,811	77,362	128,613
sd04003	1	16.9	1,850	14,926	21,484	39,709
sd04004	1	16.5	1,394	13,248	19,361	36,546
sd04005	1	18.2	147	7,977	12,886	27,670
sd04007	1	8.2	67	3,633	5,868	12,600
sd04008	1	26.4	213	11,562	18,677	40,106
sd04010	1	42.3	17,439	70,267	93,095	152,426
sd04012	1	32.8	3,549	28,638	41,220	76,188
sd04013	1	11.6	1,285	10,365	14,919	27,576
sd04505	1	184.2	485	70,433	116,898	259,271

sd05004	1	39.7	24,809	83,334	107,391	168,410
sd05008	1	57.4	947	28,456	44,869	93,521
sd05009	1	47.3	11,761	59,801	81,765	140,384
sd05012	1	72.0	6,091	57,907	84,628	159,740
sd05013	1	57.0	459	24,857	40,154	86,221
sd05016	1	85.0	30,161	130,408	174,511	290,120
sd05017	1	60.6	493	26,693	43,120	92,590
sd05018	1	116.3	35,286	164,795	222,850	376,385
sd05019	1	33.8	1465	21,553	32,604	64,449
sd05021	1	66.9	37,132	131,981	171,603	272,900
sd05021	2	64.8	52,671	159,487	202,054	308,391
sd05023	1	62.4	507	27,477	44,386	95,309
sd05025	1	47.3	2,871	33,212	49,346	95,246
sd05026	1	58.4	1,644	32,857	50,693	102,796
sd05027	1	119.9	967	52,397	84,640	181,746
sd05029	1	59.2	484	26,200	42,322	90,878
sd05030	1	40.4	676	20,307	32,020	66,740
sd05032	1	50.6	414	22,424	36,223	77,781
sd05033	1	17.4	142	7,674	12,396	26,617
sd05034	1	36.2	5,120	35,929	50,989	92,390
sd05040	1	33.9	0	6,733	13,023	34,102
sd05042	1	16.3	5,802	25,087	33,571	55,811
sd05043	1	23.8	400	12,028	18,966	39,532
sd05045	1	39.9	322	17,458	28,201	60,555
sd05049	1	60.9	0	16,885	29,922	71,495
sd05050	1	14.6	0	2,292	4,688	12,964
sd05052	1	128.7	0	30,604	56,466	140,885
sd05053	1	35.0	94	13,653	22,660	50,259
sd05056	1	99.4	8,514	80,942	118,293	223,284
sd05059	1	22.6	189	10,254	16,564	35,567
sd05060	1	146.7	152,856	421,076	524,841	780,322
sd05061	1	29.4	7,417	37,714	51,566	88,535
sd05063	1	44.5	9,482	52,995	73,309	128,040
sd05065	1	44.1	357	19,341	31,243	67,087
sd05070	1	94.5	24,251	123,310	168,598	289,471
sd05072	1	49.1	6,879	48,267	68,497	124,116
sd05074	1	67.3	14,258	79,692	110,239	192,542
sd05076	1	34.0	8,605	43,755	59,826	102,716
sd05079	1	78.4	11,049	77,533	110,030	199,373
sd05082	1	62.4	8,532	59,868	84,961	153,948
sd05084	1	44.3	11,333	57,625	78,790	135,276

sd05086	1	63.1	8,692	60,991	86,555	156,835
sd05088	1	101.9	10,998	88,749	127,741	236,106
sd05090	1	48.8	2,113	31,096	47,040	92,984
sd05091	1	83.9	690	37,364	60,357	129,602
sd05092	1	75.9	602	32,602	52,664	113,084
sd05093	1	33.5	274	14,823	23,944	51,414
sd05095	1	63.5	16,072	81,721	111,736	191,842
sd05098	1	59.3	8,348	58,576	83,127	150,624
sd05100	1	88.3	2501	49,979	77,110	156,364
sd05101	1	50.8	852	25,611	40,382	84,170
sd05104	1	98.4	793	42,957	69,392	149,003
sd05106	1	130.1	1,054	57,063	92,177	197,929
sd05107	1	46.6	379	20,547	33,191	71,271
sd05108	1	107.3	4,677	68,828	104,120	205,812
sd05109	1	40.2	322	17,460	28,204	60,561
sd05110	1	54.5	1,515	30,280	46,717	94,733
sd05112	1	63.8	1,846	36,884	56,906	115,395
sd05115	1	60.1	493	26,679	43,096	92,539
sd05117	1	75.7	608	32,902	53,149	114,126
sd05119	1	58.1	472	25,554	41,278	88,636
sd05122	1	59.2	487	26,398	42,642	91,565
sd05125	1	148.1	1,209	65,475	105,766	227,109
sd05127	1	123.7	994	53,826	86,949	186,703
sd05129	1	70.1	572	31,001	50,078	107,530
sd05131	1	64.1	537	29,081	46,976	100,870
sd05135	1	154.0	17,071	137,755	198,277	366,478
sd05137	1	135.8	15,077	121,665	175,118	323,673
sd05139	1	89.1	1,486	44,668	70,432	146,803
sd05141	1	62.2	507	27,482	44,394	95,325
sd05144	1	63.4	518	28,049	45,309	97,290
sd05146	1	58.7	466	25,225	40,747	87,495
sd05149	1	112.0	927	50,188	81,071	174,082
sd05151	1	137.1	19,091	133,964	190,113	344,482
sd05154	1	113.7	62,589	222,463	289,248	459,991
sd05155	1	76.8	624	33,806	54,609	117,260
sd05157	1	124.1	13,634	110,019	158,356	292,690
sd05158	1	91.7	15,875	98,688	138,215	245,771
sd05163	1	89.1	721	39,028	63,045	135,374
sd05164	1	106.8	870	47,144	76,154	163,524
sd05168	1	134.4	14,932	120,489	173,427	320,546
sd05173	1	149.7	1,210	65,525	105,847	227,282

sd05176	1	106.6	865	46,842	75,667	162,478
sd05177	1	13.9	113	6,113	9,875	21,205
sd05179	1	36.1	96	13,868	23,016	51,048
sd05180	1	46.4	122	17,698	29,373	65,148
sd05182	1	23.5	2,551	20,588	29,633	54,771
sd05184	1	73.1	8,118	65,509	94,290	174,277
sd05185	1	63.5	2,764	40,676	61,533	121,631
sd05186	1	41.1	337	18,272	29,516	63,380
sd05187	1	56.4	462	25,040	40,448	86,853
sd05188	1	49.3	1,423	28,441	43,880	88,980
sd05192	1	48.0	387	20,962	33,862	72,711
sd05194	1	96.2	786	42,550	68,733	147,589
sd05197	1	60.0	1,726	34,499	53,226	107,933
sd05198	1	37.2	4,127	33,305	47,938	88,604
sd05198	1	32.8	11,609	50,307	67,346	112,029
sd05199	1	63.9	45,726	145,629	186,056	287,809
sd05200	1	45.8	1,286	25,690	39,636	80,375
sd05201	1	61.0	1,755	35,079	54,122	109,749
sd05202	1	129.8	2,202	66,192	104,371	217,543
sd05203	1	52.1	426	23,090	37,299	80,092
sd05204	1	120.4	983	53,248	86,015	184,698
sd05207	1	97.7	790	42,804	69,143	148,470
sd05209	1	225.7	19,208	182,604	266,868	503,726
sd05211	1	24.8	1,531	17,703	26,303	50,770
sd05212	1	46.2	122	17,729	29,424	65,261
sd05214	1	48.1	3,006	34,772	51,664	99,720
sd05215	1	68.1	5,706	54,245	79,277	149,639
sd05217	1	34.5	580	17,447	27,510	57,339
sd05219	1	55.7	455	24,633	39,791	85,443
sd05221	1	9.6	0	18	394	2,993
sd05223	1	19.4	2,689	18,869	26,778	48,521
sd05225	1	60.5	487	26,396	42,638	91,556
sd05226	1	75.0	19,070	96,961	132,573	227,618
sd05227	1	123.1	30,620	155,692	212,874	365,489
sd05228	1	108.1	15,104	105,983	150,403	272,528
sd05229	1	68.8	560	30,343	49,015	105,248
sd05230	1	38.5	314	17,027	27,505	59,061
sd05232	1	7.3	789	6,370	9,168	16,946
sd05233	1	12.7	104	5,653	9,131	19,607
sd05235	1	62.1	508	27,490	44,406	95,353
sd05237	1	30.4	81	11,751	19,502	43,255

sd05240	1	26.6	71	10,316	17,122	37,975
sd05267	1	11.3	1,232	9,945	14,314	26,456
sd05271	1	29.5	1,836	21,241	31,560	60,916
sd05280	1	11.0	93	5,059	8,172	17,548
sd05281	1	9.7	25	3,691	6,126	13,586
sd05282	1	50.8	1,452	29,014	44,765	90,775
sd05283	1	129.1	2,140	64,340	101,451	211,457
sd05284	1	9.7	162	4,860	7,664	15,980
sd05285	1	16.1	0	3,088	5,973	15,641
sd05286	1	16.9	0	1,173	3,104	10,660
sd05287	1	91.2	5,682	65,728	97,657	188,494
sd05288	1	8.8	966	7,794	11,219	20,736
sd05289	1	60.9	159	23,080	38,305	84,959
sd05290	1	54.1	9,424	58,588	82,054	145,906
sd05291	1	14.6	37,827	73,879	86,457	116,003
sd05292	1	22.5	65,545	122,442	142,121	188,185
sd05293	1	8.5	942	7,601	10,941	20,221
sd05294	1	25.5	2,829	22,826	32,855	60,727
sd05295	1	36.8	17,884	67,523	88,608	142,950
sd05296	1	34.5	18,804	66,837	86,902	138,200
sd05297	1	44.9	21,558	81,395	106,810	172,316
sd05298	1	35.2	16,753	63,255	83,006	133,913
sd05299	1	47.7	22,924	86,553	113,580	183,237
sd05300	1	128.5	0	20,058	41,029	113,460
sd05301	1	81.1	232,617	434,541	504,378	667,858

APPENDIX E

TOTAL SURFACE RUNOFF FOR FUTURE CONDITIONS

Squilchuck Drainage						
			2 Yr. Storm	10 Yr. Storm	25 Yr. Storm	100 Yr. Storm
Name	Basin	Area (ac)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)
sd05305	1	47.7	12,157	99,868	84,515	145,106
sd05302	1	48.0	6,752	47,377	67,234	121,826
sd05303	1	59.8	37,733	126,745	163,335	256,142
sd05304	1	11.8	7,461	25,062	32,296	50,647
sd05306	1	70.8	21,384	61,813	135,051	228,095
sd05307	1	9.5	8,712	25,152	31,608	47,619

Atwood Orchard						
			2 Yr. Storm	10 Yr. Storm	25 Yr. Storm	100 Yr. Storm
Name	Basin	Area (ac)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)
sd05006	1	115.5	4,015	68,334	104,388	208,988
sd05258	1	224.3	12,658	156,064	233,040	452,816
sd05257	1	155.4	4,251	88,161	136,317	277,197
sd05255	1	229.3	3,456	113,646	179,946	377,025
sd05007	1	118.4	2,733	62,901	97,834	200,438
sd05259	1	56.4	10,286	62,205	86,846	153,731
sd05260	1	34.8	0	8,408	15,402	38,137
sd05263	1	24.2	765	14,088	21,630	43,584
sd05262	1	137.0	5,663	86,539	131,254	260,336

Sunnyslope						
			2 Yr. Storm	10 Yr. Storm	25 Yr. Storm	100 Yr. Storm
Name	Basin	Area (ac)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)	Total Surface Runoff (ft^3)
sd03260	1	23.9	5,063	28,368	39,254	68,590
sd03265	1	39.4	6,029	40,194	56,728	101,994
sd03279	1	54.7	8,157	55,100	77,878	140,305
sd03506	1	7.2	7,194	19,844	24,740	36,797
sd03510	1	44.3	37,409	111,579	140,999	214,326
sd03515	1	9.5	24,397	47,326	55,314	74,066
sd03519	1	40.8	37,304	107,624	135,229	203,682
sd03519	2	10.5	29,644	55,376	64,276	85,109
sd03535	1	45.0	127,499	238,261	276,571	366,252
sd03538	1	17.4	17,343	48,590	60,744	90,746
sd03544	1	5.6	5,523	15,636	19,582	29,340
sd03555	1	33.5	30,576	88,610	111,424	168,037
sd03558	1	47.4	41,074	121,716	153,640	233,127
sd03560	1	48.1	55,796	147,575	182,620	268,362
sd03567	1	27.1	25,389	71,914	90,073	134,975
sd03579	1	70.1	7,551	61,997	89,386	165,599
sd03581	1	88.7	77,751	228,198	287,577	435,209
sd03583	1	23.2	21,354	61,615	77,420	116,616
sd03587	1	35.4	3,584	30,218	43,678	81,203
sd03590	1	45.8	23,191	85,507	111,804	179,371
sd03590	2	25.7	10,323	42,211	56,047	92,073
sd03590	3	16.6	11,515	37,152	47,567	73,832
sd03590	4	7.6	839	6,772	9,748	18,017
sd03597	1	7.0	816	6,265	8,974	16,472
sd03598	1	6.1	677	5,466	7,867	14,540
sd03609	1	37.3	22,306	76,843	99,425	156,908
sd04003	1	16.9	1,837	14,885	21,434	39,638
sd04004	1	16.5	1,821	14,692	21,147	39,087
sd04005	1	18.2	1,992	16,078	23,142	42,774
sd04007	1	8.2	907	7,321	10,538	19,477
sd04008	1	26.4	207	11,510	18,609	40,000
sd04010	1	42.3	24,269	84,607	109,676	173,595
sd04012	1	32.8	3,549	28,638	41,220	76,188
sd04013	1	11.6	1,285	10,365	14,919	27,576
sd04505	1	184.2	589	71,825	118,751	262,189

sd05004	1	39.7	17,859	69,101	91,010	147,658
sd05008	1	57.4	836	27,736	43,934	92,097
sd05009	1	47.3	11,339	58,730	80,486	138,665
sd05012	1	72.0	6,543	59,485	86,587	162,541
sd05013	1	57.0	367	24,037	39,074	84,546
sd05016	1	85.0	28,526	126,619	170,055	284,266
sd05017	1	60.6	493	26,693	43,120	92,590
sd05018	1	116.3	37,762	170,696	229,821	385,612
sd05019	1	33.8	1,615	1,615	1,615	1,615
sd05021	1	66.9	51,730	160,253	203,803	312,969
sd05021	2	64.8	50,747	155,967	198,090	303,553
sd05023	1	62.4	507	27,477	44,386	95,309
sd05025	1	47.3	3,223	34,563	51,037	97,696
sd05026	1	58.4	1,544	32,335	50,024	101,794
sd05027	1	119.9	967	52,397	84,640	181,746
sd05029	1	59.2	407	25,521	41,430	89,494
sd05030	1	40.4	109	15,483	25,686	56,939
sd05032	1	50.6	256	20,939	34,266	74,739
sd05033	1	17.4	1,917	15,466	22,261	41,146
sd05034	1	36.2	5,636	37,461	52,854	94,986
sd05040	1	33.9	8,369	43,795	60,097	103,734
sd05042	1	16.3	6,463	26,584	35,324	58,100
sd05043	1	23.8	179	10,396	16,836	36,260
sd05045	1	39.9	4,360	35,186	50,645	93,607
sd05049	1	60.9	0	16,284	29092	70,128
sd05050	1	14.6	0	1,225	3,036	9,912
sd05052	1	128.7	0	33,726	60,836	148,184
sd05053	1	35.0	172	14,593	23,908	52,217
sd05056	1	99.4	7,919	78,813	115,645	219,484
sd05059	1	22.6	121	9,610	15,715	34,248
sd05060	1	146.7	153,199	421,655	525483	781,084
sd05061	1	29.4	7,820	38,723	52,767	90,145
sd05063	1	44.5	9,053	51,845	71,925	126,156
sd05065	1	44.1	528	20,681	32,997	69,790
sd05070	1	94.5	22,366	118,492	162,846	281,723
sd05072	1	49.1	6,271	46,410	66,227	120,941
sd05074	1	67.3	1,320	82,490	113,595	197,095
sd05076	1	34.0	8,405	43,247	59,219	101,901
sd05079	1	78.4	10,449	75,708	107,800	196,257
sd05082	1	62.4	8,631	60,167	85,325	154,456
sd05084	1	44.3	11,311	57,569	78,723	135,186

sd05086	1	63.1	8,829	61,403	87,057	157,536
sd05088	1	101.9	10,756	87,960	126,769	234,730
sd05090	1	48.8	1,927	30,260	45,980	91,418
sd05091	1	83.9	833	38,537	61,895	131,979
sd05092	1	75.9	617	32,731	52,834	113,347
sd05093	1	33.5	274	14,823	23,944	51,414
sd05095	1	63.5	16,072	81,721	111,736	191,842
sd05098	1	59.3	8,670	59,541	84,304	152,265
sd05100	1	88.3	1,818	46,232	72,293	149,117
sd05101	1	50.8	0	13,146	23,721	57,802
sd05104	1	98.4	0	15,760	31,964	87,678
sd05106	1	130.1	0	38,712	67,615	158,994
sd05107	1	46.6	379	20,547	33,191	71,271
sd05108	1	107.3	3,808	64,842	99,055	198,317
sd05109	1	40.2	318	17,426	28,160	60,493
sd05110	1	54.5	1,122	28,133	43,958	90,584
sd05112	1	63.8	1,947	37,402	57,570	116,388
sd05115	1	60.1	418	26,017	42,225	91,189
sd05117	1	75.7	528	32,206	52,233	112,706
sd05119	1	58.1	0	0	0	3,399
sd05122	1	59.2	0	0	218	9,500
sd05125	1	148.1	0	20,963	44,157	125,498
sd05127	1	123.7	994	53,826	86,949	186,703
sd05129	1	70.1	572	31,001	50,078	107,530
sd05131	1	64.1	537	29,081	46,976	100,870
sd05135	1	154.0	16,563	136,099	196,238	363,593
sd05137	1	135.8	0	0	0	378
sd05139	1	89.1	0	24,390	43,400	104,165
sd05141	1	62.2	513	27,527	44,453	95,417
sd05144	1	63.4	518	28,049	45,309	97,290
sd05146	1	58.7	466	25,225	40,747	87,495
sd05149	1	112.0	927	50,188	81,071	174,082
sd05151	1	137.1	0	14,941	33,948	103,185
sd05154	1	113.7	0	6,966	19,297	68,496
sd05155	1	76.8	624	33,806	54,609	117,260
sd05157	1	124.1	14,709	113,465	162,592	298,666
sd05158	1	91.7	16,256	99,760	139,512	247,557
sd05163	1	89.1	721	39,028	63,045	135,374
sd05164	1	106.8	870	47,144	76,154	163,524
sd05168	1	134.4	29,087	161,587	223,361	389,704
sd05173	1	149.7	0	304	6,053	45,079

sd05176	1	106.6	0	13,772	29,733	86,418
sd05177	1	13.9	113	6,113	9,875	21,205
sd05179	1	36.1	107	14,022	23,221	51,371
sd05180	1	46.4	653	22,471	35,653	74,890
sd05182	1	23.5	3,697	24,088	33,912	60,755
sd05184	1	73.1	7,441	63,281	91,543	170,386
sd05185	1	63.5	7,815	5,8951	84,286	154,337
sd05186	1	41.1	365	18,503	29,819	63,848
sd05187	1	56.4	624	26,336	42,147	89,474
sd05188	1	49.3	1,198	27,236	42,334	86,659
sd05192	1	48.0	387	20,962	33,862	72,711
sd05194	1	96.2	786	42,550	68,733	147,589
sd05197	1	60.0	1,633	34,009	52,599	106,992
sd05198	1	37.2	4,046	33,039	47,610	88,141
sd05199	1	63.9	2,145	37,972	58,153	116,804
sd05200	1	45.8	1,493	26,731	40,968	82,362
sd05201	1	61.0	2,136	36,975	56,544	113,363
sd05202	1	129.8	1,784	63,423	100,773	212,054
sd05203	1	52.1	426	23,090	37,299	80,092
sd05204	1	120.4	983	53,248	86,015	184,698
sd05207	1	97.7	790	42,804	69,143	148,470
sd05209	1	225.7	19,164	182,450	266,676	503,452
sd05211	1	24.8	2,710	21,872	31,481	58,186
sd05212	1	46.2	142	18,003	29,790	65,837
sd05214	1	48.1	5,324	42,959	61,834	114,288
sd05215	1	68.1	5,213	52,475	77,074	146,477
sd05217	1	34.5	1	11,088	19,090	44,171
sd05219	1	55.7	455	24,633	39,791	85,443
sd05221	1	9.6	0	0	214	2,410
sd05223	1	19.4	2,093	17,005	24,493	45,312
sd05225	1	60.5	0	12,832	24,202	61,781
sd05226	1	75.0	18,395	95,250	130,531	224,872
sd05227	1	123.1	30,539	155,486	212,628	365,159
sd05228	1	108.1	26,527	137,430	188,349	324,510
sd05229	1	68.8	1,571	37,139	57,849	118,739
sd05230	1	38.5	171	15,638	25,673	56,210
sd05232	1	7.3	789	6,370	9,168	16,946
sd05233	1	12.7	1,412	11,393	16,398	30,309
sd05235	1	62.1	9,550	63,660	89,849	161,543
sd05237	1	30.4	81	11,751	19,502	43,255
sd05240	1	26.6	71	10,316	17,122	37,975

sd05267	1	11.3	1,232	9,945	14,314	26,456
sd05271	1	29.5	3,119	25,808	37,237	69,058
sd05280	1	11.0	1,264	10,196	14,676	27,126
sd05281	1	9.7	36	3,825	6,305	13,868
sd05282	1	50.8	30,154	103,957	134,522	212,336
sd05283	1	129.1	1,592	60,650	96,654	204,130
sd05284	1	9.7	195	5,063	7,926	16,378
sd05285	1	16.1	0	3,112	6,007	15,700
sd05286	1	16.9	0	1,199	3,149	10,748
sd05287	1	91.2	9,764	80,227	115,678	214,330
sd05288	1	8.8	966	7,794	11,219	20,736
sd05289	1	60.9	0	17,870	31,272	73,691
sd05290	1	54.1	15,467	74,383	100,976	171,531
sd05291	1	14.6	37,400	73,366	85,927	115,443
sd05292	1	22.5	65,185	122,033	141,701	187,750
sd05293	1	8.5	942	7,601	10,941	20,221
sd05294	1	25.5	2,829	22,826	32,855	60,727
sd05295	1	36.8	23,746	79,424	102,283	160,227
sd05296	1	34.5	29,153	86,538	109,266	165,873
sd05297	1	44.9	37,554	112,487	142,249	216,476
sd05298	1	35.2	36,100	99,490	124,017	184,409
sd05299	1	47.7	52,891	141,979	176,160	259,980
sd05300	1	128.5	0	25,285	48,661	126,793
sd05301	1	81.1	230,329	431,940	501,716	665,094

APPENDIX F

STORAGE NODE CAPACITY AND FLOWS FOR EXISTING CONDITIONS

Notes:

1. Storage nodes sd04003, sd04004, sd04005, sd04007, sd04008, sd04010, sd04012 and sd04013 all receive their flows directly from an assigned sub-basin. Storage nodes sd04001 and sd04002 do not have any flows to them. There are no flows from any nearby sub-basins or any flows into these areas from above. Storage nodes sd04003 and sd040013 are "standalone" storage nodes and are not connected to the rest of the storm network. Storage node sd04005 and sd04006 are part of a small storm network which is not connected to the rest of the storm network
2. sd04006 does not have any flows for the 2 year storms. The flows are collected upstream in sd04005 because it has adequate capacity to store the flows without a release downstream. Storage node sd04009 does not have any flows for the 2 year storm. This is because there is enough storage in the upstream storage node sd04008. Storage area sd04015 and sd04016 do not have any flows out them for the 2 year storm because the storage at sd04014 is adequate to store the flows from above.

Definitions

- Link Name – Facility name.
- Design Full Flow –Calculated design full flow under normal conditions, in cfs.
- Design Velocity –Calculated design velocity under normal conditions for design full flow, in ft/sec.
- Diameter – This is the diameter using the height value for the open channel depth, the diameter of pipes and the height of rectangular sections, in ft.
- Max Flow – Maximum flow rate calculated during the model run, in cfs.
- Max Velocity –Maximum velocity calculated during the model run, in ft/sec.
- Max d/D –A ratio of the maximum calculated depth divided by diameter during the model run.
- Total Flow –The total calculated flow through the link during the model run, in ft^3.
- Node Name –The facility name of the upstream node to the above defined link.
- Invert Elevation – Bottom elevation at the node, in feet.
- Max Water Elevation –Maximum water elevation calculated at the node during the model run, in feet.
- Max Water Depth –Maximum water depth calculated at the node during the model run, in ft.

- Volume of Outflow –The total volume of outflow leaving the system from either flooding out the top of a node or being discharged at a discharge node, in ft^3.
- Duration of Flooding –Time that flooding occurs at the node, in minutes (min).
- Duration of Surcharge –Time that the pipe was flowing full and under pressure, but the pressure was not high enough to discharge out the node, in minutes.
- Flood Loss –Total amount of water that flooded out the top of the node, in ft^3. This volume of water is lost from the system and not assumed to return at a node lower down due to surface flow down to a lower node.
- Freeboard – The difference between the top of the water and the surface elevation at that node, in ft. If this value is positive, the water is below the surface at that given distance. If the value is 0, that means there is flooding at that node.

STORAGE NODE CAPACITY AND FLOWS FOR EXISTING CONDITIONS

FacilityID	Capacity (ft^3)	Stage (ft)	Flows (ft^3)			
			2 Year Storm	10 Year Storm	25 Year Storm	100 Year Storm
sd04000	6,777	3.6	10,867	103,850	153,104	292,712
sd04001	594	3.0	No Flow into this node			
sd04002	3,159	4.6	No Flow into this node			
sd04003	14,040	3.8	1,850	14,926	21,484	39,709
sd04004	11,367	4.6	1,394	13,248	19,361	36,546
sd04005	4,644	0.8	147	7,977	12,886	27,670
sd04006	3,429	1.1	0	3,078	7,982	22,761
sd04007	22,032	7.4	67	3,633	5,868	12,600
sd04008	7,425	3.4	213	11,562	18,677	40,106
sd04009	19,548	3.0	0	4,698	11,813	33,180
sd04010	106,866	8.0	17,439	70,267	93,095	152,426
sd04011	386,343	8.5	292,475	391,377	400,679	424,719
sd04012	361	6.8	3,549	28,638	41,220	76,188
sd04013	678	3.8	1,285	10,365	14,919	27,576
sd04014	15,880	2.6	5,897	245,482	394,169	840,635
sd04015	21,345	2.7	0	235,610	384,296	787,517
sd04016	37,143	4.2	0	215,528	364,206	767,398

IDENTIFICATION OF STORM SEWER DEFICIENT AREAS FOR EXISTING CONDITION

SUNNYSLOPE 2 YR. STORM
No identified flooded areas.

Sunnyslope 10 Yr. Storm											
Link Name	**Design Full Flow cfs**	**Diameter (Height) ft**	**Max Flow cfs**	**Max d/D (depth/diameter)**	**Node Name**	**Max Water Depth ft**	**Volume of Outflow (ft3)**	**Duration of Flooding (min)**	**Duration of Surcharge (min)**	**Flood Loss (ft3)**	**Problem**
sd00178	3.4	1.0	5.6	4.0	sd03183	4.0	0	48.7	27.3	2,191	Insufficient Capacity
sd00340	7.6	1.5	7.4	3.0	sd03560	4.5	13,551	108.6	27.4	2,838	Conveyance
sd00163	7.4	1.5	8.6	3.0	sd03592	4.5	0	738.3	549.0	6,293	Insufficient Capacity
sd00342	4.7	1.5	6.3	3.0	sd03558	4.5	0	231.5	76.4	7,410	Insufficient Capacity
sd00444	3.4	1.0	7.8	3.0	sd05045	3.0	0	0.0	266.9	8,093	Insufficient Capacity
sd00341	3.1	1.5	3.5	3.0	sd03559	4.5	7,410	217.1	95.2	13,551	Insufficient Capacity
sd00159	9.4	1.5	8.8	3.0	sd03596	4.5	0	624.8	507.9	22,553	Conveyance
sd00165	6.4	1.0	7.4	4.0	sd03590	4.0	0	967.6	805.8	151,553	Insufficient Capacity
sd00167	2.7	1.0	4.7	4.0	sd03588	4.0	0	1,043.4	1,010.4	159,953	Insufficient Capacity
sd00755	3.4	1.5	6.8	2.0	sd05004	3.0	0	0.0	1,001.1	404,701	Insufficient Capacity
sd00743	22.4	2.0	20.7	1.5	sd05200	3.0	0	0.0	955.8	1,151,981	Conveyance

Sunnyslope 25 Yr. Storm											
Link Name	**Design Full Flow cfs**	**Diameter (Height) ft**	**Max Flow cfs**	**Max d/D (depth/diameter)**	**Node Name**	**Max Water Depth ft**	**Volume of Outflow (ft3)**	**Duration of Flooding (min)**	**Duration of Surcharge (min)**	**Flood Loss (ft3)**	**Problem**
sd00176	4.6	1.0	8.3	4.0	sd03185	4.0	0	51.0	17.3	417	Insufficient Capacity
sd00175	13.6	1.5	17.3	2.0	sd05199	3.0	0	0.0	21.2	1,955	Insufficient Capacity
sd00178	3.4	1.0	5.6	4.0	sd03183	4.0	0	73.3	33.7	4,440	Insufficient Capacity
sd00340	7.6	1.5	7.4	3.0	sd03560	4.5	19,909	214.7	38.6	7,574	Conveyance
sd00163	7.4	1.5	8.7	3.0	sd03592	4.5	0	942.4	918.7	10,897	Insufficient Capacity
sd00157	11.2	1.5	12.5	5.0	sd03598	7.5	86,004	0.0	236.8	12,750	Insufficient Capacity
sd00342	4.7	1.5	6.4	3.0	sd03558	4.5	0	503.3	109.5	15,115	Insufficient Capacity
sd00341	3.1	1.5	3.6	3.0	sd03559	4.5	15,115	393.9	159.6	19,909	Insufficient Capacity
sd00158	10.7	1.5	10.7	3.0	sd03597	4.5	101,977	910.2	877.4	86,004	Insufficient Capacity
sd00159	9.4	1.5	8.9	3.0	sd03596	4.5	0	928.1	917.9	101,977	Conveyance
sd00444	3.4	1.0	7.8	3.0	sd05045	3.0	0	0.0	622.6	146,917	Insufficient Capacity
sd00167	2.7	1.0	4.7	4.0	sd03588	4.0	0	1,075.2	1,067.5	194,764	Insufficient Capacity
sd00165	6.4	1.0	7.5	4.0	sd03590	4.0	0	1,062.1	1,052.6	250,240	Insufficient Capacity
sd00755	3.4	1.5	6.8	2.0	sd05004	3.0	0	0.0	1,014.2	622,311	Insufficient Capacity
sd00743	22.4	2.0	20.7	1.5	sd05200	3.0	0	0.0	975.9	2,239376	Conveyance

Sunnyslope 100 Yr. Storm											
Link Name	**Design Full Flow cfs**	**Diameter (Height) ft**	**Max Flow cfs**	**Max d/D (depth/diameter)**	**Node Name**	**Max Water Depth ft**	**Volume of Outflow (ft3)**	**Duration of Flooding (min)**	**Duration of Surcharge (min)**	**Flood Loss (ft3)**	**Problem**
sd00176	4.6	1.0	8.3	4.0	sd03185	4.0	0	102.5	31.8	5,761	Insufficient Capacity
sd00178	3.4	1.0	5.6	4.0	sd03183	4.0	0	125.0	48.0	6,613	Insufficient Capacity
sd00163	7.4	1.5	9.1	3.0	sd03592	4.5	0	1,067.9	1,061.2	12,590	Insufficient Capacity
sd00340	7.6	1.5	7.4	3.0	sd03560	4.5	47,878	622.2	77.3	23,104	Conveyance
sd00762	12.2	1.5	14.5	2.3	sd04014	6.0	0	0.0	633.1	43,187	Insufficient Capacity
sd00342	4.7	1.5	6.4	3.0	sd03558	4.5	0	948.5	384.5	45,335	Insufficient Capacity
sd00341	3.1	1.5	3.5	3.0	sd03559	4.5	45,335	909.7	524.0	47,878	Insufficient Capacity
sd00159	9.4	1.5	9.5	3.0	sd03596	4.5	0	1,065.0	1,062.3	120,064	Insufficient Capacity
sd00158	10.7	1.5	10.7	3.0	sd03597	4.5	120,064	1,062.8	1,060.9	128,643	Insufficient Capacity
sd00167	2.7	1.0	4.7	4.8	sd03588	4.0	0	1,118.2	1,097.1	237,755	Insufficient Capacity
sd00165	6.4	1.0	7.5	4.0	sd03590	4.0	0	1,094.4	1,091.7	409,858	Insufficient Capacity
sd00175	13.6	1.5	17.4	2.0	sd05199	3.0	0	0.0	984.6	426,526	Insufficient Capacity
sd00444	3.4	1.0	7.8	3.0	sd05045	3.0	0	0.0	893.3	688,998	Insufficient Capacity
sd00157	11.2	1.5	12.5	5.0	sd03598	7.5	128,643	0.0	931.5	698,517	Insufficient Capacity
sd00755	3.4	1.5	6.8	2.0	sd05004	3.0	0	0.0	1,046.4	801,163	Insufficient Capacity
sd00743	22.4	2.0	20.7	1.5	sd05200	3.0	0	0.0	1,006.0	5,339,122	Conveyance

APPENDIX G

STORAGE NODE CAPACITY AND FLOWS FOR FUTURE CONDITIONS

Notes:

1. Storage nodes sd04003, sd04004, sd04005, sd04007, sd04008, sd04010, sd04012 and sd04013 all receive their flows directly from an assigned sub-basin. Storage nodes sd04001 and sd04002 do not have any flows to them. There are no flows from any nearby sub-basins or any flows into these areas from above. Storage nodes sd04003 and sd040013 are "standalone" storage nodes and are not connected to the rest of the storm network. Storage node sd04005 and sd04006 are part of a small storm network which is not connected to the rest of the storm network.
2. For the future conditions, sd04006 does not have any flows for the 2 storms. Storage node sd04009 does not have any flows for the 2 year storm, just like for existing conditions. Storage area sd04015 and sd04016 do not have any flows out them for the 2 year storm just like the existing conditions.

Definitions:

- Link Name – Facility name.
- Design Full Flow –Calculated design full flow under normal conditions, in cfs.
- Design Velocity –Calculated design velocity under normal conditions for design full flow, in ft/sec.
- Diameter – This is the diameter using the height value for the open channel depth, the diameter of pipes and the height of rectangular sections, in ft.
- Max Flow – Maximum flow rate calculated during the model run, in cfs.
- Max Velocity –Maximum velocity calculated during the model run, in ft/sec.
- Max d/D –A ratio of the maximum calculated depth divided by diameter during the model run.
- Total Flow –The total calculated flow through the link during the model run, in ft^3.
- Node Name –The facility name of the upstream node to the above defined link.
- Invert Elevation – Bottom elevation at the node, in feet.
- Max Water Elevation –Maximum water elevation calculated at the node during the model run, in feet.
- Max Water Depth –Maximum water depth calculated at the node during the model run, in ft.

- Volume of Outflow –The total volume of outflow leaving the system from either flooding out the top of a node or being discharged at a discharge node, in ft^3.
- Duration of Flooding –Time that flooding occurs at the node, in minutes (min).
- Duration of Surcharge –Time that the pipe was flowing full and under pressure, but the pressure was not high enough to discharge out the node, in minutes.
- Flood Loss –Total amount of water that flooded out the top of the node, in ft^3. This volume of water is lost from the system and not assumed to return at a node lower down due to surface flow down to a lower node.
- Freeboard – The difference between the top of the water and the surface elevation at that node, in ft. If this value is positive, the water is below the surface at that given distance. If the value is 0, that means there is flooding at that node.

STORAGE NODE CAPACITY AND FLOWS FOR FUTURE CONDITIONS

FacilityID	Capacity (ft^3)	Stage (ft)	Flows (ft^3)			
			2 Year Storm	10 Year Storm	25 Year Storm	100 Year Storm
sd04000	6,777	3.6	10,964	104,533	153,988	294,127
sd04001	594	3.0	No Flow into this node			
sd04002	3,159	4.6	No Flow into this node			
sd04003	14,040	3.8	1,837	14,885	21,434	39,638
sd04004	11,367	4.6	1,821	14,692	21,147	39,087
sd04005	4,644	0.8	1,992	16,078	23,142	42,774
sd04006	3,429	1.1	0	11,173	18,234	37,869
sd04007	22,032	7.4	907	7,321	10,538	19,477
sd04008	7,425	3.4	207	11,510	18,609	40,000
sd04009	19,548	3.0	0	4,646	11,745	33,074
sd04010	106,866	8.0	24,269	84,607	109,676	173,595
sd04011	386,343	8.5	293,444	391,434	400,750	424,789
sd04012	361	6.8	3,549	28,638	41,220	76,188
sd04013	678	3.8	1,285	10,365	14,919	27,576
sd04014	15,880	2.6	4,988	150,446	252,265	587,298
sd04015	21,345	2.7	0	140,576	242,393	577,423
sd04016	37,143	4.2	0	120,509	222,316	557,321

STORM SEWER DEFICIENT AREAS FOR FUTURE CONDITIONS

SUNNYSLOPE 2 YR. STORM
No identified flooded areas

Sunnyslope 10 Yr. Storm											
Link Name	**Design Full Flow cfs**	**Diameter (Height) ft**	**Max Flow cfs**	**Max d/D (depth/diameter)**	**Node Name**	**Max Water Depth ft**	**Volume of Outflow (ft3)**	**Duration of Flooding (min)**	**Duration of Surcharge (min)**	**Flood Loss (ft3)**	**Problem**
sd00178	3.4	1.0	5.6	4.0	sd03183	4.0	0	47.7	26.2	1,875	Insufficient Capacity
sd00340	7.6	1.5	7.4	3.0	sd03560	4.5	13,494	109.8	26.9	2,693	Conveyance
sd00342	4.7	1.5	6.3	3.0	sd03558	4.5	0	237.9	81.1	8,498	Insufficient Capacity
sd00341	3.1	1.5	3.4	3.0	sd03559	4.5	8,498	220.2	96.6	13,494	Insufficient Capacity
sd00165	6.4	1.0	7.4	4.0	sd03590	4.0	0	972.1	784.9	93,026	Insufficient Capacity
sd00167	2.7	1.0	4.7	4.0	sd03588	4.0	0	1,032.6	1,000.0	162,900	Insufficient Capacity
sd00755	3.4	1.5	6.8	2.0	sd05004	3.0	0	0.0	940.2	237,806	Insufficient Capacity
sd00743	22.4	2.0	20.7	1.5	sd05200	3.0	0	0.0	955.0	1,041,118	Conveyance

Sunnyslope 25 Yr. Storm											
Link Name	**Design Full Flow cfs**	**Diameter (Height) ft**	**Max Flow cfs**	**Max d/D (depth/diameter)**	**Node Name**	**Max Water Depth ft**	**Volume of Outflow (ft3)**	**Duration of Flooding (min)**	**Duration of Surcharge (min)**	**Flood Loss (ft3)**	**Problem**
sd00176	4.6	1.0	8.3	4.0	sd03185	4.0	0	50.0	15.0	219	Insufficient Capacity
sd00178	3.4	1.0	5.6	4.0	sd03183	4.0	0	65.0	32.9	4,251	Insufficient Capacity
sd00340	7.6	1.5	7.4	3.0	sd03560	4.5	19,909	216.8	38.3	7,369	Conveyance
sd00163	7.4	1.5	8.6	3.0	sd03592	4.5	0	877.0	779.9	9,183	Insufficient Capacity
sd00158	10.7	1.5	10.7	3.0	sd03597	4.5	68,143	671.6	401.1	12,619	Insufficient Capacity
sd00342	4.7	1.5	6.4	3.0	sd03558	4.5	0	507.7	114.0	16,549	Insufficient Capacity
sd00341	3.1	1.5	3.5	3.0	sd03559	4.5	16,549	397.7	161.5	19,909	Insufficient Capacity
sd00444	3.4	1.0	7.8	3.0	sd05045	3.0	0	0.0	462.6	57,418	Insufficient Capacity
sd00159	9.4	1.5	8.8	3.0	sd03596	4.5	0	817.7	762.3	68,143	Conveyance
sd00167	2.7	1.0	4.7	4.0	sd03588	4.0	0	1,046.5	1,023.4	185,618	Insufficient Capacity
sd00165	6.4	1.0	7.5	4.0	sd03590	4.0	0	1,012.9	994.0	249,669	Insufficient Capacity
sd00755	3.4	1.5	6.8	2.0	sd05004	3.0	0	0.0	996.2	419,091	Insufficient Capacity
sd00743	22.4	2.0	20.7	1.5	sd05200	3.0	0	0.0	975.4	2,087,045	Conveyance

Sunnyslope 100 Yr. Storm											
Link Name	Design Full Flow cfs	Diameter (Height) ft	Max Flow cfs	Max d/D (depth/diameter)	Node Name	Max Water Depth ft	Volume of Outflow (ft3)	Duration of Flooding (min)	Duration of Surcharge (min)	Flood Loss (ft3)	Problem
sd00176	4.6	1.0	8.3	4.0	sd03185	4.0	0	100.6	31.1	5,376	Insufficient Capacity
sd00178	3.4	1.0	5.6	4.0	sd03183	4.0	0	121.3	47.8	6,509	Insufficient Capacity
sd00163	7.4	1.5	9.1	3.0	sd03592	4.5	0	1063.9	1,057.2	12,542	Insufficient Capacity
sd00340	7.6	1.5	7.4	3.0	sd03560	4.5	47,765	625.8	76.2	22,769	Conveyance
sd00341	3.1	1.5	3.5	3.0	sd03559	4.5	48,339	913.2	526.2	47,765	Insufficient Capacity
sd00342	4.7	1.5	6.4	3.0	sd03558	4.5	0	951.2	397.1	48,339	Insufficient Capacity
sd00159	9.4	1.5	9.4	3.0	sd03596	4.5	0	1060.9	1,058.3	119,609	Insufficient Capacity
sd00158	10.7	1.5	10.7	3.0	sd03597	4.5	119,609	1058.7	1,057.1	128,520	Insufficient Capacity
sd00175	13.6	1.5	17.4	2.0	sd05199	3.0	0	0.0	921.6	179,043	Insufficient Capacity
sd00167	2.7	1.0	4.7	4.7	sd03588	4.0	0	1114.0	1,091.1	235,176	Insufficient Capacity
sd00165	6.4	1.0	7.4	4.0	sd03590	4.0	0	1086.6	1,083.7	418,324	Insufficient Capacity
sd00157	11.2	1.5	12.5	5.0	sd03598	7.5	128,520	0.0	909.7	432,050	Insufficient Capacity
sd00444	3.4	1.0	7.8	3.0	sd05045	3.0	0	0.0	893.5	541,930	Insufficient Capacity
sd00755	3.4	1.5	6.8	2.0	sd05004	3.0	0	0.0	1,022.1	756,758	Insufficient Capacity
sd00743	22.4	2.0	20.7	1.5	sd05200	3.0	0	0.0	1,005.6	5085,463	Conveyance

APPENDIX H

11.24.080 Culverts, Trestles, Bridges and Drainage Channels

All culverts, trestles or bridges over waterways, draws or gulches shall conform to the city engineer's specifications for structures of this nature. Where streets or roads of subdivisions connect to, or intersect with, existing roadways, there shall be installed drains of metal or concrete pipe approved by the city engineer. Existing drainage channels draining Dry Gulch, Number One Canyon and Number Two Canyon shall be improved pursuant to the city engineer's specifications so as to provide the following minimum flow capacities:

Dry Gulch: 150 cubic feet per second;

Number One Canyon: 100 cubic feet per second;

Number Two Canyon:100 cubic feet per second. (Ord. 2010-24 § 1; Ord. 3080 § 614.120, 1994)

APPENDIX I

U.S. Army Corps of Engineers - Financial Strategy for Flood Risk Reduction Projects

City of Wenatchee, Washington ***June 1, 2009***

Reviewed by: Ben Floyd

Prepared by: Eric E. Nagy, PE

Introduction

This technical memorandum (TM) serves to document potential sources of financial assistance available through the U.S. Army Corps of Engineers for the planning, design, and/or construction of flood damage reduction projects by the City of Wenatchee (City) in the State of Washington. This TM provides a brief synopsis of two potential processes through which the City may be successful in securing Federal financial and technical assistance. The financial and technical assistance opportunities described in this TM are intended to complement the other planning and preliminary engineering studies previously conducted or commissioned by the City.

Background

Over the last century, the western side of the City of Wenatchee has experienced alluvial fan flooding periodically at Canyons No. 1, No. 2, and Dry Gulch. These events have resulted damages to infrastructure and private property as well as demonstrated the existing level of flood risk currently facing the community. Many of these storms have transmitted large sediment loads leading to mud and debris flows. These floods are triggered by both convective thunderstorms and rain-on-snow events.

HDR Engineering, Inc. (HDR) has been asked, as part of updating the City's storm water management plan, to review and summarize Canyon No. 1, No. 2, and Dry Gulch flood studies conducted to date, evaluate potential alternatives to these flood hazards within FEMA regulatory constraints, and identify next steps for pursuing additional studies, design and construction through Corps funding program opportunities. This information will be summarized in a chapter in the updated storm water management plan.

Financial Strategy Overview

Potential sources of financial assistance for the planning, design, and construction of flood risk reduction projects is often available at the Federal, State, and sometimes local levels of government. Financial assistance programs for flood risk reduction projects generally fall into two primary categories: 1) Competitive Grants; and, 2) Coordinated Project Implementation. As should be expected with any type financial assistance program, each program has very specific and complex procedural and technical requirements that expand well beyond the scope of this document. The applicant or project sponsor is advised to consult an expert familiar with the program or contact the program proponent for additional information prior to relying on any financial assistance program for project implementation.

Competitive Grants

Competitive grants refer to the receipt of funding based upon project selection through a competitive application process. Each competitive grant program has established requirements for project eligibility as well as documented screening criteria for the selection of grant awardees. These awardees often must agree to follow established guidelines in the expenditure of these funds. The most common examples in this category are administered by the Federal Emergency Management Agency; however, other agencies have programs authorized to provide financial assistance with the implementation of water resource projects that may include flood protection as an ancillary benefit of project implementation.

Coordinated Project Implementation

Coordinated project implementation refers to the joint or coordinated implementation of a project by a Federal agency and a non-Federal sponsor. These two partners implement the entire project or a phase of a project through some form of cost-sharing or cooperation agreement. The most common example of this category is a Civil Work Project implemented through a partnership between the U.S. Army Corps of Engineers (Corps) and a non-Federal sponsor. Other Federal agencies have programs authorized for the coordinated implementation of water resource projects that may include flood protection as an ancillary benefit of project implementation. For example, the National Resource Conservation Service (NRCS) is authorized to participate with other Federal, State and Local sponsors in conducting watershed scale flood damage reduction projects through the Watershed Protection and Flood Prevention Act (Public Law 83-566).

This TM focuses on financial assistance opportunities offered by the Corps.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (Corps) has a broad range of authorities and programs through which to implement (or assist in the implementation of) water resources projects. Describing or even listing all of these authorities and programs is well beyond the scope of this TM. As a result, this TM will focus on two commonly used processes to implement a water resources project.

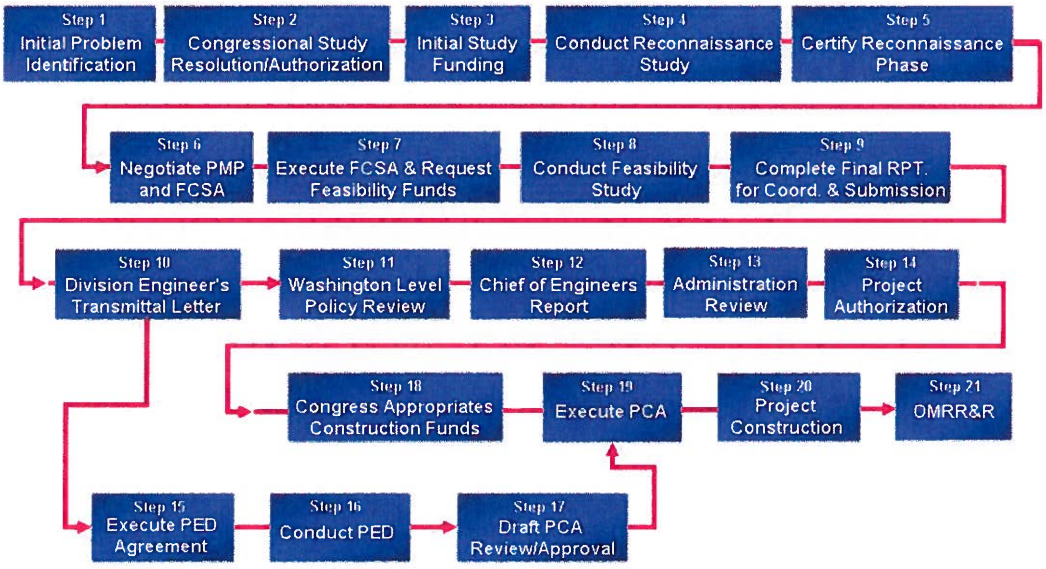
The Civil Works Process

Successfully implementing a project through the Corps' Civil Works Program requires patience and persistence. It also requires two separate and distinct forms of Congressional action. Both of the following forms of action are required for a project to proceed through the established process:

- ***Authorization*** – Congress must grant the Corps specific authority to undertake a study. Upon the completion of this study, Congress must subsequently and separately authorize the Corps to construct the project recommended in the study. Generally, Congress grants these authorities through the Water Resources Development Act (WRDA).
- ***Appropriation*** – Congress must annually appropriate Federal funds in support of a project specific study or construction authorization. In the Civil Works Program, the Corps does not receive one large appropriation which it decides to distribute amongst its projects. Conversely, Congress appropriates funding annually on a project by project basis therefore establishing the priorities of the agency. These appropriations typically come through the Energy and Water Development Appropriations Act (EWDAA).

The Civil Work Project process is often summarized by the Corps as having 21-Steps. These steps integrate the Congressional authorization and appropriations requirements with the administrative actions required for completion by the Corps in cooperation with the non-Federal sponsor. A figure describing these steps has been inserted on the following page. Additional information associated with the Civil Works Program can be found in IWR Report No. 96-R-10 dated January 2001 and titled the "Project Partnership Kit".

Civil Works Project Delivery Process



Standard Cost-Sharing Requirements

The Water Resources Development Act (WRDA) of 1986 (PL 99-662) established cost-sharing requirements for each phase of a Corps' Civil Works Project. Although these requirements can change based on specific circumstances, the following distribution of costs generally applies to each phase of the project:

- ***Reconnaissance Phase*** = 100% Federal / 0% non-Federal
- ***Feasibility Phase*** = 50% Federal / 50% non-Federal
- ***Pre-Construction Engineering and Design (PED) Phase*** =75% Federal / 25% non-Federal
- ***Construction Phase*** = 65% Federal / 35% non-Federal
- ***Operations and Maintenance*** = 0% Federal / 100% non-Federal

Several important items should be carefully considered upon reviewing these cost-sharing requirements. First, the Feasibility Phase is the only phase in which the non-Federal sponsor can contribute their 50% share as any combination of cash contributions or in-kind services. Second, the non-Federal share of the Construction Phase includes a mandatory 5% cash contribution as well as the provision of all Lands, Easements, Rights-of-Way, Relocation, and Disposal (LERRD's). These LERRD's are creditable as part of the non-Federal share; however, the non-Federal sponsor is responsible to provide these project features up to 50% of the total estimated project cost.

Advanced non-Federal Actions

Congress has granted the Corps' several authorities through which a non-Federal sponsor can implement prospective or authorized project features in advance of construction by the Federal Government. The two most common authorities considered in this situation are as follows:

- ***Section 104*** – Authorized by WRDA or 1986, Section 104 allows the non-Federal sponsor to request and receive conditional assurance from the Corps that the construction of prospective project features initiated after completion of the reconnaissance phase but before project authorization will be considered as credit against the Federal Plan if authorized and determined to be compatible. For additional information, please reference Engineer Regulation (ER) 1165-2-29.

Section 215 – Authorized by the Flood Control Act of 1968 (PL 90-483) and amended, Section 215 allows the non-Federal sponsor to request approval from the Corps to construct a project feature in return for credit or reimbursement under the Congressionally-authorized project. For additional information, please reference Engineer Regulation (ER) 1165-2-18.

The Continuing Authorities Program

The Continuing Authorities Program (CAP) provides the Corps with the authority to solve water resource problems in partnership with local sponsors without Congressional authorization if the planning, design, and construction occur within specified funding limits. This "pre-authorization" saves time in the development and approval of many projects. Cost sharing by a local project sponsor is required for studies, design and construction. A local project sponsor must be a municipality or a legally constituted public body empowered under State laws to give assurances and be financially capable of fulfilling all measures of local cooperation, including, but not limited to, study and construction cost sharing. Funding limits for continuing authorities projects range from $500,000 to $7,000,000, as described in the following table

Continuing Authorities Program - Authorization Categories

Category	Authorization	Max. Federal Contribution
Emergency Streambank & Shoreline Protection	Section 14 (FCA 1946)	$1,500,000
Hurricane & Storm Damage Reduction Projects	Section 103 (RHA 1962)	$5,000,000
Small Navigation Projects	Section 107 (RHA 1960)	$4,000,000
Shore Erosion Mitigation due to Federal Navigation	Section 111 (RHA 1968)	$2,000,000
Ecosystem Restoration in Connection with Dredging	Section 204 (WRDA 1992)	N/A
Small Flood Damage Reduction Projects	Section 205 (FCA 1948)	$7,000,000
Aquatic Ecosystem Restoration	Section 206 (WRDA 1996)	$5,000,000
Snagging & Clearing for Flood Control	Section 208 (FCA 1954)	$500,000
Environmental Restoration	Section 1135 (WRDA 1986)	$5,000,000

CAP Project Criteria

Each project constructed by the Corps to solve a water resource problem must meet the following criteria:

- The project must be separately useful and not commit the Corps to further construction. This means that the project must solve a specific problem and not require a subsequent project to complete the solution.
- The project must be economically justified. That is, the benefits from the project must exceed the cost of the project, including project maintenance. This is usually expressed on an average annual basis.

- The project must be environmentally acceptable. Consideration of the environment is an integral part of the planning of the project. In all cases, the Corps prepares environmental assessments, which it coordinates with Federal, State, and local agencies, and the concerned public. In more controversial projects, the Corps prepares an environmental impact statement.
- The sponsor of the project must be willing to assist with the project. This usually entails providing the lands, easements, rights-of-way, relocations, and disposal sites, necessary for construction and maintenance of the project, and any permits mandated by the state.
- Cost sharing is also required for studies, design, and construction. In addition, some projects must be maintained by the project sponsor.
- The sponsor is also responsible for any costs for clean up and response to hazardous and toxic waste on lands necessary for the project.

Section 205 – Small Flood Damage Reduction Projects

The City of Wenatchee may be particularly interested in the authority granted to the Corps for the implementation of Small Flood Damage Reduction Projects under the Continuing Authorities Program. Section 205 of the 1948 Flood Control Act authorizes the Corps to study, design, and construct small flood control projects in partnership with non-Federal government agencies, such as cities, counties, special authorities, or units of state government. Projects are planned and designed under this authority to provide the same complete flood control project that would be provided under specific congressional authorizations. The maximum Federal cost for planning, design, and construction of any one project is $7,000,000. Each project must be economically justified, environmentally sound, and technically feasible. Flood control projects are not limited to any particular type of improvement. Levee and channel modifications are examples of flood control projects constructed utilizing the Section 205 authority.

The Feasibility Study is 100% federally funded up to $100,000. Costs over $100,000 are shared equally with the non-federal sponsor. Up to one-half of the non-federal share can be in the form of in-kind services. Costs for preparation of plans and specifications and construction are shared at 65 percent federal/35 percent non-federal. The non-federal share of construction consists of provision of any necessary lands, easements, rights-of-way, relocations and disposal areas (LERRD), plus a cash contribution of 5% of the total project costs. In the event that the value of LERRD, plus 5% cash, does not equal at least 35% of the total project cost, the non-federal sponsor must contribute additional cash to equal 35%. If LERRD plus 5% exceeds 35%, the sponsor is responsible up to a maximum of 50% of the total project costs.

The Corps conducts an initial appraisal early in the Feasibility Study to determine whether the project meets program criteria and provides a basis for determining scope and cost of an entire feasibility study. The solution must be economically feasible and environmentally acceptable. If an acceptable alternative is identified in the feasibility study, the Corps prepares plans and specifications, then manages construction of the project.

Recommendation

If the City elects to pursue a flood damage reduction project through the Corps, HDR recommends transmitting a letter to the Seattle District Commander, Colonel Anthony Wright. The letter should describe the known risk currently facing the City from both flood and debris flows, both of which have previous resulted in damages to public and private property within the City. The letter should request Corps participation in a flood damage reduction study, the assignment of a study manager, and a written response within 30 days. The City should provide a point of contact for the USACE.

The Corps Mailing address is:

Seattle District
U.S. Army Corps of Engineers
PO Box 3755
Seattle, WA 98124-3755

APPENDIX J

Chelan County Stormwater

Pipe Cost Breakdown per Linear Foot

Pipes Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Solid PVC 12"*	*Solid PVC 18"*	*PVC or ADS 24"*	*PVC or ADS 30"*	*PVC or ADS 36"*	*Concrete 48"*	*Concrete 60"*	*Concrete 72"*
1	Pipe Cost	LF	$8.00	$16.00	$30.00	$40.00	$48.00	$130.00	$180.00	$243.00
2	Trench Excavation and Backfill	LF	$22.50	$25.00	$27.00	$30.00	$35.00	$40.00	$50.00	$60.00
3	Pipe Bedding	LF	$3.00	$4.00	$5.50	$7.00	$9.00	$13.00	$17.50	$22.50
4	Bankrun Gravel	LF	$2.50	$2.50	$4.80	$4.80	$4.80	$4.80	$9.60	$9.60
5	Trench Safety	LF	$3.50	$3.50	$3.50	$3.50	$3.50	$10.00	$10.00	$10.00
6	Vertical Sawcut	LF	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00
7	Crushed Surfacing, Base Course	LF	$5.67	$6.00	$7.00	$8.00	$9.00	$10.71	$12.60	$14.50
8	Asphalt Concrete, Class B	LF	$16.00	$16.50	$18.00	$20.50	$23.00	$30.00	$32.00	$36.00
9		LF								
	TOTAL INSTALLED PIPE COST	LF	$63.17	$75.50	$97.80	$115.80	$134.30	$240.51	$313.70	$397.60

Note: Some pipe costs have been modified in the project sheets to reflect difficult construction.

Item	*Description of Item*	*Unit*	*Cost*
1	Catch Basin, Type I with Grate	Each	$950.00
2	Catch Basin, Type II 48" Dia.	Each	$2,400.00
3	Catch Basin, Type II, 54" Dia.	Each	$2,900.00
4	Catch Basin, Type II, 60" Dia.	Each	$3,500.00
5	Catch Basin, Type II, 72" Dia.	Each	$4,000.00
6	Catch Basin, Type II, 96" Dia.	Each	$8,000.00

Eaglerock Drainage Improvements

Pipes Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$8,504.00
2	Ditch Cleaning	LF	$3.00	22000	$66,000.00
3	Culvert Cleaning	Each	$75.00	140	$10,500.00
4	Flaggers	Hours	$60.00	80	$4,800.00
5	Hydroseeding	Acre	$5,000.00	5	$25,000.00
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27	Restoration and Cleanup	LS	Varies	1	$5,315.00

Construction Subtotal	$120,119.00
Sales Tax (8.0%)	$9,609.52
Contingency (15%)	$18,017.85
Construction Total	$147,746.37
Engineering (15%)	$22,161.96
Inspection (10%)	$14,774.64
PROJECT TOTAL	$184,682.96

Peters Street Conveyance Improvements

Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$19,357.68
2	Pipe	12	LF	$63.17	300	$18,951.00
3	Pipe	18	LF	$75.50		
4	Pipe	24	LF	$97.80	900	$88,020.00
5	Pipe	30	LF	$115.80	1000	$115,800.00
6	Pipe	36	LF	$134.30		
7	Pipe	48	LF	$240.51		
8	Pipe	60	LF	$313.70		
9	Pipe	72	LF	$397.60		
10	Catch Basin, Type I with Grate		Each	$950.00		
11	Catch Basin, Type II 48" Dia.		Each	$2,400.00	8	$19,200.00
12	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
13	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
14	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
15	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
16						
17						
18						
19						
20						
21						
22	Restoration and Cleanup		LS	Varies	1	$12,098.55

Construction Subtotal	$273,427.23
Sales Tax (8.0%)	$21,874.18
Contingency (15%)	$41,014.08
Construction Total	$336,315.49
Engineering (15%)	$50,447.32
Inspection (10%)	$33,631.55
PROJECT TOTAL	$420,394.37
TOTAL LF OF PIPE	*2,200*

Note: Estimate assumes that pipe ROW is secured from property owners for no cost.

Ohme Garden Road

Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$46,639.68
2	Pipe	12	LF	$63.17		
3	Pipe	18	LF	$75.50		
4	Pipe	24	LF	$97.80		
5	Pipe	30	LF	$115.80	3620	$419,196.00
6	Pipe	36	LF	$134.30		
7	Pipe	48	LF	$240.51		
8	Pipe	60	LF	$313.70		
9	Pipe	72	LF	$397.60		
10	Catch Basin, Type I with Grate		Each	$950.00		
11	Catch Basin, Type II 48" Dia.		Each	$2,400.00	12	$28,800.00
12	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
13	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
14	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
15	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
16	SR 97A Crossing - Jack and Bore		LF	$750.00	180	$135,000.00
17						
18						
19						
20						
21						
22	Restoration and Cleanup		LS	Varies	1	$29,149.80

Construction Subtotal	$658,785.48
Sales Tax (8.0%)	$52,702.84
Contingency (15%)	$98,817.82
Construction Total	$810,306.14
Engineering (15%)	$121,545.92
Inspection (10%)	$81,030.61
PROJECT TOTAL	$1,012,882.68
TOTAL LF OF PIPE	*3,620*

Note: Estimate assumes that pipe ROW is secured from property owners for no cost.

Warm Springs Culvert Improvements

Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$3,152.00
2	Pipe	12	LF	$63.17		
3	Pipe	15	LF			
4	Pipe	18	LF	$75.50		
5	Pipe	21	LF			
6	Pipe	24	LF	$97.80		
7	Pipe	27	LF			
8	Pipe	30	LF	$115.80		
9	Pipe	36	LF	$134.30		
10	Pipe	42	LF	$180.00	80	$14,400.00
11	Pipe	48	LF	$240.51		
12	Pipe	54	LF			
13	Pipe	60	LF	$313.70		
14	Pipe	72	LF	$397.60		
15	Catch Basin, Type I with Grate		Each	$950.00		
16	Catch Basin, Type II 48" Dia.		Each	$2,400.00		
17	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
18	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
19	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
20	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
21	Ditch Shaping, Headwalls and Hydroseed		LS	$25,000.00	1	$25,000.00
22						
23						
24						
25						
26						
27	Restoration and Cleanup		LS	Varies	1	$1,970.00

Construction Subtotal	$44,522.00
Sales Tax (8.0%)	$3,561.76
Contingency (15%)	$6,678.30
Construction Total	$54,762.06
Engineering (15%)	$8,214.31
Inspection (10%)	$5,476.21
PROJECT TOTAL	$68,452.58
TOTAL LF OF PIPE	*80*

Note: Cost of connections from CB to MH is considered incidental to the cost of the mainline pipe.

Burch Mountain Road Storm Improvements

Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$14,297.60
2	Pipe	12	LF	$63.17	1000	$63,170.00
3	Pipe	15	LF			
4	Pipe	18	LF	$75.50	1100	$83,050.00
5	Pipe	21	LF			
6	Pipe	24	LF	$97.80		
7	Pipe	27	LF			
8	Pipe	30	LF	$115.80		
9	Pipe	36	LF	$134.30		
10	Pipe	42	LF			
11	Pipe	48	LF	$240.51		
12	Pipe	54	LF			
13	Pipe	60	LF	$313.70		
14	Pipe	72	LF	$397.60		
15	Catch Basin, Type I with Grate		Each	$950.00	14	$13,300.00
16	Catch Basin, Type II 48" Dia.		Each	$2,400.00	8	$19,200.00
17	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
18	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
19	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
20	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
21						
22						
23						
24						
25						
26						
27	Restoration and Cleanup		LS	Varies	1	$8,936.00

Construction Subtotal	$201,953.60
Sales Tax (8.0%)	$16,156.29
Contingency (15%)	$30,293.04
Construction Total	$248,402.93
Engineering (15%)	$37,260.44
Inspection (10%)	$24,840.29
PROJECT TOTAL	$310,503.66
TOTAL LF OF PIPE	*2,100*

Note: Cost of connections from CB to MH is considered incidental to the cost of the mainline pipe.

Golden Lane Conveyance Improvements
Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$22,383.36
2	Pipe	12	LF	$63.17		
3	North of Highway 97A - Open Field	18	LF	$53.00	1300	$68,900.00
4	South of Highway 97A - Open Field	24	LF	$72.80	2200	$160,160.00
5	Pipe	30	LF	$115.80		
6	Pipe	36	LF	$134.30		
7	Pipe	48	LF	$240.51		
8	Pipe	60	LF	$313.70		
9	Pipe	72	LF	$397.60		
10	Catch Basin, Type I with Grate		Each	$950.00		
11	Catch Basin, Type II 48" Dia.		Each	$2,400.00	12	$28,800.00
12	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
13	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
14	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
15	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
16	Canal Crossing		LS	$15,000.00	1	$15,000.00
17	Easy Street Crossing	18	LF	$75.50	40	$3,020.00
18	Lower Sunnyslope Crossing	24	LF	$97.80	40	$3,912.00
19						
20						
21						
22	Restoration and Cleanup		LS	Varies	1	$13,989.60

Construction Subtotal	$316,164.96
Sales Tax (8.0%)	$25,293.20
Contingency (15%)	$47,424.74
Construction Total	$388,882.90
Engineering (15%)	$58,332.44
Inspection (10%)	$38,888.29
PROJECT TOTAL	$486,103.63
TOTAL LF OF PIPE	*3,500*

Note: Estimate assumes that pipe ROW is secured from property owners for no cost.

School Street Conveyance Improvements
Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$22,121.60
2	Pipe	12	LF	$63.17		
3	Pipe	18	LF	$75.50		
4	Pipe	24	LF	$97.80	1400	$136,920.00
5	Pipe	30	LF	$115.80		
6	Pipe	36	LF	$134.30		
7	Pipe	48	LF	$240.51		
8	Pipe	60	LF	$313.70		
9	Pipe	72	LF	$397.60		
10	Catch Basin, Type I with Grate		Each	$950.00		
11	Catch Basin, Type II 48" Dia.		Each	$2,400.00	4	$9,600.00
12	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
13	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
14	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
15	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
16	Canal Crossing		LS	$30,000.00	1	$30,000.00
17	Lined Intake Basin		LS	$100,000.00	1	$100,000.00
18						
19						
20						
21						
22	Restoration and Cleanup		LS	Varies	1	$13,826.00

Construction Subtotal	$312,467.60
Sales Tax (8.0%)	$24,997.41
Contingency (15%)	$46,870.14
Construction Total	$384,335.15
Engineering (15%)	$57,650.27
Inspection (10%)	$38,433.51
PROJECT TOTAL	$480,418.94
TOTAL LF OF PIPE	*1,400*

Note: Estimate assumes that pipe ROW is secured from property owners for no cost.

Boodry Street Conveyance Improvements
Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$24,946.88
2	Pipe	12	LF	$63.17	800	$50,536.00
3	Pipe	15	LF			
4	Pipe	18	LF	$75.50	1000	$75,500.00
5	Pipe	21	LF			
6	Pipe	24	LF	$97.80		
7	Pipe	27	LF			
8	Pipe	30	LF	$115.80		
9	Pipe	36	LF	$134.30		
10	Pipe	42	LF			
11	Pipe	48	LF	$240.51		
12	Pipe	54	LF			
13	Pipe	60	LF	$313.70		
14	Pipe	72	LF	$397.60		
15	Catch Basin, Type I with Grate		Each	$950.00	12	$11,400.00
16	Catch Basin, Type II 48" Dia.		Each	$2,400.00	6	$14,400.00
17	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
18	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
19	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
20	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
21	Water Quality Improvements - Including Land		LS	$160,000.00	1	$160,000.00
22						
23						
24						
25						
26						
27	Restoration and Cleanup		LS	Varies	1	$15,591.80

Construction Subtotal	$352,374.68
Sales Tax (8.0%)	$28,189.97
Contingency (15%)	$52,856.20
Construction Total	$433,420.86
Engineering (15%)	$65,013.13
Inspection (10%)	$43,342.09
PROJECT TOTAL	$541,776.07
TOTAL LF OF PIPE	*1,800*

Note: Cost of connections from CB to MH is considered incidental to the cost of the mainline pipe.

Ohme Garden Routing Improvements
Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$7,368.00
2	Pipe	12	LF	$63.17		
3	Pipe	18	LF	$75.50	1000	$75,500.00
4	Pipe	24	LF	$97.80		
5	Pipe	30	LF	$115.80		
6	Pipe	36	LF	$134.30		
7	Pipe	48	LF	$240.51		
8	Pipe	60	LF	$313.70		
9	Pipe	72	LF	$397.60		
10	Catch Basin, Type I with Grate		Each	$950.00		
11	Catch Basin, Type II 48" Dia.		Each	$2,400.00	3	$7,200.00
12	Catch Basin, Type II, 54" Dia.		Each	$2,900.00	1	$2,900.00
13	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
14	Catch Basin, Type II, 72" Dia.		Each	$4,000.00	1	$4,000.00
15	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
16	Hydroseeding		Acre	$5,000.00	0.5	$2,500.00
17						
18						
19						
20						
21						
22	Restoration and Cleanup		LS	Varies	1	$4,605.00

Construction Subtotal	$104,073.00
Sales Tax (8.0%)	$8,325.84
Contingency (15%)	$15,610.95
Construction Total	$128,009.79
Engineering (15%)	$19,201.47
Inspection (10%)	$12,800.98
PROJECT TOTAL	$160,012.24
TOTAL LF OF PIPE	*1,000*

Note: Estimate assumes that pipe ROW is secured from property owners for no cost.

Love Lane Routing Improvements
Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$11,259.20
2	Pipe	12	LF	$63.17	2000	$126,340.00
3	Pipe	18	LF	$75.50		
4	Pipe	24	LF	$97.80		
5	Pipe	30	LF	$115.80		
6	Pipe	36	LF	$134.30		
7	Pipe	48	LF	$240.51		
8	Pipe	60	LF	$313.70		
9	Pipe	72	LF	$397.60		
10	Catch Basin, Type I with Grate		Each	$950.00		
11	Catch Basin, Type II 48" Dia.		Each	$2,400.00	6	$14,400.00
12	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
13	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
14	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
15	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
16					180	
17						
18						
19						
20						
21						
22	Restoration and Cleanup		LS	Varies	1	$7,037.00

Construction Subtotal	$159,036.20
Sales Tax (8.0%)	$12,722.90
Contingency (15%)	$23,855.43
Construction Total	$195,614.53
Engineering (15%)	$29,342.18
Inspection (10%)	$19,561.45
PROJECT TOTAL	$244,518.16
TOTAL LF OF PIPE	*2,000*

Note: Estimate assumes that pipe ROW is secured from property owners for no cost.

Columbia Outfall Improvements

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$6,100.00
2	Outfall Reconstruction	LS	$45,000.00	1	$45,000.00
3	Erosion Protection	LS	$30,000.00	1	$30,000.00
4	Hydroseeding	Acre	$5,000.00	0.25	$1,250.00
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
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19					
20					
21					
22					
23					
24					
25					
26					
27	Restoration and Cleanup	LS	Varies	1	$3,812.50

Construction Subtotal	$86,162.50
Sales Tax (8.0%)	$6,893.00
Contingency (15%)	$12,924.38
Construction Total	$105,979.88
Engineering (15%)	$15,896.98
Inspection (10%)	$10,597.99
PROJECT TOTAL	$132,474.84
TOTAL LF OF PIPE	*2*

Westridge Place Maintenance Improvements
Pipes Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$846.80
2	Ditch Cleaning	LF	$3.00	2000	$6,000.00
3	Culvert Cleaning	Each	$75.00	15	$1,125.00
4	Flaggers	Hours	$60.00	16	$960.00
5	Hydroseeding	Acre	$5,000.00	0.5	$2,500.00
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27	Restoration and Cleanup	LS	Varies	1	$529.25

Construction Subtotal	$11,961.05
Sales Tax (8.0%)	$956.88
Contingency (15%)	$1,794.16
Construction Total	$14,712.09
Engineering (15%)	$2,206.81
Inspection (10%)	$1,471.21
PROJECT TOTAL	$18,390.11

Crestview Maintenance Improvements

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$927.20
2	Ditch Cleaning	LF	$3.00	1300	$3,900.00
3	Culvert Cleaning	Each	$75.00	4	$300.00
4	Flaggers	Hours	$60.00	16	$960.00
5	Vactor Catch Basins	Each	$55.00	26	$1,430.00
6	Hydroseeding	Acre	$5,000.00	1	$5,000.00
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27	Restoration and Cleanup	LS	Varies	1	$579.50

Construction Subtotal	$13,096.70
Sales Tax (8.0%)	$1,047.74
Contingency (15%)	$1,964.51
Construction Total	$16,108.94
Engineering (15%)	$2,416.34
Inspection (10%)	$1,610.89
PROJECT TOTAL	$20,136.18

Alpine Drive Maintenance Improvements

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$1,016.80
2	Ditch Cleaning	LF	$3.00	2000	$6,000.00
3	Culvert Cleaning	Each	$75.00	10	$750.00
4	Flaggers	Hours	$60.00	16	$960.00
5	Hydroseeding	Acre	$5,000.00	1	$5,000.00
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27	Restoration and Cleanup	LS	Varies	1	$635.50

Construction Subtotal	$14,362.30
Sales Tax (8.0%)	$1,148.98
Contingency (15%)	$2,154.35
Construction Total	$17,665.63
Engineering (15%)	$2,649.84
Inspection (10%)	$1,766.56
PROJECT TOTAL	$22,082.04

Knowles Road Maintenance Improvements

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$3,029.20
2	Ditch Cleaning	LF	$3.00	800	$2,400.00
3	Culvert Cleaning	Each	$75.00	10	$750.00
4	Flaggers	Hours	$60.00	24	$1,440.00
5	Vactor Catch Basins	Each	$55.00	5	$275.00
6	Ditch Construction	LF	$14.00	2000	$28,000.00
7	Hydroseeding	Acre	$5,000.00	1	$5,000.00
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27	Restoration and Cleanup	LS	Varies	1	$1,893.25

Construction Subtotal	$42,787.45
Sales Tax (8.0%)	$3,423.00
Contingency (15%)	$6,418.12
Construction Total	$52,628.56
Engineering (15%)	$7,894.28
Inspection (10%)	$5,262.86
PROJECT TOTAL	$65,785.70

School Street Maintenance Improvements

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$2,748.00
2	Ditch Cleaning	LF	$3.00	2000	$6,000.00
3	Culvert Cleaning	Each	$75.00	15	$1,125.00
4	Flaggers	Hours	$60.00	16	$960.00
5	Vactor Catch Basins	Each	$55.00	15	$825.00
6	Ditch Construction	LF	$14.00	1460	$20,440.00
7	Hydroseeding	Acre	$5,000.00	1	$5,000.00
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27	Restoration and Cleanup	LS	Varies	1	$1,717.50

Construction Subtotal	$38,815.50
Sales Tax (8.0%)	$3,105.24
Contingency (15%)	$5,822.33
Construction Total	$47,743.07
Engineering (15%)	$7,161.46
Inspection (10%)	$4,774.31
PROJECT TOTAL	$59,678.83

Mari Lane Area Maintenance Improvements

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$1,376.80
2	Ditch Cleaning	LF	$3.00	3000	$9,000.00
3	Culvert Cleaning	Each	$75.00	30	$2,250.00
4	Flaggers	Hours	$60.00	16	$960.00
5	Hydroseeding	Acre	$5,000.00	1	$5,000.00
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27	Restoration and Cleanup	LS	Varies	1	$860.50

Construction Subtotal	$19,447.30
Sales Tax (8.0%)	$1,555.78
Contingency (15%)	$2,917.10
Construction Total	$23,920.18
Engineering (15%)	$3,588.03
Inspection (10%)	$2,392.02
PROJECT TOTAL	$29,900.22
TOTAL LF OF PIPE	*3,047*

Note: Cost of connections from CB to MH is considered incidental to the cost of the mainline pipe.

McMullan Road Maintenance Improvements
Pipes Sized for 25 Year Event

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$3,714.00
2	Pipe	12	LF	$63.17		
3	Pipe	18	LF	$75.50	150	$11,325.00
4	Pipe	24	LF	$97.80		
5	Pipe	30	LF	$115.80		
6	Pipe	36	LF	$134.30		
7	Pipe	48	LF	$240.51		
8	Pipe	60	LF	$313.70		
9	Pipe	72	LF	$397.60		
10	Catch Basin, Type I with Grate		Each	$950.00		
11	Catch Basin, Type II 48" Dia.		Each	$2,400.00	3	$7,200.00
12	Catch Basin, Type II, 54" Dia.		Each	$2,900.00	1	$2,900.00
13	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
14	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
15	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
16	Curb Removal and Ditching		LS	$20,000.00	1	$20,000.00
17	Hydroseeding		Acre	$5,000.00	1	$5,000.00
18						
19						
20						
21						
22	Restoration and Cleanup		LS	Varies	1	$2,321.25

Construction Subtotal	$52,460.25
Sales Tax (8.0%)	$4,196.82
Contingency (15%)	$7,869.04
Construction Total	$64,526.11
Engineering (15%)	$9,678.92
Inspection (10%)	$6,452.61
PROJECT TOTAL	$80,657.63
TOTAL LF OF PIPE	*150*

Note: Estimate assumes that pipe ROW is secured from property owners for no cost.

Chatham Hill Conveyance Improvements

Item	*Description of Item*	*Size*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization		LS	Varies	1	$2,617.60
2	Pipe Cleaning		LF	$5.00	3200	$16,000.00
3	Flaggers		Hours	$60.00	24	$1,440.00
4	Vactor Catch Basins		Each	$55.00	16	$880.00
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10	Catch Basin, Type I with Grate		Each	$950.00		
11	Catch Basin, Type II 48" Dia.		Each	$2,400.00	6	$14,400.00
12	Catch Basin, Type II, 54" Dia.		Each	$2,900.00		
13	Catch Basin, Type II, 60" Dia.		Each	$3,500.00		
14	Catch Basin, Type II, 72" Dia.		Each	$4,000.00		
15	Catch Basin, Type II, 96" Dia.		Each	$8,000.00		
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22	Restoration and Cleanup		LS	Varies	1	$1,636.00

Construction Subtotal	$36,973.60
Sales Tax (8.0%)	$2,957.89
Contingency (15%)	$5,546.04
Construction Total	$45,477.53
Engineering (15%)	$6,821.63
Inspection (10%)	$4,547.75
PROJECT TOTAL	$56,846.91

Chelan County Stormwater — *DP-1*
Goodfellow Outfall Improvements

Facility Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$63,725.44
2	Clearing and Grubbing	AC	$1,000.00	10.7	$10,700.00
3	Excavation	CF	$0.60	686,960	$412,176.00
4	Embankment	CF	$0.20	686,960	$137,392.00
5	Site Improvements (Access)	LS	$10,000.00	1	$10,000.00
6	Control Structure	LS	$15,000.00	1	$15,000.00
7	Fencing	LS	$8,000.00	1	$8,000.00
8	Hydroseeding	AC	$5,000.00	10.7	$53,500.00
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21	Land Acquisition	AC	$14,000.00	10.7	$149,800.00
22	Restoration and Cleanup	LS	Varies	1	$39,828.40

Construction Subtotal	$900,121.84
Sales Tax (8.0%)	$72,009.75
Contingency (20%)	$180,024.37
Construction Total	$1,152,155.96
Engineering (15%)	$172,823.39
Inspection (10%)	$115,215.60
PROJECT TOTAL	$1,440,194.94

Chelan County Stormwater — *DP-2*

Ohme Garden

Basin No. 1

Facility Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$21,516.80
2	Clearing and Grubbing	AC	$1,000.00	4	$4,000.00
3	Excavation	CF	$0.60	194,950	$116,970.00
4	Embankment	CF	$0.20	194,950	$38,990.00
5	Site Improvements (Access)	LS	$10,000.00	1	$10,000.00
6	Control Structure	LS	$15,000.00	1	$15,000.00
7	Fencing	LS	$8,000.00	1	$8,000.00
8	Hydroseeding	AC	$5,000.00	4	$20,000.00
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21	Land Acquisition	AC	$14,000.00	4	$56,000.00
22	Restoration and Cleanup	LS	Varies	1	$13,448.00

Construction Subtotal	$303,924.80
Sales Tax (8.0%)	$24,313.98
Contingency (20%)	$60,784.96
Construction Total	$389,023.74
Engineering (15%)	$58,353.56
Inspection (10%)	$38,902.37
PROJECT TOTAL	$486,279.68

Chelan County Stormwater ***DP-3***

Ohme Garden

Basin No. 2

Facility Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$16,352.00
2	Clearing and Grubbing	AC	$1,000.00	4	$4,000.00
3	Excavation	CF	$0.60	114,250	$68,550.00
4	Embankment	CF	$0.20	114,250	$22,850.00
5	Site Improvements (Access)	LS	$10,000.00	1	$10,000.00
6	Control Structure	LS	$15,000.00	1	$15,000.00
7	Fencing	LS	$8,000.00	1	$8,000.00
8	Hydroseeding	AC	$5,000.00	4	$20,000.00
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21	Land Acquisition	AC	$14,000.00	4	$56,000.00
22	Restoration and Cleanup	LS	Varies	1	$10,220.00

Construction Subtotal	$230,972.00
Sales Tax (8.0%)	$18,477.76
Contingency (20%)	$46,194.40
Construction Total	$295,644.16
Engineering (15%)	$44,346.62
Inspection (10%)	$29,564.42
PROJECT TOTAL	$369,555.20

Chelan County Stormwater — *DP-4*

Ohme Garden

Basin No. 3

Facility Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$24,211.20
2	Clearing and Grubbing	AC	$1,000.00	4	$4,000.00
3	Excavation	CF	$0.60	180,800	$108,480.00
4	Embankment	CF	$0.20	180,800	$36,160.00
5	Site Improvements (Access)	LS	$10,000.00	1	$10,000.00
6	Control Structure	LS	$15,000.00	1	$15,000.00
7	Fencing	LS	$8,000.00	1	$8,000.00
8	Hydroseeding	AC	$5,000.00	4	$20,000.00
9	Erosion Protection Overflow	LS	$45,000.00	1	$45,000.00
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21	Land Acquisition	AC	$14,000.00	4	$56,000.00
22	Restoration and Cleanup	LS	Varies	1	$15,132.00

Construction Subtotal	$341,983.20
Sales Tax (8.0%)	$27,358.66
Contingency (20%)	$68,396.64
Construction Total	$437,738.50
Engineering (15%)	$65,660.77
Inspection (10%)	$43,773.85
PROJECT TOTAL	$547,173.12

Chelan County Stormwater *DP-5*
Central Basin
Basin No. 1
Facility Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$18,688.00
2	Clearing and Grubbing	AC	$1,000.00	4	$4,000.00
3	Excavation	CF	$0.60	94,500	$56,700.00
4	Embankment	CF	$0.20	94,500	$18,900.00
5	Site Improvements (Access)	LS	$10,000.00	1	$10,000.00
6	Control Structure	LS	$15,000.00	1	$15,000.00
7	Fencing	LS	$8,000.00	1	$8,000.00
8	Hydroseeding	AC	$5,000.00	4	$20,000.00
9	Erosion Protection Overflow	LS	$45,000.00	1	$45,000.00
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19					
20					
21	Land Acquisition	AC	$14,000.00	4	$56,000.00
22	Restoration and Cleanup	LS	Varies	1	$11,680.00

Construction Subtotal	$263,968.00
Sales Tax (8.0%)	$21,117.44
Contingency (20%)	$52,793.60
Construction Total	$337,879.04
Engineering (15%)	$50,681.86
Inspection (10%)	$33,787.90
PROJECT TOTAL	$422,348.80

Chelan County Stormwater *DP-6*
Central Basin
Basin No. 2
Facility Sized for 25 Year Event

Item	*Description of Item*	*Unit*	*Unit Price*	*Quantity*	*Total Price*
1	Mobilization	LS	Varies	1	$11,617.92
2	Clearing and Grubbing	AC	$1,000.00	4	$4,000.00
3	Excavation	CF	$0.60	40,280	$24,168.00
4	Embankment	CF	$0.20	40,280	$8,056.00
5	Site Improvements (Access)	LS	$10,000.00	1	$10,000.00
6	Control Structure	LS	$15,000.00	1	$15,000.00
7	Fencing	LS	$8,000.00	1	$8,000.00
8	Hydroseeding	AC	$5,000.00	4	$20,000.00
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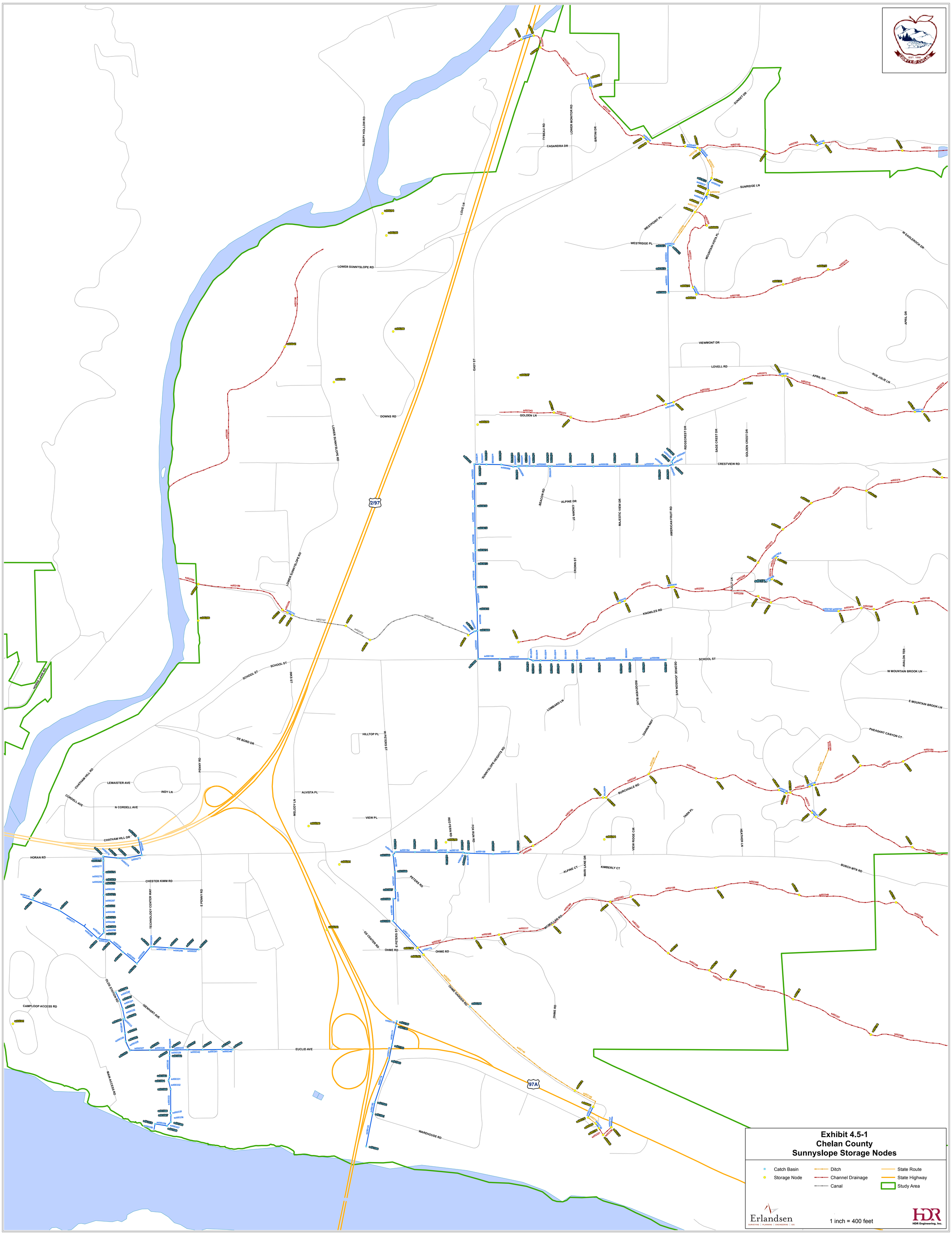
19					
20					
21	Land Acquisition	AC	$14,000.00	4	$56,000.00
22	Restoration and Cleanup	LS	Varies	1	$7,261.20

Construction Subtotal	$164,103.12
Sales Tax (8.0%)	$13,128.25
Contingency (20%)	$32,820.62
Construction Total	$210,051.99
Engineering (15%)	$31,507.80
Inspection (10%)	$21,005.20
PROJECT TOTAL	$262,564.99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LOVE LN
LOWER SUNNYSLOPE RD
DOWNS RD
TYBEAU RD
LOWER MONITOR RD
BRITNI DR
CASANDRA DR
SUNSET DR
SUNRIDGE LN
WESTPOINT PL
WESTRIDGE PL
MOUNTAIN VISTA PL
W EAGLEROCK DR
APRIL DR
VIEWMONT DR
LOVELL RD
RUE JOLIE LN
EASY ST
GOLDEN LN
RIDGECREST DR
SAGE CREST DR
GOLDEN CREST DR
CRESTVIEW RD
BEACON RD
ALPINE DR
CROWN ST
MAJESTIC VIEW DR
AMERICAN FRUIT RD
KNOWLES RD
LILLY LN
SCHOOL ST
GEORGE JOHNSON AVE
RIDGEVIEW BLVD
LOMBARD LN
DIANNA WAY
AVALON TER
W MOUNTAIN BROOK LN
E MOUNTAIN BROOK LN
PHEASANT CANYON CT
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HORSE LAKE RD
SCHOOL ST
INKS ST
DE BORD DR
PENNY RD
CHATHAM HILL RD
LEMAISTER AVE
INDY LN
CORDELL AVE
N CORDELL AVE
CHATHAM HILL DR
HORAN RD
CHESTER KIMM RD
TECHNOLOGY CENTER WAY
E PENNY RD
HILLTOP PL
W PETERS ST
SUNNYSLOPE HEIGHTS RD
ALVISTA PL
MELODY LN
VIEW PL
RED FERN RD
FOX RUN RD
PETERS RD
GS CENTER RD
E PETERS ST
OHME RD
OHME GARDEN RD
MCMILLAN RD
BURCHVALE RD
TARN PL
VIEW RIDGE CIR
HEATHER LN
ALPINE CT
MARI LANE DR
KIMBERLY CT
BURCH MTN RD
CAMPLOOP ACCESS RD
OLDS STATION RD
ISENHART AVE
MAIN ACCESS RD
EUCLID AVE
WAREHOUSE RD
97A
Exhibit 4.5-1
Chelan County
Sunnyslope Storage Nodes
Catch Basin
Storage Node
Ditch
Channel Drainage
Canal
State Route
State Highway
Study Area
Erlandsen
SURVEYING | PLANNING | ENGINEERING | GIS
1 inch = 400 feet
HDR Engineering, Inc.