The Dalles Watershed Assessment

Prepared by
Wasco County Soil and Water Conservation District

For
The Dalles Watershed Council

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As accepted by watershed council action
January 2003

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Introduction

The Dalles Watershed Assessment generally follows the format and protocols described in the Oregon Watershed Assessment Manual, developed by Watershed Professionals Network for what is now the Oregon Watershed Enhancement Board (OWEB). Wasco County Soil and Water Conservation District (SWCD) has access to ArcView 3.1 Geographic Information System (GIS) software and electronic data including georectified aerial photos and US Geological Survey (USGS) topographical maps. In some places, the Watershed Manual procedures were modified to take advantage of the electronic data and tools. Conditions that are specific to the east-side climate were assessed using Natural Resources Conservation Service (NRCS) manuals and guides, as the OWEB manual is somewhat west side in direction and assumptions.

A watershed consists of all the land that drains to a common point. The ridges that border the area and direct the runoff to the common outlet generally define the watershed boundaries. As there are watersheds within larger watersheds, the US Geological Survey terms were used to define the individual watersheds. The USGS has assigned Hydrologic Unit Codes that indicate where a particular region is and its hierarchical relationship to other areas within a watershed. The Dalles Watershed is one of 1,063 5th field watersheds in Oregon (http://water.usgs.gov/GIS/huc.html). The subwatersheds of The Dalles would be considered 6th field watersheds.

A watershed assessment can help to identify how the processes of the watershed are functioning. The assessment can be used to identify and prioritize issues that need to be addressed and point out areas that are doing well and need no intervention. The process of creating the assessment should involve landowners and other stakeholders in the watershed so that the goals and processes are understood and the finished product is utilized. This can help to catalyze projects by community-based groups or provide additional data for an established organization. Some of the issues that might become community concerns include fish habitat, water quality, land management practices, and development impacts.

Preparation

Georectified digital topographic maps, aerial photos, ArcView 3.1 Geographic Information System (GIS), Microsoft Word, Microsoft Excel, and the Oregon Watershed Enhancement Board (OWEB) Watershed Assessment Manual were used to conduct this assessment. During the writing of the assessment, data was obtained from US Department of Agriculture (USDA) agencies; the Farm Services Agency (FSA), Natural Resources Conservation Service (NRCS), and the US Forest Service (USFS). Information was gathered from State and local agencies including the Oregon Department of Environmental Quality (ODEQ), Oregon Department of Fish and Wildlife (ODFW), Oregon Water Resources Department (OWRD) and Oregon Department of Forestry (ODF). The local agencies contacted were Wasco County Soil and Water Conservation District (SWCD), Wasco County Public Works Department, Wasco County Planning Department and The City of The Dalles Wicks Water Treatment Plant.

The ArcView GIS computer software allows maps to be created and stored on the computer. The maps can be digitally drawn from photos or taken from existing data files and used as "layers" that can be stacked much like transparencies would. In this way, data from different layers can be put together to learn something about a particular area. For instance, a layer showing streams can be stacked with a roads data layer and a soils data layer to show where a road near a stream coincides with highly erodible soil types.

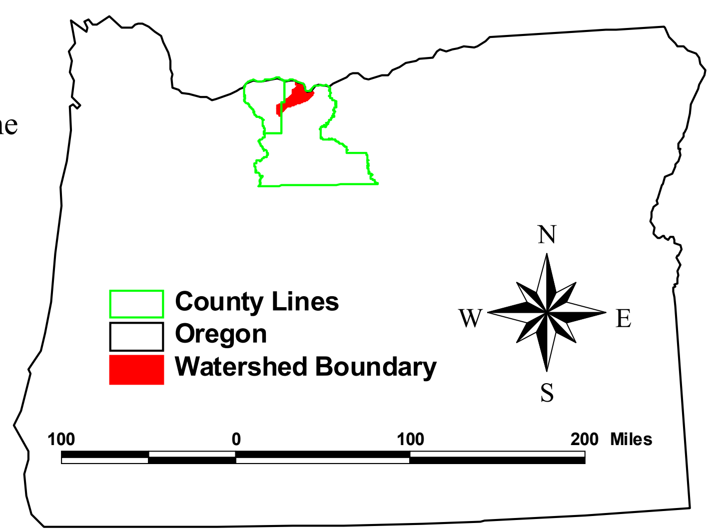
Using ArcView tools, a map of the watershed boundary and subwatershed divisions was created by drawing in the ridgelines of a USGS topographic map. Roads, streams, tax lots, soils, climate and county land use data were added using existing data from county agencies. Aerial photos from the FSA were used for the most recent information of what's on the ground. The different data sets were "clipped" to the watershed boundary map to include just the data that would be pertinent to this assessment. The watershed maps and data were divided into the individual subwatersheds for ease of use and to show more clearly where trends exist.

The USFS Soil Resource Inventory for Mt. Hood and Wasco County Soil Survey, Northern Part provided soils information. Historical information on ground cover was taken from surveyor's notes circa 1850-1880, which were obtained from the Wasco County Public Works Department. Historical information on The Dalles area was obtained from the web sites of http://historysavers.com/orwasco and The Discovery Center at http://www.gorgediscovery.org. The Wasco County Soil Survey also provided both natural and human history information. Some data was entered into Microsoft Excel and graphed to present trends visually.

1) Description of The Dalles Watershed

The Dalles Watershed area is 82,406 acres, or 129 square miles. The Dalles Watershed is oriented in a southwest to northeast direction in the eastern foothills of the Cascade Range and on the western edge of the Columbia Plateau.

Map 1.1: Location of The Dalles Watershed in the State of Oregon



The Dalles Watershed is comprised of five subwatersheds: Rowena/Hidden Valley, Chenowith/Brown's Creek, Mill Creek, Dry Hollow, and Threemile (Maps 1.2 –1.6). All of the subwatersheds drain in a southwest to northeast direction. The watershed is bounded by the Columbia River on the north, Mosier Creek Watershed and the Hood River basin on the west and Fifteenmile Watershed to the south and east. The elevation ranges from 4900 feet at the headwaters of Mill Creek, to 98 feet at the Columbia River. The watershed includes the City of The Dalles along the Columbia River. The urban area is included in portions of Threemile, Dry Hollow, Mill Creek, and Chenowith subwatersheds.

The Rowena Subwatershed contains a short drainage west of the community of Rowena that roughly parallels Rowena Creek, but on the eastern side of Rowena Ridge. This drainage flows from the east side of McCall Point, down a steep ravine and empties into a small bay at Mayer State Park on the Columbia River. Other features in the subwatershed include Foley Lakes, Gooseberry Creek and a number of small wetlands.

The majority of the wetlands are along the banks of the Columbia River and make up the bulk of the wetlands in the watershed. Gooseberry Creek and a small tributary are seasonal streams in Hidden Valley.

Chenowith Watershed includes Chenowith and Brown's Creeks, each of which have a number of small tributaries. Chenowith Creek flows generally east and north from Wasco Butte and empties into the Columbia River at the north edge of The Dalles. Tributaries of Chenowith include Badger Creek, which flows south and east from Sevenmile Hill to its confluence near Foley Lakes and a few small drainages that flow north from Government Flats. Brown's Creek flows to the northeast from the Seward Flat area until it joins Chenowith Creek just east of Chenowith Air Park. Brown's Creek has a few small tributaries that flow in from Government Flats to the west and one that joins from the southwest. Chenowith Watershed is bounded by Mosier Creek Watershed on the west, Mill Creek Watershed on the south and east, and the Columbia River and Rowena Creek Watershed on the north.

The Mill Creek drainage is the largest of The Dalles' subwatersheds, containing as much area as the other four subwatersheds combined. Of the 41,894 acres in the Mill Creek drainage, 65% are zoned for forestry and 29% is in agricultural land. The US Forest Service has completed an extensive analysis of forest and resource conditions in Mill Creek (Mill Creek Watershed Analysis, USFS, Barlow Ranger District). Mill Creek has as its three major tributaries; Crow Creek, South Fork Mill Creek, and North Fork Mill Creek. Alder Creek is a tributary of Crow Creek, which it joins just before it empties into the Crow Creek Reservoir. Mill Creek and its tributaries all originate on the east slope of Surveyor's Ridge, in Mill Creek Buttes, about 25 miles southwest of The Dalles. Crow Creek and South Fork Mill Creek flow into Crow Creek Reservoir, which is the main storage for The Dalles water supply. Water is also diverted into the South Fork from Dog River to augment the municipal water supply. Dog River is a tributary of Hood River just to the southwest of The Dalles Watershed. The Mill Creek Subwatershed is bounded by the Mosier Creek and Chenowith Watersheds to the northwest, the East Fork Hood River Watershed on the west, the Fifteenmile Watershed and Threemile and Dry Hollow Subwatersheds to the southeast and the Columbia River on the northeast.

Dry Hollow Watershed is the smallest subwatershed in The Dalles. It encompasses just over 2,691 acres and is 40% urban. While mostly dry, the drainage does contain a few wetlands, particularly in the upper half. Dry Hollow is about five miles long before it enters the urban area and the drainage disappears into the storm water system for the last mile and a half of its journey to the Columbia River. Dry Hollow Watershed is bounded by the Mill Creek Subwatershed on the northwest, Threemile Subwatershed to the southeast, and by The Columbia River on the north.

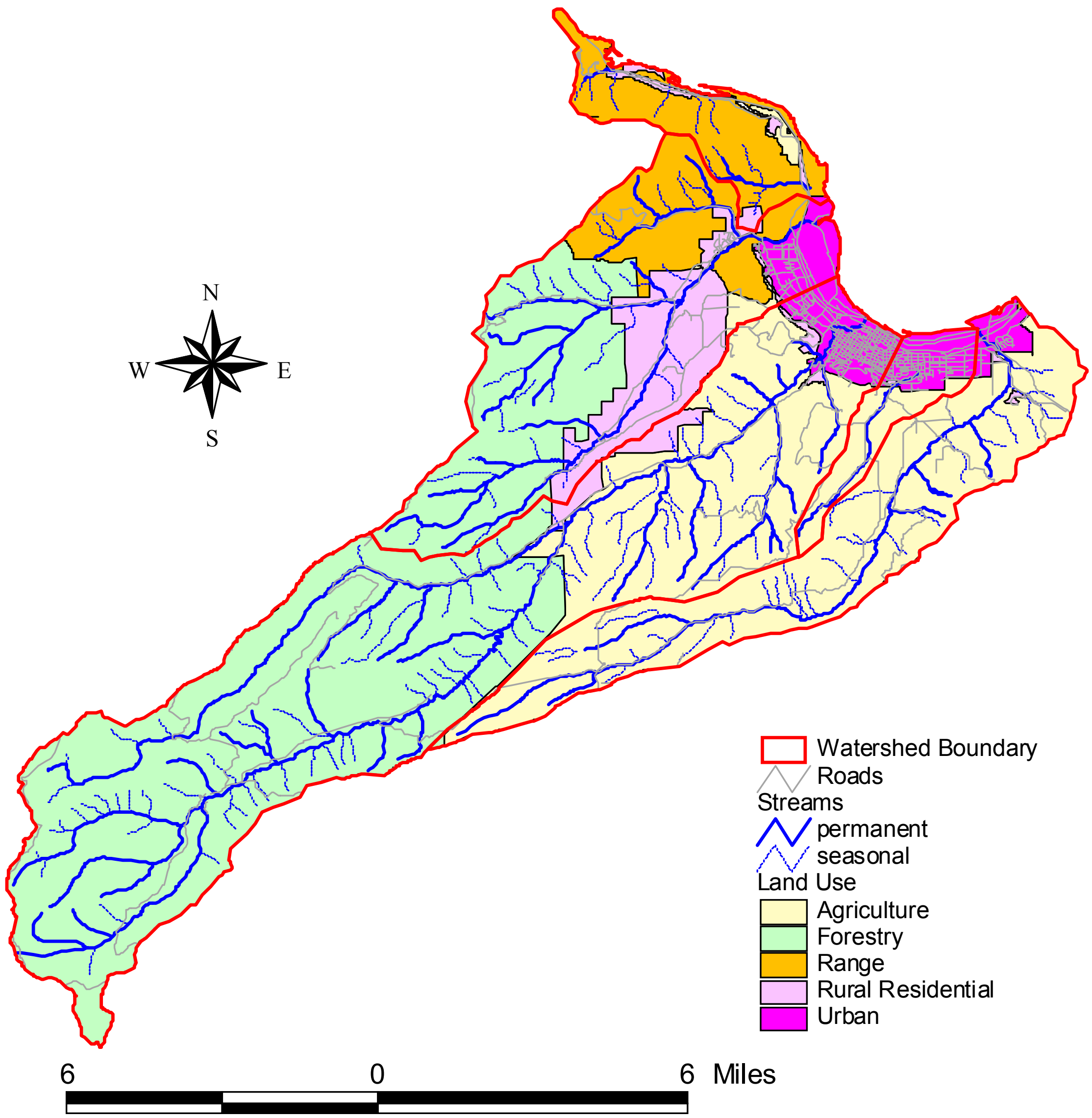
Threemile Creek begins in Dutch Flat and flows east then north to the Columbia River. A few small tributaries enter Threemile Creek from the east near Pleasant Ridge and one tributary enters from the west. This tributary flows from Evans Reservoir, which is in Dutch Flat in the upper end of the watershed. Threemile Watershed is bounded to the west by Mill Creek and Dry Hollow Watersheds, on the south and east by Fifteenmile Watershed, and on the north by the Columbia River.

Land uses in the watershed include forestland, cropland, rangeland, rural residential and urban area. (table 1.1, map 1.2).

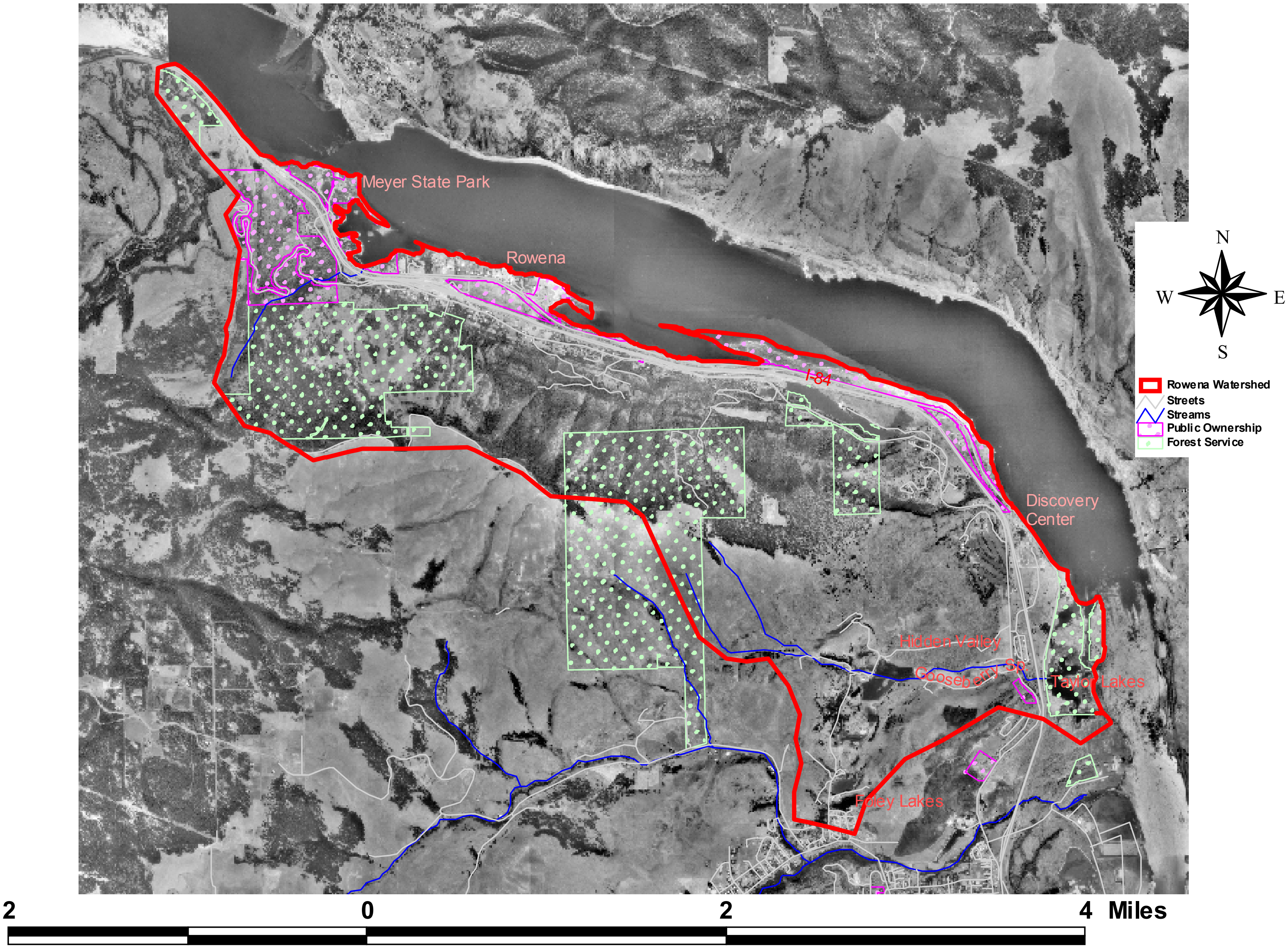
Table 1.1: Land Use in The Dalles Watershed (based on Wasco County Zoning Info)

	Forestry	Agriculture	Range	Rural Residential	Urban
ACRES:	36,427	27,294	8,239	5,892	4,552
% total	44.2%	33.1%	10%	7.1%	5.5%

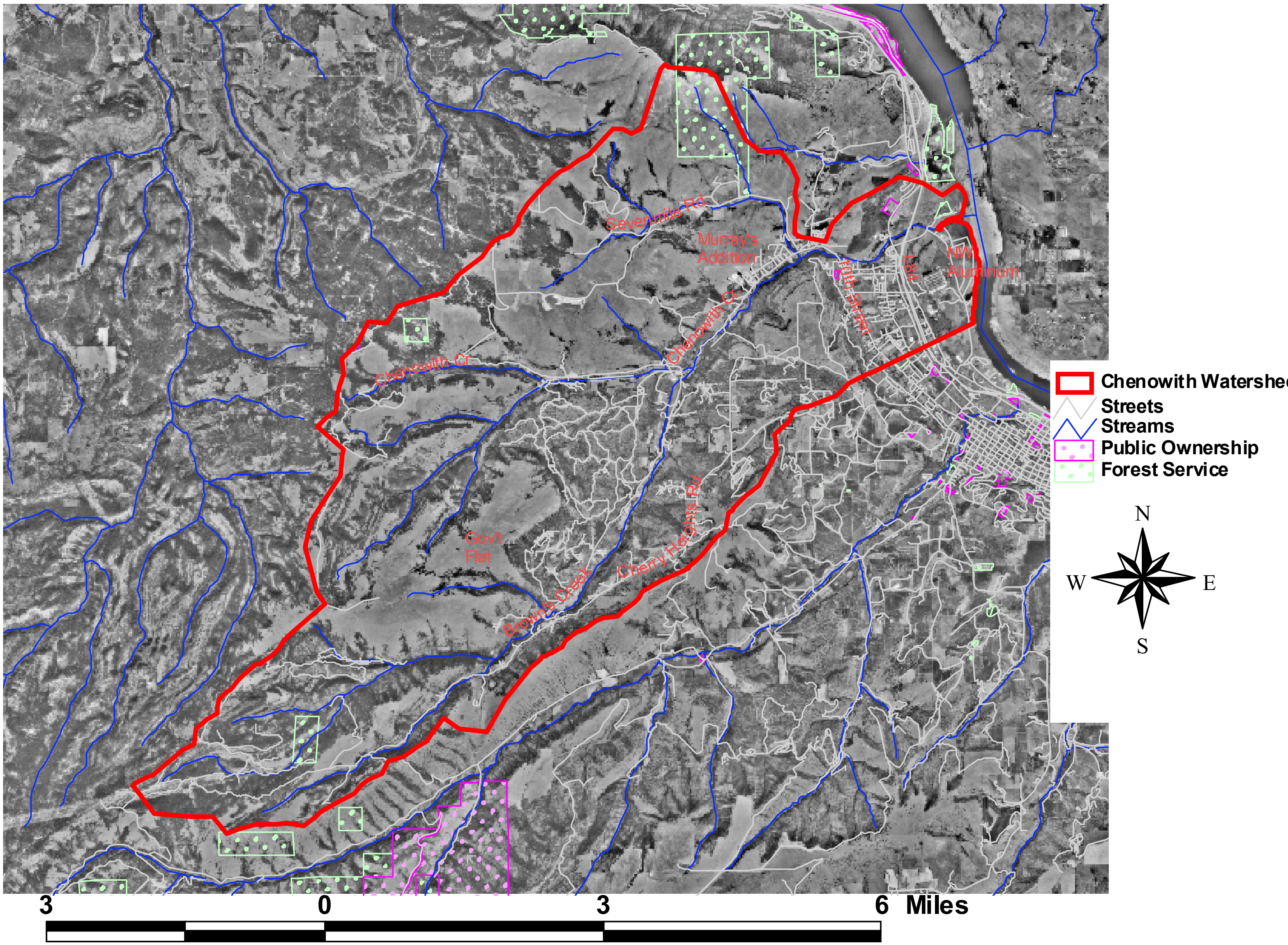
Map 1.2: Land Use in The Dalles Watershed. Source: Wasco County Planning Dept.



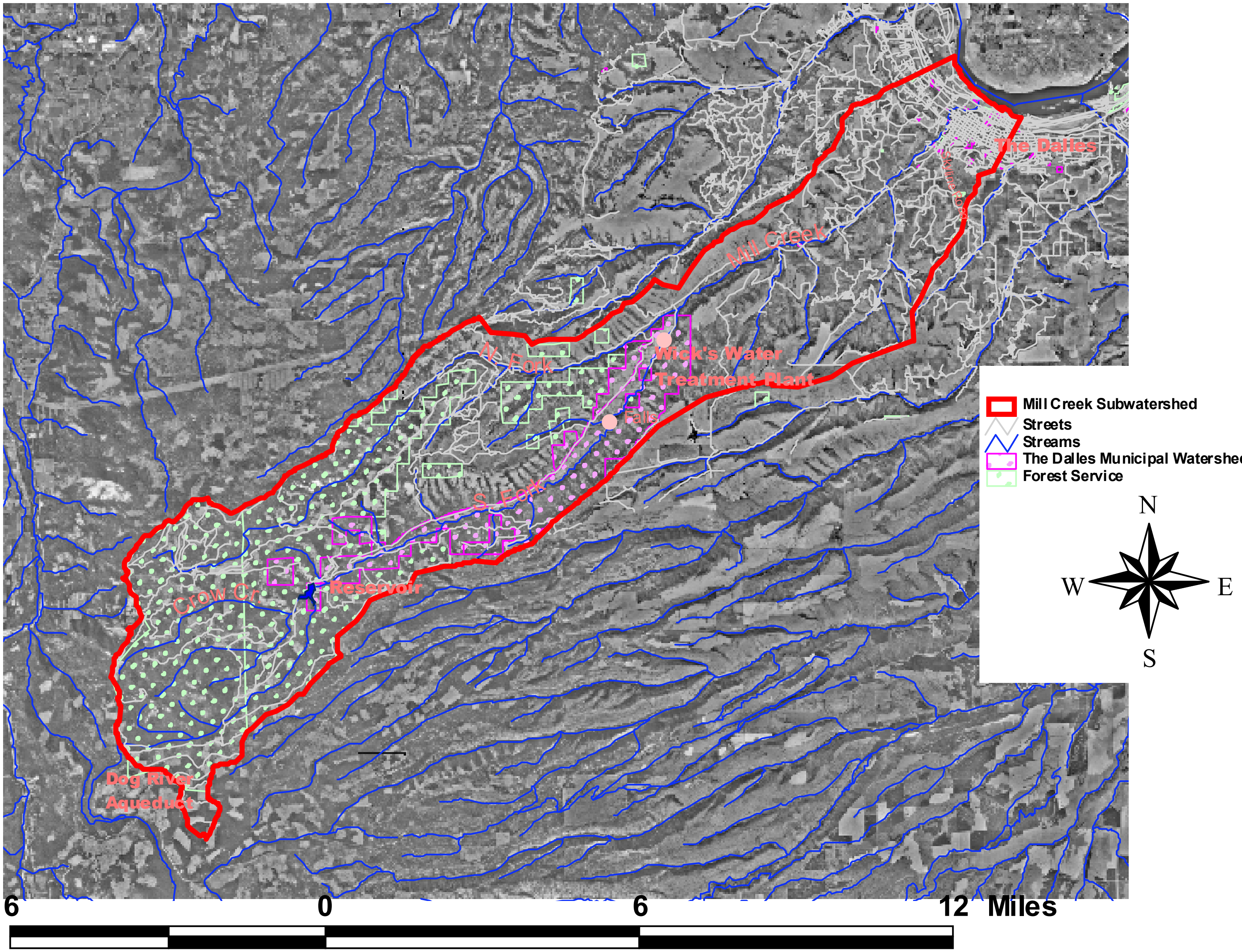
Map 1.3: Rowena Subwatershed



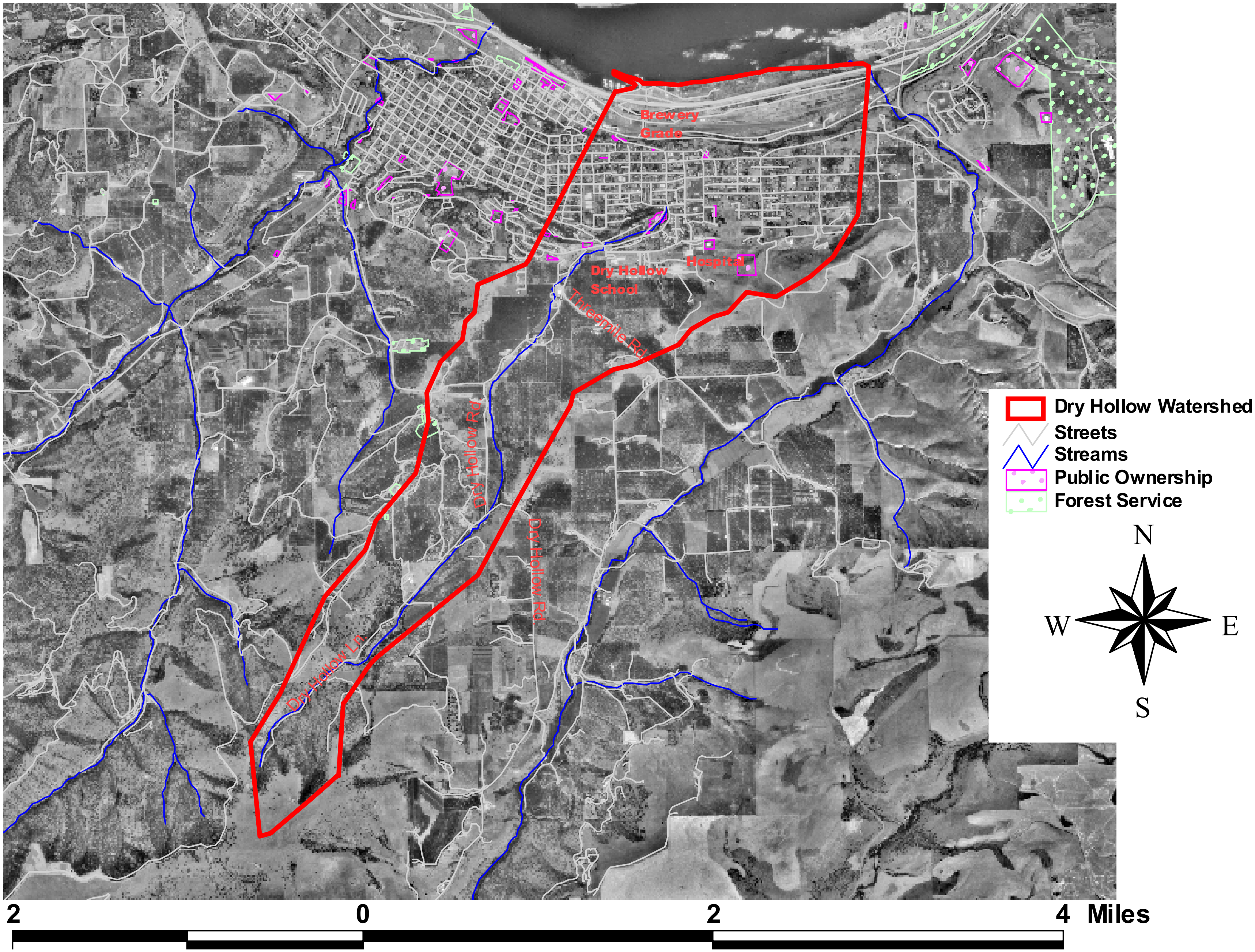
Map 1.4: Chenowith Subwatershed



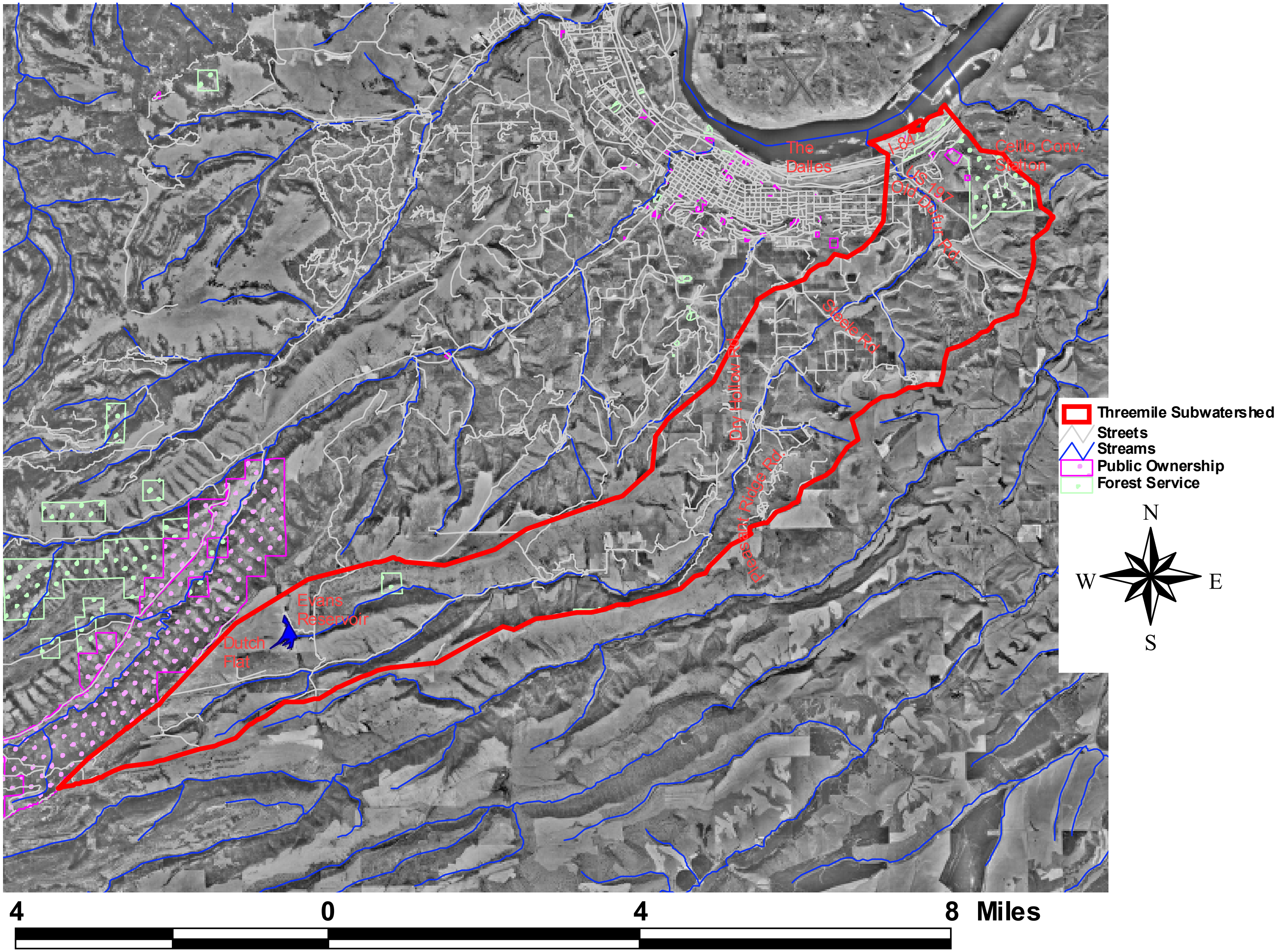
Map 1.5: Mill Creek Subwatershed



Map 1.6: Dry Hollow Subwatershed



Map 1.7: Threemile Subwatershed



Geology

The Dalles Watershed lies on the boundary between two geologic provinces. Geologic provinces are large areas of land that have similar characteristics. These similarities show in biotic and abiotic (living and nonliving, respectively) patterns and composition. These phenomena are the factors that shape the form and function of a region. The Dalles Watershed lies partly within the Eastern Cascade Mountain Province and partly in the Columbia Plateau.

The Cascade Mountains mark the edge of the Pacific Northwest section of the 'Ring of Fire', a fiery array of volcanoes that rim the Pacific Ocean and includes the Cascade Mountain Range. The Cascade Range made its first appearance during mountain building episodes 36 million years ago (Pliocene) but the major peaks that rise up from today's volcanic centers were born within the last 1½ million years (Pleistocene). The Pliocene uplift blocked the flow of many rivers and they appear to have been diverted to the Columbia River. Because the Columbia River was large enough, it was able to cut down through the Cascades and today is a deep gorge through the range that begins west of The Dalles (http://www.geolgeol.fau.edu).

More than 3000 vents erupted during the most recent volcanic episodes, which began 5 million years ago**.** The Eastern Cascade portion of the watershed is now a high upland terrace of coarse alluvial and pyroclastic materials (from river and volcanic activity). The terrace is eroded with wide, nearly level ridgetops and deep, V-shaped canyons. The streams are mostly of steep gradients and flow through the deep canyons. There are no large alluvial areas in The Dalles Watershed other than a few acres of riverwash.

The portion of the watershed within the Eastern Cascades Geologic Province comprises the southwestern part of the watershed including Rowena subwatershed west of The Discovery Center, Sevenmile Hill, most of the Mill Creek drainage, a small portion of Dry Hollow and the upper half of Threemile subwatershed.

The Columbia Plateau is a lava-floored plain that has been folded and uplifted since the lava flowed into the area between 17 and 6 million years ago. Most of the lava flooded out in the first 1.5 million years. These volcanoes were cracks in the earth's crust, several miles long, which poured out floods of liquid molten rock. In all, 41,000 cubic miles (170,000 cubic kilometers) of this lava flowed out of the ground and spread to cover over 50,000 square miles (129,600 square kilometers) of Oregon and Washington. Out of 270 lava flows that spread across the region, 21 poured through the Gorge, forming layers of rock up to 2,000 feet (600 meters) deep. These lava flows became the Columbia River basalt bedrock of the interior Columbia Plateau and cliffs along the shores of the Columbia River. Whatever topography was present prior to the Columbia River Basalt eruptions was buried and smoothed over by flow upon flow of lava (USGS). Several important interbeds are present between flows and are a source of groundwater.

The portion of the watershed within the Columbia Plateau Province is found in the northeastern part of the watershed beginning just east of The Discovery Center near Taylor Lake and encompassing a large portion of Chenowith, the lower end of Mill Creek, most of Dry Hollow, and the northern half of Threemile subwatershed.

The basalts and hills of The Dalles Watershed are overlain by up to 1000 feet of strata known as The Dalles Formation (Mill Creek Watershed Analysis). The Dalles Formation was formed by the release of hot ash and rock by volcanic activity. These pyroclastic flows moved overland like a huge landslide, covering the basalt layers. They are looser and much more erodible than the underlying basalt and most of the landslides in this area originate in this formation (John Dodd, personal communication).

The Dalles area was further altered and eroded by the impacts from the Bretz, or Missoula floods as they are also known, which took, place around 15,000 years ago. This was a series of floods that flowed down the Columbia River Basin near the end of the last period of glacial advance. The floods were first postulated by J. Harlan Bretz in 1923, and he spent much his career documenting his assertion. After being initially discounted by many, the evidence that Bretz collected eventually received support and recognition.

A tongue of ice from a Canadian glacier dammed the Clark Fork River north of the present day Spokane, Washington. The dam started backing up water into the valley, forming glacial Lake Missoula. As the water level rose and the temperature began to increase, the water pressure finally caused the dam to break, producing the largest documented floods ever recorded. The flood rates may have reached nine cubic miles per hour, and, since the total storage behind the dam was about 500 cubic miles, the flood was over in about two days. The flows reached depths of up to 1000 feet at The Dalles and going through the Columbia Gorge. It appears that 30-50 years were required for ice to reblock the outlet and another 500 cubic miles of water to accumulate. Flooding occurred many times, with estimates ranging between 13-70, with most putting it at 30-40 times. The floods cut tremendous channels, with huge scars of devastation marking their path. The massive erosion produced what is known as the scablands of eastern Washington and Oregon and deposited materials in the valleys (http://www.geolgeol.fau.edu).

Ecoregions

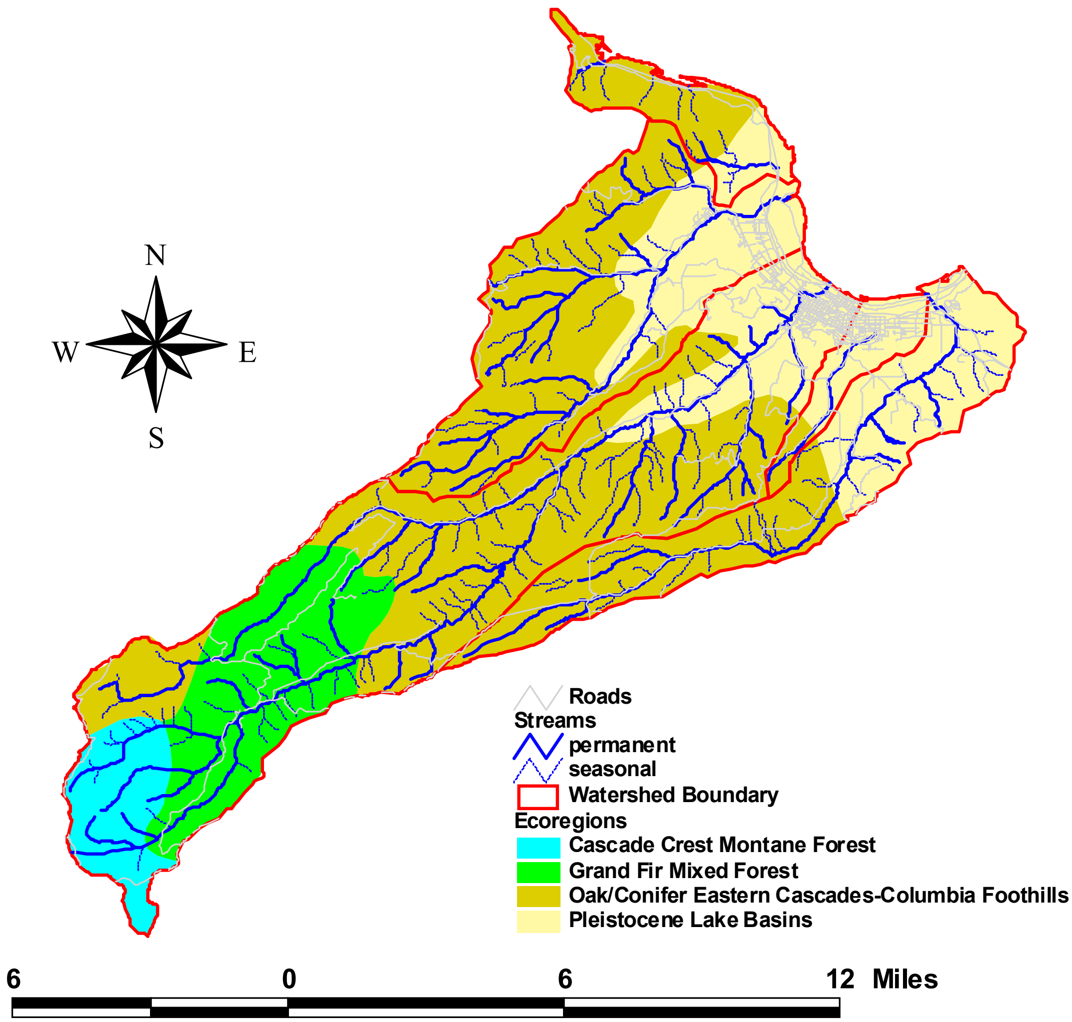
Once the geologic groundwork has been laid in the region, various species of plant and animal life emerge. The climate and substrate existing within the region largely determine the species composition. The Dalles Watershed is composed of four ecoregions. These ecoregions are the Cascade Crest Montane Forest; the Grand Fir Mixed Forest; the Oak/Conifer Eastern Cascades-Columbia Foothills, and the Pleistocene Lake Basin (table 1.2, map 1.8).

The Cascade Crest Montane Forest and the Grand Fir Mixed Forest fall within the Eastern Cascades Mountain Province. They tend to be found toward the west, and at the higher elevations. The Pleistocene Lake Basin falls within the Columbia Plateau, and is found in the northeastern portion of the watershed. The Oak/Conifer Eastern Cascades-Columbia Foothills ecosystem is in a transition zone between the two geologic provinces.

Table 1.2: Ecoregions in The Dalles Watershed. Source: Oregon Natural Heritage Foundation (http://www.gis.state.or.us/data/alphalist.html)

ECOREGION	Upland Vegetation
Cascade Crest Montane Forest	Mountain Hemlock, Pacific Silver Fir, Engelmann Spruce, Lodgepole Pine
Grand Fir Mixed Forest	White Fir, Douglas Fir, Ponderosa Pine
Oak/Conifer & Eastern Cascades/Columbia Foothills	Eastern: Ponderosa Pine and Oregon White Oak Western: Douglas Fir and Western Hemlock
Pleistocene Lake Bottom	Big Sagebrush, Bluebunch Wheatgrass

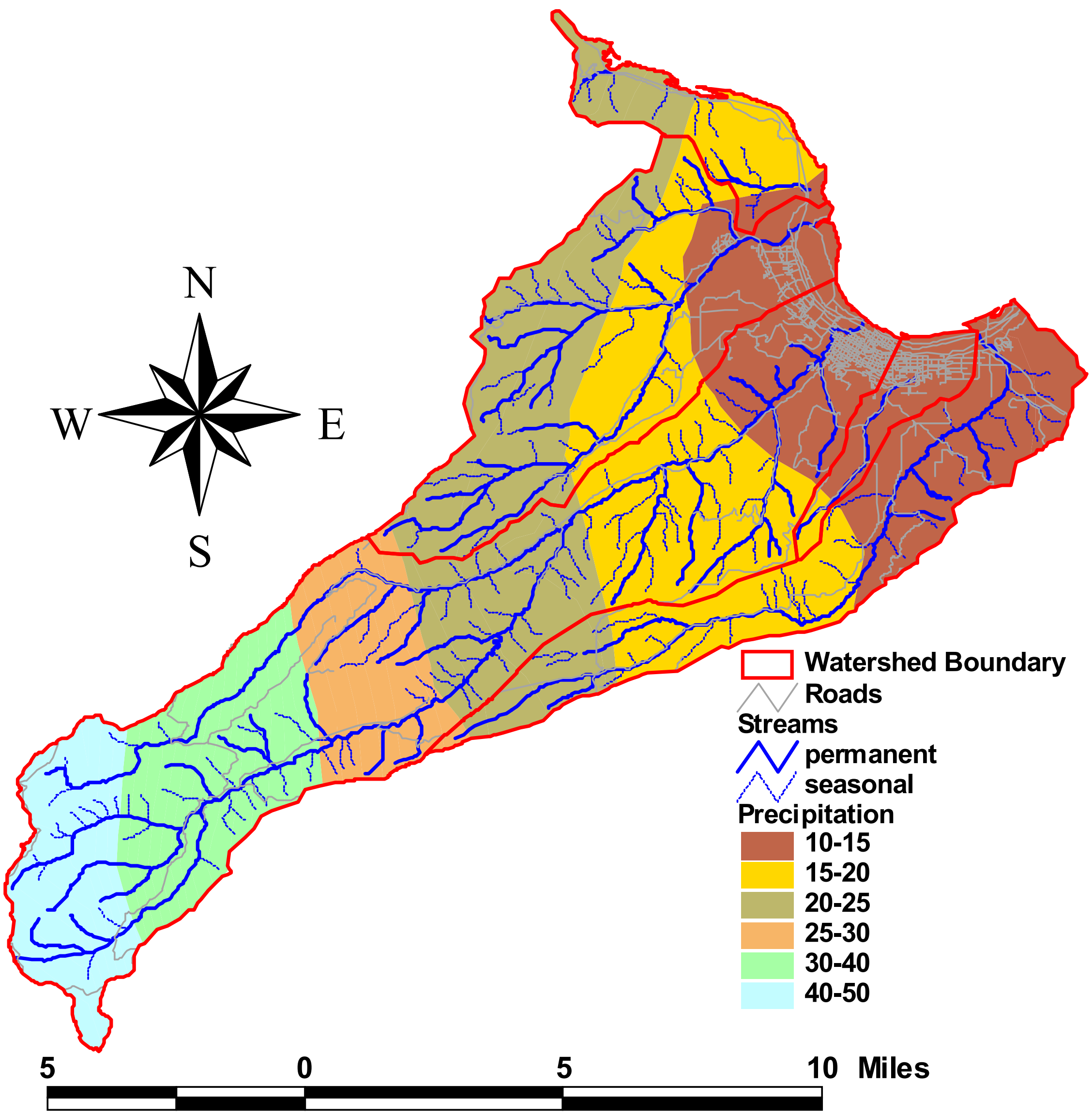
Map 1.8: Ecoregions in The Dalles Watershed. Source: Oregon Natural Heritage Foundation (http://www.gis.state.or.us/data/alphalist.html)



2) Climate

Temperature in The Dalles is moderated by marine air moving up through the Columbia Gorge. Occasional extremely cold temperatures occur as the result of arctic air flowing west from the inland areas. There are also periods of very hot days during the summer caused by high pressure areas stagnating over the Great Basin Desert to the south, often accompanied by "Chinook Winds". Temperatures have ranged from –30 degrees F to 115 degrees F, both recorded at The Dalles. Most years the range is –3 degrees to 107 degrees Fahrenheit (Northern Wasco County Soil Survey, 1982).

Map 2.1: Precipitation. Source: USDA climatological model and Hood River County Dept. of Forestry, verified with local data from Crow Creek Reservoir



The annual average precipitation ranges from 13 inches on the eastern edge to over 40 inches on the higher slopes to the west (map 2.1). Between 70 and 80 percent of the annual precipitation is between November and March and about 5 to 10 percent occurs from June to August. Measurable precipitation can be expected on about 75 days a year in The Dalles. There are sunny days about 20 to 30 percent of the time in December and January; 55 to 65 percent of the time in April, May, and June; and 75 to 85 percent in July, August, and early September (Wasco County Soil Survey). Precipitation maps from the Hood River Department of Forestry disagrees with the Soil Survey and shows the annual precipitation ranging from 10-15 inches on the eastern side of the watershed to40-50 inches in the upper Mill Creek drainage. The Hood River DOF maps are consistent with precipitation records from Crow Creek Reservoir however.

The relative humidity varies dramatically throughout the day during the summer. In the early morning hours when the air temperature is the lowest, relative humidity of 90 to 100 percent occurs in the summer. It is not unusual, however, to have a relative humidity of 10 to 20 percent during the warmest part of summer days. High humidity throughout the day is common in late fall and winter. The yearly average is 35 percent relative humidity (Northern Wasco County Soil Survey, 1982).

3) History

Some scholars claim Native Americans first came to North America from Siberia more than 12,000 years ago across an Alaskan land bridge, the Bering Strait. Experts theorize that they were following game that crossed over to new fertile land, a result of the warming of the earth after the last ice age. Prehistoric occupants of North America probably moved down interior valleys, then over into the mid-Columbia area. Archaeological evidence indicates that they arrived in The Dalles by at least 11,500 years ago (Discovery Center).

The Indians living along the Columbia River were the first known inhabitants of the area and fishing was their main livelihood. Indians from other tribes in the Pacific Northwest traveled annually to Winquatt (the native name for the area now known as The Dalles) to trade and barter for fish (Northern Wasco County Soil Survey, 1982).

The Wascos lived along the south bank of the Columbia River from Hood River east to the great narrows below Celilo Falls. Their Upper Chinook language was related to the Cascades, Multnomah, and Clackamas dialects to the west. The Wascos prospered because of their control of major fishing stations and central position in regional trading patterns. Their primary village was located at what is today, The Dalles. The Wascos are now one of the Confederated Tribes of Warm Springs.

Although their first encounters were with the traders of the Hudson Bay Company and the Northwest Companies, local Native Americans first entered the historic record in 1805-1806, through the Lewis and Clark journeys (Discovery Center). Lewis and Clark wrote the first general description of prehistoric occupants of the area and made estimates of their population numbers. Native Americans who lived along the Columbia River were the most populous of all the groups in Oregon that were encountered by the Lewis and Clark expedition. On October 25, 1805 the Lewis and Clark Expedition camped at a site on the Columbia River they called “Rock Fort” which was near the confluence of Mill Creek and the Columbia.

When Lewis and Clark arrived at The Dalles, they found an Indian village full of Euro-American goods that had already been introduced into the region via the native trade routes (Discovery Center). For about the next 25 years, fur trading was big in the area and the Hudson's Bay Company established a temporary trading post at The Dalles in 1820 (Wasco County Soil Survey).

An early tragic effect of Euro-Americans on local Native Americans was disease, particularly smallpox. The devastation was especially severe along the Columbia River in the western portion of the Gorge, which was the major artery of travel and trade. Within a few years of contact, the majority of the Native American populations perished. The Wascos were estimated to number 900 in the 1820s. The 1910 Census numbered the Wascos at 242 and the Office of Indian Affairs numbered them at 227 in 1937.

The Dalles gets it name from the French words, "le dalle," meaning "the trough," in this case, the trough of the Columbia River. Before the dams, The Dalles was a dangerous point for boats running the river due to whirlpools and rapids. In the years around 1843 to 1848, The Dalles was considered the end of the overland Oregon Trail; from here, settlers made a choice to either brave the Columbia River or take the Barlow Pass across the Cascades to reach the Willamette Valley in western Oregon (CGEDA website). After 1846, those choosing the Barlow Pass toll road often turned west from the Columbia River once they had crossed the Deschutes River and traveled toward Wamic, where Barlow Road started (Northern Wasco County Soil Survey, 1982).

The Whitman Massacre occurred in 1847, and the Oregon Territorial Governor Abernathy promptly dispatched a company of troops to The Dalles on December 8, 1847. They began what could be considered the permanent establishment of a community in Wasco County. Dalles City was incorporated June 22, 1857.

Wasco County, once the largest county in the United States, has been reduced to a fraction of its original size. At its inception, Wasco County encompassed about 130,000 square miles. It extended from the Cascade Mountains to the Rocky Mountains and from Washington, Idaho, and Montana borders to the California, Nevada, and Utah borders. Wasco County was formed January 11, 1854, and maintained its original size until February 14, 1859, when Oregon gained statehood. Seventeen counties have been formed in Oregon alone from the original county. It is now in north-central Oregon between Hood River, Sherman, and Jefferson counties, and the Columbia River. The county seat is The Dalles.

In the 1860 census there were 1300 people living in The Dalles. Of these, 23 were Chinese, four were noted as Black, and three were listed as Native. One major difference from today is the ratio of males to females. In 1860, 63.4% of the population was male, whereas today the population is about 51% female. In 1860 the age distribution was different also; over 53% of the females were under 20, making up almost 20% of the population, and just over 36% of the females were from 20 to 40. There were slightly more than 30% of the males in the 1 to 20 year-old age group, just over 19% of the total population. Over 50% of the males were from 20 to 40, representing more than 32% of the population of the day. In sum, over 81% of the people in The Dalles in 1860 were between 1 and 40 years old, ~84% counting those under one year old (http://usgenweb.com). These figures possibly represent those who were able or willing to make the arduous journey across the country.

The population in Wasco County was 23,791 in 2000, a 9.7% increase from 1990. Statewide, the increase was 20.4% in the same period. There were 10 persons per square mile in 2000 compared to a statewide average of 35.6 persons per square mile. The county has 10,651 housing units with 2.47 persons per household and a homeownership rate of 68.4%, as compared to a statewide homeownership rate of 64.3% and 2.51 persons per household (http://factfinder.census.gov).

The City of The Dalles had a population of 11,765 in 1999. The projected 2000 population was 11,637. (CGEDA website) The population of The Dalles in 1860 was 1300 residents as reported by USGenWeb, 11% of 2000's population.

Discovery of gold in the early 1860's in the eastern and central parts of Oregon hastened the settlement of Wasco County. Wagon stops were located out of The Dalles at half-day travel intervals. The main travel route was south across Three, Five, Eight, and Fifteenmile Creeks then over Tygh Ridge and across the Deschutes River. So much gold was coming out of the John Day-Canyon City Country that the government started construction on a mint in The Dalles. The gold supply dwindled before coins could be minted.

Farming became big business in Wasco County in the 1860's. Sheep and cattle raised in the central and southern parts of the county contributed to the economic stability. Shaniko was once one of the world's largest wool shipping points. Wheat and other grains gradually gained acreage in the eastern and northern parts of the county (Soil Survey). Fruit orchards began to be established with apples, plums, peaches, pears and cherries in the 1850's and 1860's in Rowena and The Dalles area and the first commercial operation began in 1886. The Columbia Brewery was started in 1860 at the foot of Brewery grade on 2nd Street (OSU Extension).

Sources

The history of The Dalles was compiled from website sources including The Discovery Center at http://www.gorgediscovery.org, the Wasco County Local Resource Page at http://historysavers.com/orwasco, and USGenWeb at http://usgenweb.com. The US Department of Agriculture Soil Survey of Wasco County, Oregon State University Extension and The Dalles Chronicle archives at the Wasco County Library also provided historical information. The population figures were obtained from the websites of; Columbia Gorge Economic Development Association at http://www.cgeda.com, the U.S. Census Bureau's American Factfinder at http://factfinder.census.gov, and USGenWeb at http://usgenweb.com.

Historical Timeline

11,500 years ago: Indian people inhabit local area
1805: Lewis and Clark Expedition reaches Rock Fort
1832: First group of settlers led down the gorge by Nathaniel Wyeth
1838: First Methodist Mission began in Dalles City
1838: First homes erected in Dalles City
1843: Settlers first reached Dalles City via Oregon Trail
1846: Barlow Trail opens to Oregon City
1847: Whitman massacre – inspired by measles epidemic in Native population
1848: Father Louis Rousseau founds St Peter's Mission at Dalles City
1850: Fort Drum established at Dalles City
1851: Post office established in Dalles City
1853: Flood at Dalles City
1853: Fort Drum renamed Fort Dalles
1853: Dalles City renamed Wascopum
1854: Wasco County created by Oregon Territorial Government

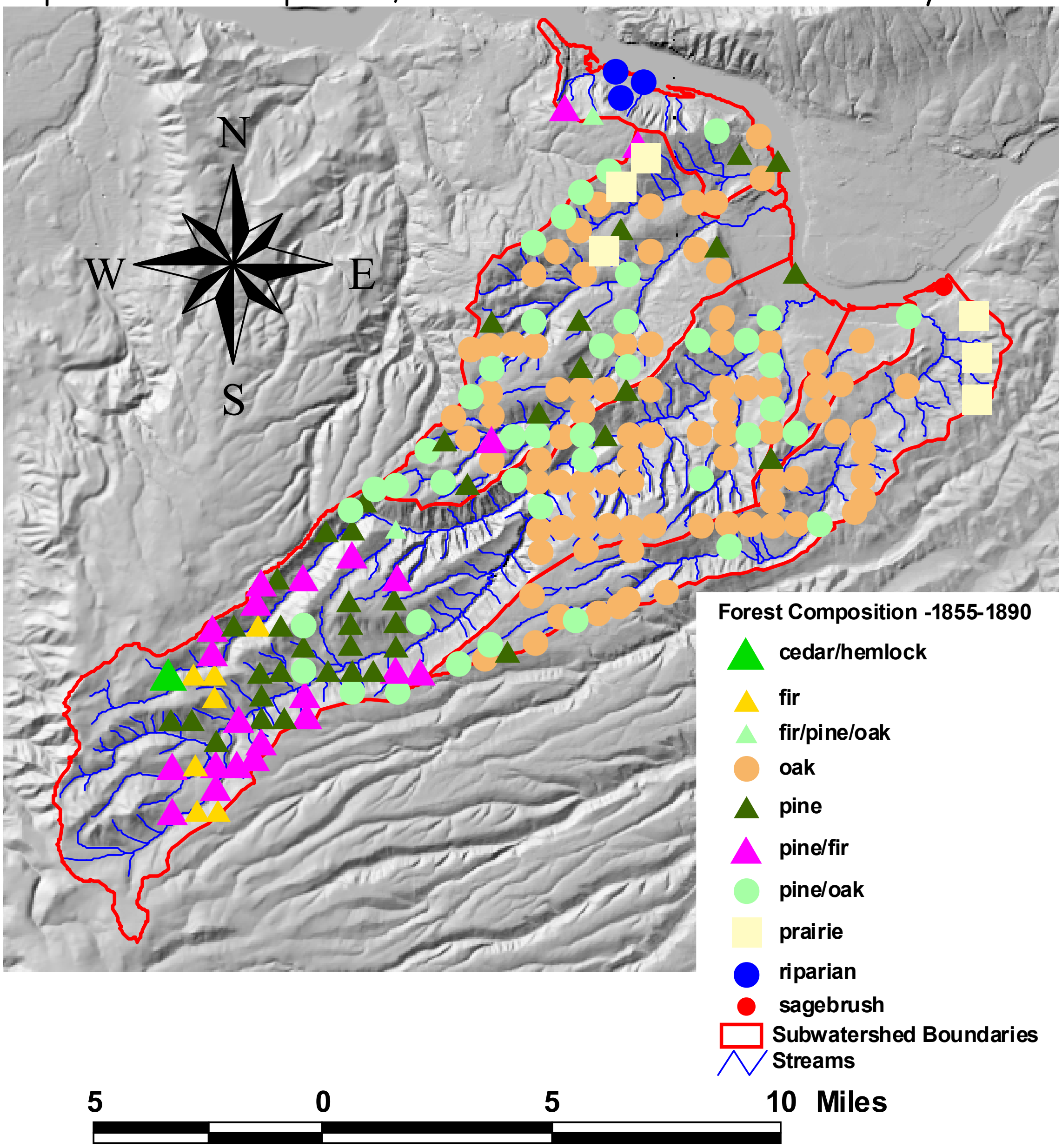
1854: Fruit orchard started in Rowena by George Snipes
1855: Indian lands ceded in treaty to U.S.
1859: Wascopum Courthouse built
1859: Flood at Wascopum
1859: Oregon statehood
1860: Columbia Brewery started by Amiel Schanno
1860: Name changed to The Dalles
1862: Gold discovered in Canyon City – shipping route between The Dalles and Canyon City established
1862: US Government mint built in The Dalles (never used)
1863: Columbia River floods
1866: Orchard started on Brown's Creek in Chenowith
1867: Fort Dalles abandoned
1867: The Dalles-Klamath agency Road built
1870: Columbia River floods
1871: Columbia River floods
1876: Columbia River floods
1877: Fruit orchards started on Sunset Hills (Sorosis Park) by Amiel Schanno
1880: Columbia River floods
1884: The Dalles Courthouse #2 built
1886: First commercial cherry orchard started by Frank Seufert - operated until 1952
1890: The Dalles Chronicle established
1891: The "Great Fire" in The Dalles
1894: The "Great Flood" at The Dalles
1898: St Peter's church built in The Dalles
1908: Hood River County established out of Wasco County
1908: Dog River Fire affects 1600 acres at headwaters of South Fork Mill Creek
1910: Carnegie Library built (now the Art Center Building)
1913: Construction begins on Scenic Columbia River Highway
1914: The Dalles Courthouse #3 built
1916: Dedication of the Scenic Highway took place at Crown Point
1922: Hood River to The Dalles section of Scenic Highway completed
1924: The Dalles Cherry Growers Association established
1925: Columbia River Scenic Highway opens to The Dalles
1929: Granada Theatre opens
1937: Columbia Fruit Growers Association established
1938: Bonneville dam completed – first federal dam on the Columbia River
1942: First Soil and Water Conservation District established in Wasco County
1948: Flood at The Dalles
1955: Interstate 84 completed – widened to 4 lanes in 1976
1957: The Dalles Dam completed
1964: Flood at The Dalles
1966: Name of "The City of The Dalles" officially adopted
1966: The Dalles Fruit Growers Association and Columbia Fruit Growers Association consolidated to become The Dalles Fruit Growers Association

1967: Schoolmarm Fire burns 9,710 acres in South Fork Mill Creek, prompting development of cooperative management of The Dalles Municipal Watershed
1967: Two days after Schoolmarm, 1300 acres burn in the Brown's Creek Drainage
1986: National Scenic Area established encompassing 253,500 acres of the Columbia Gorge
1996: Floods throughout the Pacific Northwest
2000: The Dalles Watershed Council formed

Historic Forest Composition

Using historical notes from public land surveys taken from the late 1800's, a glimpse of the historic vegetation cover was obtained. This shows that there were stands of Ponderosa Pines and Oregon White Oak with some scattered fir in the area. Most of the pines and firs were on the upper half of Mill Creek watershed in higher elevations. The majority of the oaks were in the middle portion of the watershed along with scatterings of pines. Sevenmile Hill was grassland with oak and brush along the streambeds and the farthest eastern portion of the watershed consisted mostly of grassland. Sagebrush was mentioned in the northeast corner, near the Columbia River (map 3.1).

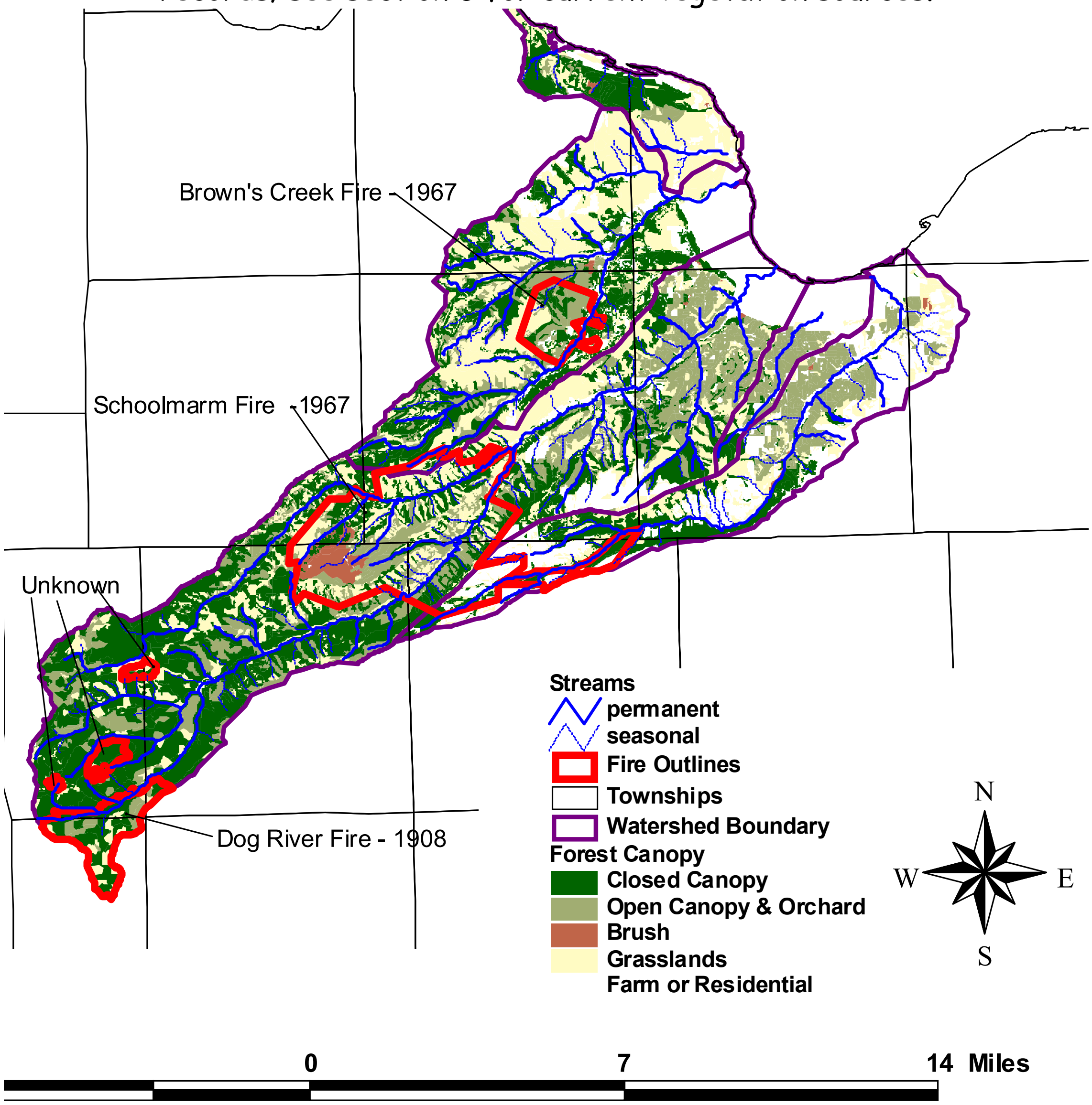
Map 3.1: Forest Composition, 1855-1890. Source Public Land Survey Records



Fire History

The Dalles Watershed, like most watersheds in the West, has been disturbed at various times in the past by wildfire. Particularly large fires occurred in 1908 (Dog River Fire), and in 1967 (Schoolmarm and Brown's Creek). The effect of the Schoolmarm Fire resulted in a lighter forest canopy that is still present today (map 1.9). The Schoolmarm Fire affected the most acreage in the Mill Creek Watershed, but also spilled over into the headwaters of Threemile Creek, on Dutch Flat.

Map 3.2: Fire Footprints and current vegetation. Sources: USFS and ODF records; see section 6 for current vegetation sources.



5) Channel Habitat Type Classification

Channel Habitat Types (CHT's) are based on the physical characteristics of slope and width. The stream gradient, or steepness of the slope, relates to the amount of smaller particles and debris that might accumulate in the stream channel. The stream's sediment transport capacity is proportional to the energy of the flow. As the flow slows in a stream, either due to an obstruction, a widening of the channel or a reduction in the gradient, material that has been carried by the current begins to be deposited. Larger materials drop out of the current first so cobbles and gravels are found in medium gradient stretches of the stream. Streambeds with clean gravel are very important to many fish species for spawning habitat. The finer sediments and silts tend to drop out where the flow is very slow, typically at the river mouth or stretches where the gradient is very low.

Stream reaches with gradients too steep would not be likely fish habitat as the current is too fast and resting places are not adequately provided. Low and moderate gradients are the most common places for fish habitat, with low gradient being 1-2% and moderate up to as much as 6%. Along with gradient, the width of the flood plain poses different conditions and opportunities. A stream with an unconfined channel will have a much wider floodplain and riparian vegetation corridor than one with a confined channel. The stream will also be more sinuous, or winding, due to the wider floodplain width. As a result, the instream structure in an unconfined channel will be more complex and diverse, allowing for better fish habitat.

The species of plants found in the riparian zone may differ as well. The steep rocky banks of a V-shaped valley may support a few small trees or bushes while the flatter and more fertile unconfined area will usually have a more diverse population of trees, shrubs, flowering plants, and grasses.

Gradient and channel width both influence how a stream reacts to impacts from high flow events. Confined or steep channels will move greater volumes of water more rapidly as the flow does not spread out or encounter much impediment. An unconfined channel is more likely to have a developed floodplain that will allow the runoff to spread and slow.

Using the CHT's, a stream may be evaluated for things such as land use influences and potential restoration activities.

<u>Methods</u>

The watershed streams data layer was created from an existing streams data layer in GIS. Accuracy was refined by comparisons to aerial photos and a topographical map. Stream reaches were assigned CHT's according to the steepness of the gradient (slope) and the proportion of the channel width to the floodplain width. In confined channels the floodplain is not more than twice the width of the stream at its normal full channel width (bankfull width). A moderately confined channel is defined as one that has a floodplain between twice and four times the bankfull width of the stream and an unconfined channel has a floodplain more than four times the bankfull width. Stream reaches were defined based on gradient or confinement changes and each section was assigned the code that described the channel type. The gradient was determined by placing the streams layer over the topographic map then using the GIS tools to measure the stream length and noting the number of elevation gridlines the reach of stream crossed. The topographic map gridlines indicate forty-foot elevation changes. This change in elevation was divided by the length of stream to find the slope. Floodplain width is difficult to determine from a photo or map so a rough estimate was made. Where the topographic map indicated a deep V-shaped valley it was assumed that the channel would be confined while a flat area with little slope toward the stream was noted as unconfined. Significant changes in gradient or channel confinement, and points where a stream converges or a tributary enters the main channel were used as endpoints of the CHT for each particular reach of stream. Many sites were visited in the field to verify the map findings and assumptions.

<u>Discussion</u>

Eight channel habitat types were identified in the watershed (Table 5.1, 5.2, map 5.1).

No unconfined channel habitat types were found in the watershed. The moderately confined reaches of streams comprised 38.21% of the stream system. Confined reaches comprised slightly over 4% of the low gradient reaches. Much of the confinement of the stream is due to road building and agricultural or homestead channelizing activities.

About 43% of the confined reaches are in moderate gradient reaches and approximately one third are in high gradient headwaters, typically in narrow valleys.

Although crops account for just 2% of the lands along the streams of the watershed, almost half of these are on confined reaches of streams. Homes are much more likely to occur along confined reaches as well, with 70% of the homes and associated driveways situated along confined reaches of stream. These percentages may reflect changes in the stream morphology and are, therefore, the most likely to reflect the human influence on the CHT's.

Channel Habitat Types are relatively evenly distributed among different vegetation types, although confined channels show up somewhat less in open-canopy woods and moderately confined channels are slightly less common in grasslands.

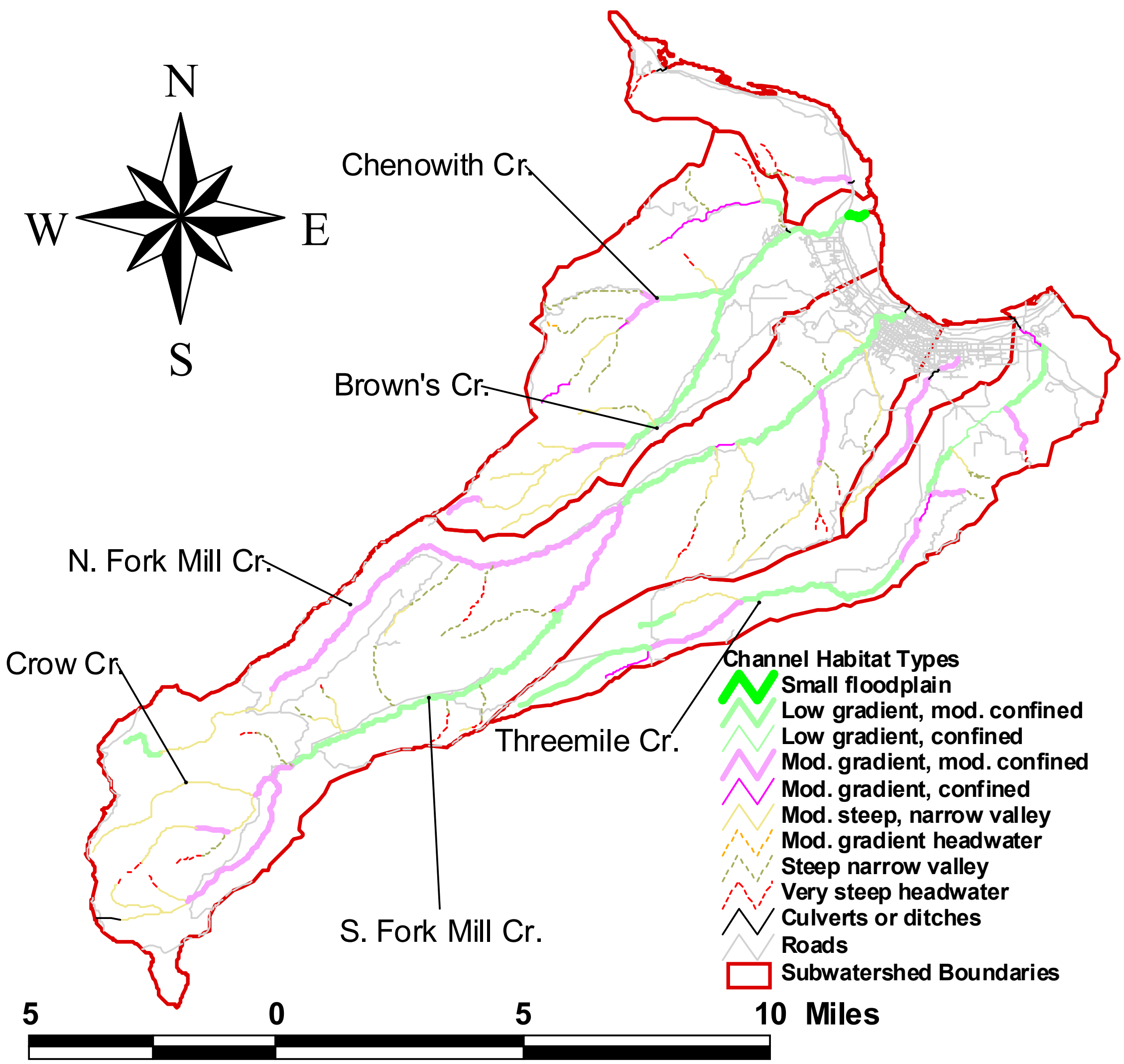
Table 5.1: Descriptions of channel habitat types found in The Dalles Watershed

		Stream gradient	**Valley shape**	**Channel pattern**	**Confinement**	**Position in drainage**	**Dominant Substrate**
MV	Moderately Steep, Narrow Valley	4-8%, may vary between 3-10%	Narrow, V-shaped valley	Single channel, relatively straight	Confined	Mid to upper	Small cobble to bedrock
MC	Moderate Gradient, Confined	2-4%, may vary up to 6%	Gentle to narrow V-shaped valley	Single, straight or conforms to hill-slope	Confined	Middle to lower	Course gravel to bedrock
LC	Low gradient, confined	<2%	Moderate gradient hill slopes w/ limited floodplain	Single channel, variable sinuosity	Confined by slopes or high terraces	Generally mid to lower in larger basin	Boulder, cobble, bedrock with pockets of sand, gravel, cobble
SV	Steep Narrow Valley	8-16%	Steep, narrow V-shaped valley	Single, straight	Tightly confined	Middle upper to upper	Large cobble to bedrock
LM	Low gradient, moderately confined	<2%	Broad, generally much wider than channel	Single w/ some multiple channels	Variable	Mainstem & lower end of main tributaries	Fine gravel to bedrock
MH	Moderate gradient Headwaters	1-6%	Open, gentle V-shaped valley	Low sinuosity to straight	Confined	Upper, headwater	Sand to cobble, bedrock; possibly some boulders
MM	Moderate Gradient, Moderately Confined	2-4%	Narrow valley with floodplain or narrow terrace	Single channel, low to moderate sinuosity	Variable	Mid to lower	Gravel to small boulder
VH	Very Steep Headwaters	>16%	Steep, narrow V-shaped valley	Single, straight	Tightly confined	Middle upper to upper	Large cobble to bedrock

Table 5.2: Summary (in miles) of channel habitat types for stream channels in The Dalles Watershed. Channel habitat types listed in order of frequency.

Subwatershed	MV	MM	LM	SV	VH	MC	LC	MH	TOTAL
Rowena	-	1.12	-	0.65	2.24	-	-	-	**4.01**
Chenowith	10.78	2.93	9.58	8.27	1.24	3.53	-	0.28	**36.61**
Mill Creek	23.65	18.75	15.76	15.42	5.58	0.52	-	-	**79.68**
Dry Hollow	1.24	2.80	-	-	-	-	-	-	**4.04**
Threemile	2.17	4.94	10.33	1.15	0.27	2.39	1.52	-	**22.77**
Total miles	**37.84**	**30.54**	**35.67**	**25.49**	**9.33**	**6.44**	**1.52**	**0.28**	**147.11**
% of Watershed	*25.72*	*20.76*	*17.45*	*17.33*	*6.34*	*4.38*	*1.03*	*0.19*	***100***

Map 5.1: Channel Habitat Types. Source: 1995 Aerial Photos and Field Observation



6) Hydrology and Water Use

Runoff versus Infiltration

This section will look at runoff originating from upland areas. Historic runoff levels will be compared to existing runoff levels to determine if land use and vegetative cover conditions are contributing to flood damages in the streams.

Runoff is a function of many factors. The climate and the amount, type, and frequency of precipitation are part of the hydrology of a watershed. The contour of the terrain in the watershed will affect how fast the water moves over the surface and influence the amount and type of vegetation that will be likely to grow in an area. The soil type will be a factor in what proportion of the water will run off overland, be stored in bogs, ponds and lakes, or infiltrate to the water table. The vegetation that grows in an area is greatly dependent on the soil type and thickness and is a large factor in the hydrology. Urban and rural communities are also large factors as they can prevent infiltration, redirect streams, and concentrate runoff amounts. Road building and land development impact the hydrology through changes to runoff conditions, infiltration opportunities, water use, land and sediment movement, and introduced substances. There may also be substances added to the hydrology through yard care, vehicle use, agricultural practices, and maintenance operations.

The hydrologic cycle describes the circulation of water from evaporation off of the land, streams, lakes, and the ocean, into the atmosphere and then to solid or liquid precipitation in a continuing cycle. The cycle includes the processes by which water moves between the phases of the cycle such as precipitation, evaporation, runoff, stream flow, and transpiration by plants, and the processes of storage mechanisms like groundwater recharge, snowpack, wetlands, and reservoirs.

Evaporation is the process by which the water on the surface is converted from liquid to vapor, usually due to solar energy. The vapor then enters the atmosphere to condense and precipitate once again in liquid or solid form, usually at another location. Run off describes the movement of water over land due to the effect of gravity. This is the process that is most visible as it creates gullies and other structures from land movement and erosion. Plants move water from the soil to the atmosphere by the process of transpiration. Transpiration is, in fact, one of the main ways in which the plant gets the water to flow "uphill" through its system. Once the water has passed up from the roots to the leaves it evaporates from sun and wind energy acting upon it. The combination of evaporation from the soil and plant surfaces, and of transpiration by plants is known as evapotranspiration.

Stream flow is the amount of water flowing in the channel of a stream or river, generally measured in cubic feet per second (cfs). Peak flow is the amount of water that is discharged in a channel after a two-year, or greater, storm event. Exaggerated peak flows have the potential to scour streambeds, exacerbate sediment flow into the stream, which can increase turbidity (a measure of the particles suspended in the water), and flood streamside areas.

Peak flows are largely influenced by the elevations within the watershed. In the higher elevations, snowmelt accounts for much of the runoff and in the lower elevations it is mostly from rain. The area between these realms is termed the "rain-on-snow" area.

This is the zone in which rain events are most likely to occur on top of frozen soil or snowpacks, leading to very severe, rapid runoff events. Such events can occur at any elevation.

Some of the water that falls onto the ground infiltrates the soil vertically to end up in the underground aquifer. The aquifer is the source that is tapped when a well is drilled and thus, supplies much of the water that we use. Lakes and streams may also be recharged from the aquifer through springs and seeps, which run over the surface or enter from underwater.

The proportion of water that runs off, is intercepted, evaporated, or transpired in the watershed is dependent, in a large part, on the type and extent of vegetative cover. Land uses that reduce or alter the vegetative cover in the watershed can increase the percentage of precipitation that becomes runoff. Steep slopes and areas with thin soils over bedrock are also places that may experience higher runoff quantities. Anthropomorphic (man-made) changes such as roads, landuse, and other development will increase runoff or alter infiltration opportunities. Conditions that increase runoff correspondingly reduce the infiltration rate and can lead to a reduction in groundwater available for storage and recharge (Watershed Professionals Network, 1999).

Agriculture may change the hydrology in a watershed by changing the type and amount of vegetation growing in an area, which can then alter infiltration, runoff, and sediment amounts. Programs such as CREP (Conservation Reserve Enhancement Program) and CRP (Conservation Reserve Program), administered and implemented by US Department of Agriculture and Soil and Water Conservation Districts in cooperation with landowners, contribute to the health of the watershed. CREP and CRP set aside areas along streams that will not be grazed or farmed and are allowed to regrow native vegetation. No-till (a method of planting) is another practice that farmers can use to reduce soil disturbance and water use as well as herbicide use and erosion.

Roads can have an impact on the hydrology of a watershed by creating impervious surfaces and directing runoff to concentrated routes. The concentrated runoff can exaggerate peak flows, increase erosion and bring sediments to streams. This can result in scouring of streambeds and filling in spawning gravels. The impervious surfaces also reduce infiltration potential which can affect the underground aquifer by reducing inputs.

Sources

Data layers for roads, land use, soils, and stream flow were all created from existing county and state data as well as information downloaded from the USDA, USGS, and the US Census Bureau's TIGER files at http://www.gis.state.or.us. The runoff analysis was based on USDA NRCS August 1989 Engineering Field Manual Chapter 2 "*Estimating Runoff and Peak Discharges*".

Effects of Land Use on Runoff

Methods

Using the USDA soils data, the watershed was divided according to Hydrologic Soils Groups (HSGs). The HSGs are assigned to soils based on the type and depth of the soil and the proportion of water that will become run off. A cover type layer was then delineated using the aerial photos to show areas of forest canopy, herbaceous vegetation (non-irrigated range and grassland), crop, buildings and associated lands, pasture, brush and water. Forest zones were broken into closed canopy and open canopy woods, depending upon whether the understory was visible between trees from the aerial photos. Grand fir and mixed forests tended to fall into the closed canopy category, while oak-pine watersheds fell into the open canopy category. Orchards were treated as open-canopy woods. Field checks were carried out where possible to confirm the cover type assumed from the photos. The Common Land Unit (CLU) information from the Farm Service Agency was used to determine which crop areas are in CREP or CRP, and which are in notill conditions. This gave a more accurate representation of croplands as far as runoff potentials and vegetative cover was concerned. "Homestead" refers to houses, landscape, hard surfaces and driving areas. A substantial part of this is the urban area of The City of The Dalles but the homes scattered throughout the watershed and many of the driveways and roads connecting them are included as well.

The soils data layer was used in conjunction with the cover type layer to further split the data layer by soil type, landuse and cover type. Using the Northern Wasco County Soil Survey (1982), runoff curve numbers were assigned to each section based on the HSG, cover type and the quality of the cover. Runoff curve numbers are used to determine the amount of runoff that is likely to occur from a 2-year, 24-hour storm event. They are based on the type of land cover that exists on a section of land. These were determined for the present day conditions. Historical runoff curve numbers for 1850 were determined using the historic forest data as a means of comparison to the present day. This information was used to show potential runoff increases during peak-flow events.

Table 6.1: Cover Types by Subwatershed

	Three-mile	Dry Hollow	Mill Creek	Cheno-with	Rowena	%	TOTAL	1850 Total
Closed Canopy	3,038	296	21,182	7,228	1,632	**39.3%**	**33,376**	**38,501**
Herb-aceous	2,664	317	9,164	7,830	2,067	**26%**	**22,042**	**22,944**
Open Canopy	2,406	793	9,062	2,072	264	**17%**	**14,597**	**23,307**
Crop	4,670	144	1,335	968	263	**8.7%**	**7,380**	**0**
Homestead or Urban	1,172	1,140	1,887	1,817	313	**7.5%**	**6,329**	**0**
Pasture	79	28	0	135	27	**0.3%**	**269**	**0**
Brush	31	0	640	34	27	**0.9%**	**732**	**0**
Water	30	0	37	15	122	**0.3%**	**205**	**178**
TOTAL:	**14,011**	**2,690**	**43,307**	**19,964**	**4,686**	**100%**	**84,930**	**84,930**

Discussion

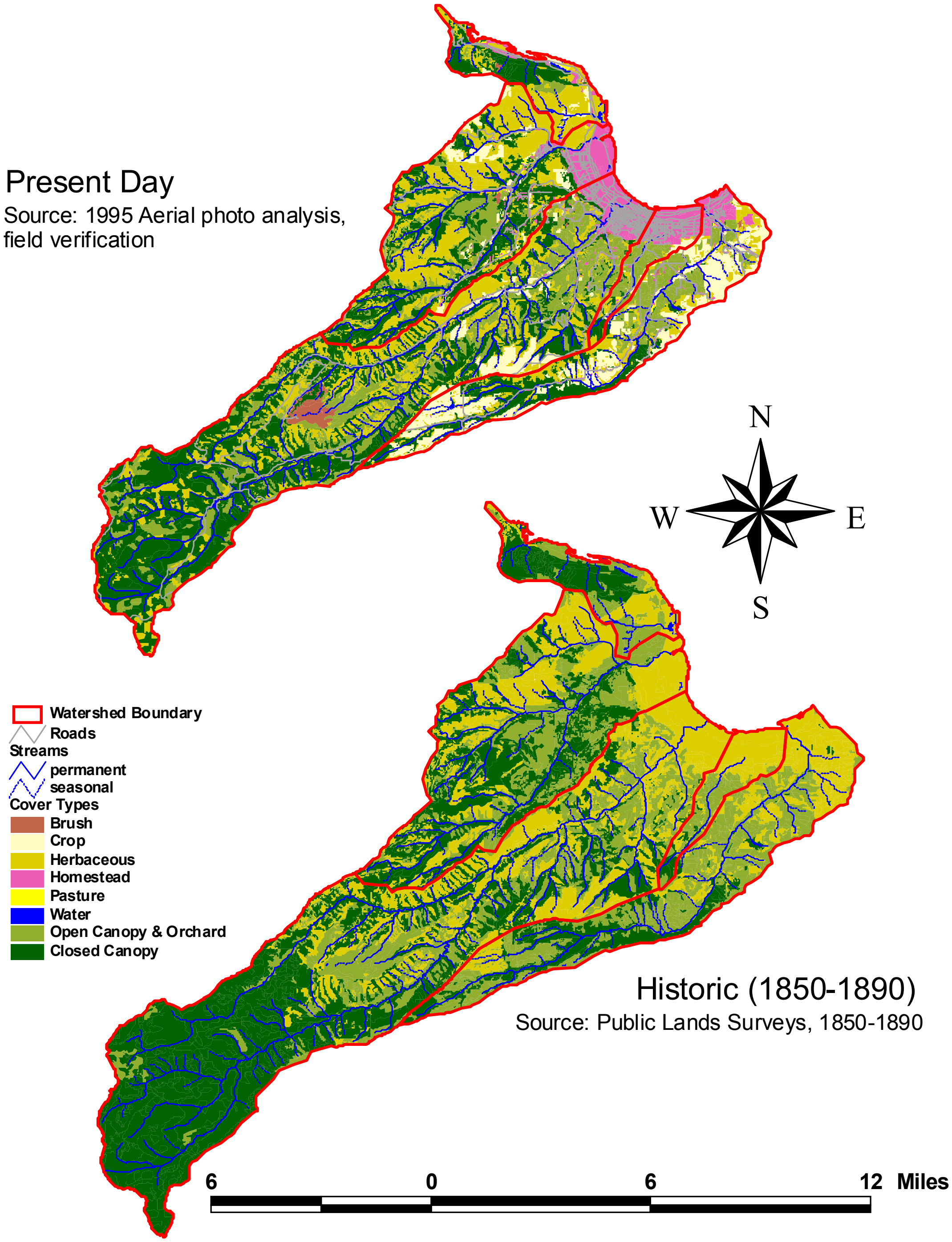
Map 6.1 illustrates the changes and similarities in landcover from 1850 to today.

As table 6.2 shows, runoff in a 2-year event was initially very low, and has only increased slightly since settlement. What change there has been can be attributed to the spread of the "Homestead" and "Crop" cover types. Runoff from croplands depends upon management. 34% of the croplands are under no-till management, which has a similar level of runoff to annual grasses. Orchards have similar runoff characteristics to open-canopied woods, and were counted as such in this assessment.

Table 6.2: Average depth of 2-year, 24-hour runoff events and change from 1850 to 1990s in inches.

Year	Rowena	Chenowith	Mill Creek	Dry Hollow	Threemile
1850	0.021	0.002	0.087	0.000	0.000
1995	0.071	0.061	0.122	0.089	0.064
Change:	+0.05	+0.059	+0.035	+0.089	+0.064

Map 6.1: Vegetative Cover Types, Present Day and Historic (1850-1890)



Effects of Roads on Runoff

Methods

The roads data layer was adjusted and refined by placing that layer over a georectified digital topographic map layer and an electronic aerial photo. New roads or those that had been omitted from the original roads data layer were drawn in electronically using GIS tools. The potential for hydrologic impact from the roads was then determined for each subwatershed and landuse type. "Rural" roads refers to those roads found in the rural residential, range or agriculture land use zones. Since the roads in the forested and rural areas were not categorized by how much of the length is paved, gravel, or dirt the impacts may vary from what is shown. It should be noted that many of the roads, particularly in the Mill Creek area, are not in use and are overgrown. By contrast, urban roads are almost all paved, and are associated with other hardened surfaces, such as parking lots, sidewalks, roofs, driveways, etc. Therefore, road density is likely to be a concern at a lower threshold in urban areas than in either "rural" or forest zones (Watershed Professionals Network, 1999).

For forest and rural areas the potential impact was determined by the percentage of the area that was covered in road surface. This was done by finding the length of the roads and multiplying by 25 feet for forest area or 35 feet for other rural area to determine the total area covered by the roads. It was assumed for this assessment that the roads in the forested areas averaged 25 feet in width and that roads averaged 35 feet in width in the agricultural and other rural areas. For the urban area the road density was expressed as miles of roads per square miles of urban area (Watershed Professionals Network, 1999).

Discussion

Tables 6.3 and 6.4 show potential impacts related to runoff from storm events. The tables break the subwatersheds up based on their land use zone (table 1.1). High potential for impact was found in all urban areas, except those in Rowena Subwatershed, where the area that is zoned "urban" is part of the Port, and no roads have yet been built. Moderate potential for impact was identified in the rural (agriculture, range and rural residential) areas of Rowena and Dry Hollow Watershed.

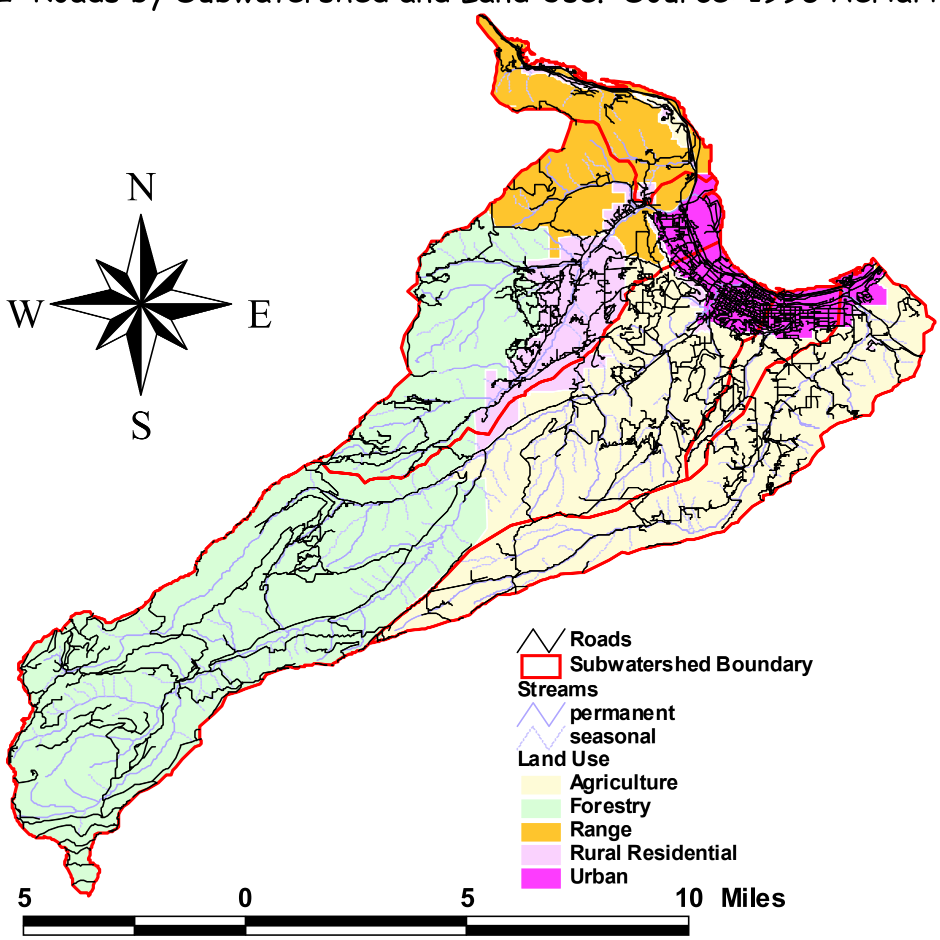
Table 6.3: Urban roads in The Dalles Subwatersheds.

Urban Roads	Area (sq miles)	Urban Zone (sq miles)	Total Linear Distance (miles)	Road Density (miles/sq mile)	Relative Potential for Peak-flow Enhancement
Threemile	21.53	0.99	13.64	13.75	High
Chenowith	30.42	1.90	23.78	12.55	High
Dry Hollow	4.21	1.68	31.89	18.95	High
Mill Creek	64.79	2.50	52.69	21.08	High
Rowena	7.24	0.04	0.00	0.00	Low
Total	128.18	7.11	122.00	17.17	High

Table 6.4: Road Densities in Non-Urban Land Use Zones.

Forest Roads / Watershed	Area (sq miles)	Forest Zone (sq miles)	Total Linear Distance (miles)	Roaded Area (sq miles)	Percent Area in Roads	Relative Potential For Impact
Threemile	21.53	0.04	0.48	0.00	5.42%	N/A
Chenowith	30.42	14.31	42.87	0.20	1.41%	Low
Dry Hollow	4.21	0.00	0.00	0.00	--	N/A
Mill Creek	64.79	41.88	109.63	0.52	1.23%	Low
Rowena	7.24	0.00	0.00	0.00	--	N/A
Total	128.18	56.23	152.98	0.72	1.28%	Low
Rural Roads / Watershed	Area (sq miles)	Rural Zone (sq miles)	Total Linear Distance (miles)	Roaded Area (sq miles)	Percent Area in Roads	Relative Potential For Impact
Threemile	21.53	20.48	77.29	0.51	2.49%	Low
Chenowith	30.42	14.19	70.60	0.47	3.28%	Low
Dry Hollow	4.21	2.52	16.83	0.11	4.41%	Moderate
Mill Creek	64.79	20.40	83.81	0.55	2.71%	Low
Rowena	7.24	7.14	45.90	0.30	4.24%	Moderate
Total	128.18	64.73	294.44	1.94	3.00%	Low

Map 6.2: Roads by Subwatershed and Land Use. Source: 1995 Aerial Photos.



Streamflow Characteristics

Methods

The City of The Dalles Wicks Water Treatment Plant supplied data for stream flow on South Fork Mill Creek at the Plant from 1996 through 2000. Stream flow data for Threemile Creek (T1N, R13E, section 31) was obtained from the Oregon Water Resources Department (WRD) website at http://www.wrd.state.or.us for 1969 until 1973. The WRD website also provides flow data for South Fork Mill Creek from 1960-1975.

Discussion

Data from The Dalles Wicks Water Treatment Plant showed storm events occurring mostly December through March and low flows in South Fork Mill Creek from July through October. The flow is augmented during summer months by the release of water from the Crow Creek Reservoir, which receives water from the Dog River diversion.

The high flows in February of 1996 shown in Chart 6.1 were the result of a 25-100 year flood event. This was followed by a similar, but smaller event in the same period of 1997.

The peak flows that are shown in the graph on the following page below were recorded in Threemile Creek. This graph shows similar trends in flow with peak flows in January and some in March. These reached as high as 90 cubic feet per second (cfs) in January 1970 with the peak flows occurring between December and March in most years. The majority of the year the flows were very small in Threemile creek, with flows less than 1 cfs for much of May through September.

Storm events can increase the streamflow a great deal, washing out otherwise dry drainages and moving material into and down the stream. During the flood of February of 1996, for instance, large boulders were moved down Mill Creek along with a great deal of smaller rocks and sediments. This material filled the existing reservoir at the water treatment plant.

A stream gage on the South Fork of Mill Creek near the Wick's Water Treatment Plant showed flows of 700 cfs during a flood event in December of 1964, and again in January of 1974 (http://www.wrd.state.or.us).

Chart 6.1: Streamflow and turbidity data collected at Wicks Water Treatment Plant on the S. Fork Mill Creek (1996-2001).

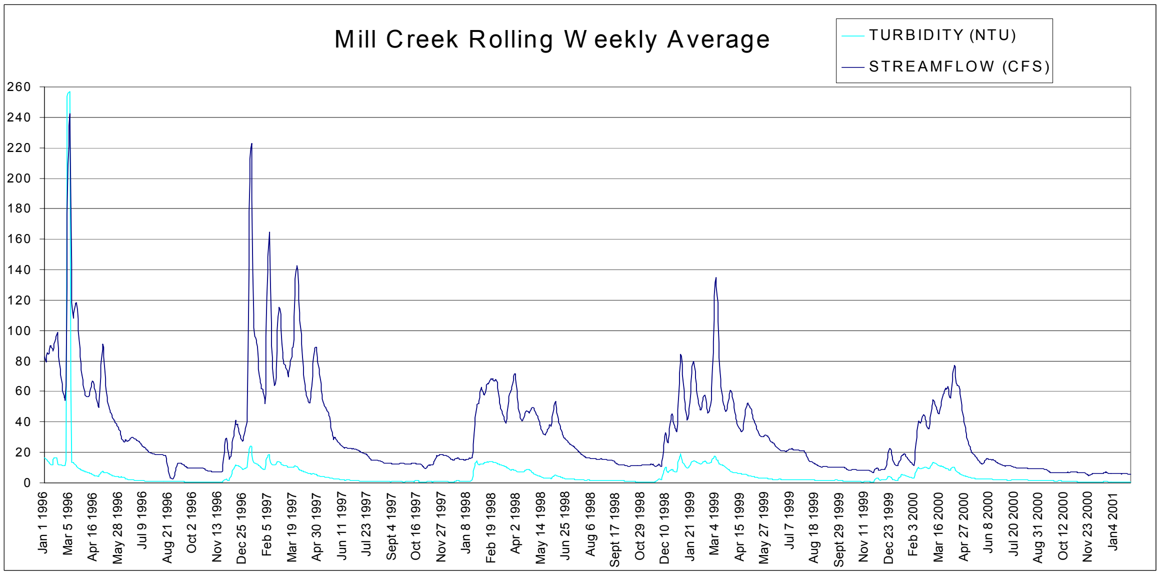
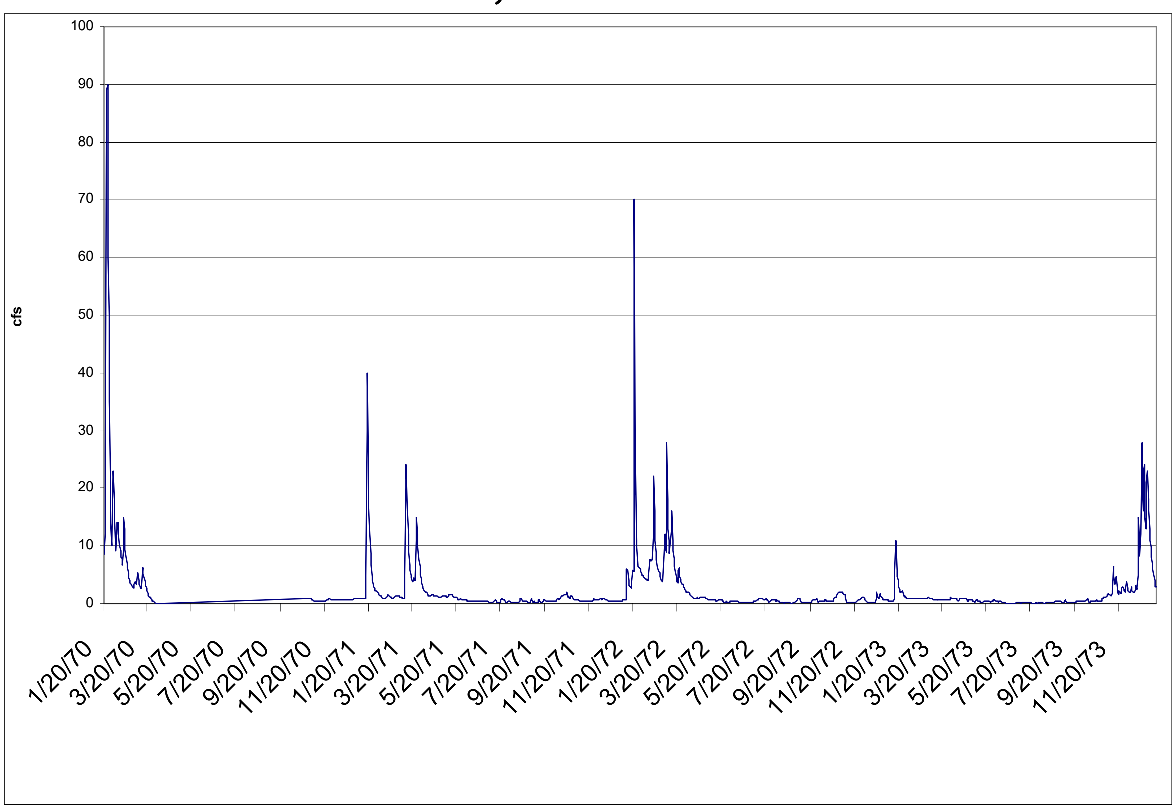


Chart 6.2: Streamflow recorded by USGS at gage 14105600 (T1N R13E section 31) in Threemile Creek.



Water Use

Water use is defined by the Oregon Water Resources Department in terms of beneficial use categories such as municipal, industrial, irrigated agriculture, etc. Water for these uses is taken directly from streams and reservoirs and is drawn from the underground aquifer through wells.

The flow of water from the streams to the aquifer goes both ways ─ each recharges the other at some point. Use of the water from a stream channel or reservoir may reduce the amount of underground storage available for use and one of the most important uses for underground storage is to recharge streams during low flow periods. Lowering the water table thus reduces the recharge potential, both to and from the stream.

Potential channel dewatering can present problems for spawning and fish passage. Spawning periods for fall chinook (September through November) coincide with low flows in August and September. (Rod French, ODFW, The Dalles, pers. comm.). Summertime rearing habitat also requires flow levels to be maintained, so while spawning times are the most critical, sufficient flow levels need to be maintained throughout the rest of the year to support all life stages of fish and other aquatic life.

Methods

Oregon Water Resources Department (WRD) models natural flows at the mouth each creek and tributary, and at certain other points. They determine the levels of flow in an average year (50% exceedance) and the level of flow that the stream can be expected to exceed 4 out of 5 years (80% exceedance). They then subtract the consumptive water rights to determine expected flow under each of those conditions. Finally, they subtract instream water rights and storage water rights (reservoirs) to determine how much water is available for new water rights. This assessment used WRD data to determine average natural flows (50% exceedance level, prior to all withdrawals) and expected flows (50% exceedance levels after all consumptive water rights are withdrawn). Water use data was obtained from the WRD website at http://www.wrd.state.or.us.

The Dalles Irrigation District provided data regarding the amount of water withdrawn from the Columbia River and delivered to farms within The Dalles Watershed.

Discussion

Charts 6.3 and 6.4 illustrate the natural streamflow and the expected flow after consumptive rights are exercised. As illustrated in Chart 6.4, if all of the consumptive use permits were executed, Chenowith Creek would have no stream flow during the months of May through September and Threemile Creek would have no flow from April through September. Notice that Chenowith, Gooseberry and Threemile Creeks actually show no natural flow during the summer months.

The Dalles Irrigation District withdraws water from the Columbia River near the mouth of Mill Creek. Most of the 5900 acres enrolled in the district are in the Threemile and Mill Creek watersheds. The Irrigation District operates during the growing season, from April through October. Two acre-feet (the amount of water that will cover an acre of land to two feet in depth) are allotted per acre. A substantial surcharge is added for uses that exceed that amount and most users do not exceed it. The average yearly amount

Chart 6.3: Natural flows of The Dalles Watershed streams. Source: Hydrologic Modeling, Water Resources Department.

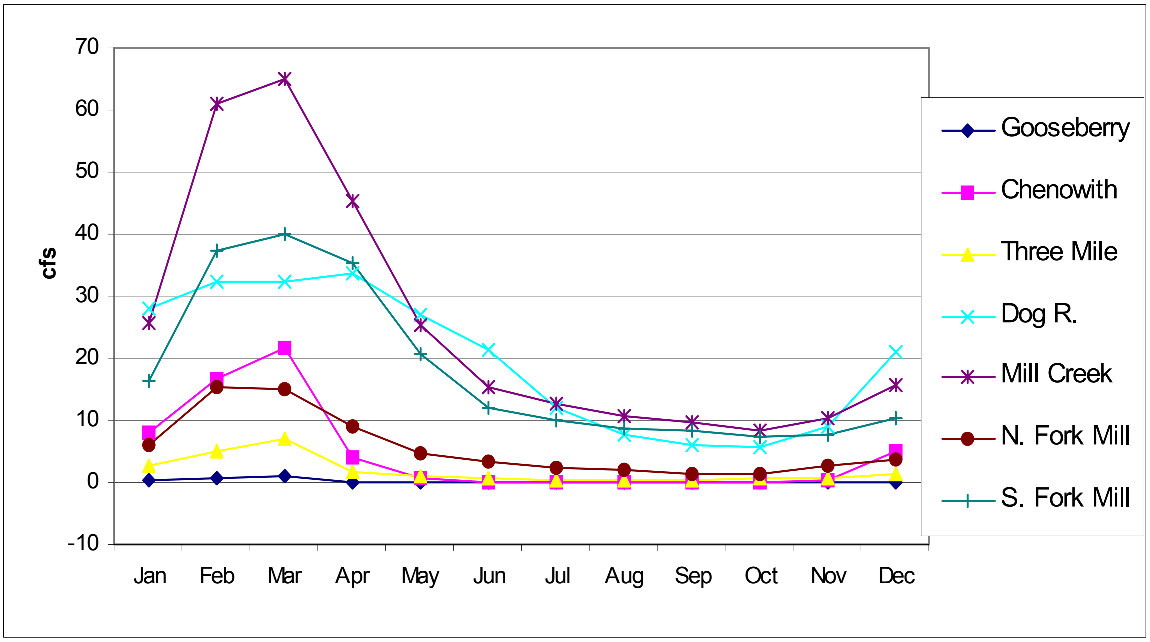
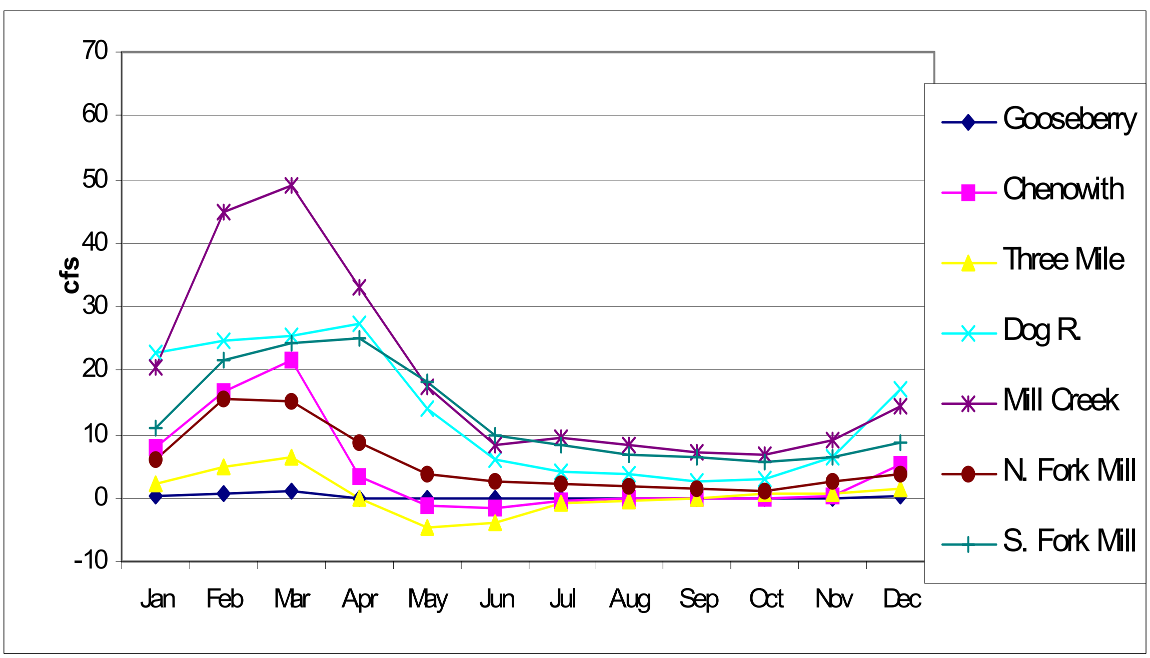


Chart 6.4: Expected flows in the streams after consumptive use. Source: Oregon Water Resources Department.



of water pumped is about 11,000 acre-feet, or, over 3½ billion gallons per year. A portion of this is shipped out in agricultural produce but the rest enters in the watershed hydrological cycle, mostly as runoff, infiltration or evapotranspiration.

The streams in the watershed all have water use permits associated with them. These include both consumptive use and instream water rights. Instream water rights do not refer to water removed from the stream but rather to water that will remain in the stream for instream use.

7) Riparian and Wetlands Conditions

Riparian Conditions

Riparian vegetation along stream corridors functions to maintain proper stream temperatures and moderate surface water runoff by slowing the flow of the water and making the soil more permeable. Leaves, branches, and detritus from the plants reduce soil erosion by providing a protective barrier from rainfall.

Riparian vegetation consists of plants that can tolerate or require more soil moisture. This includes rushes, cattails, wetland grasses, cedar, willows, and alder. They influence fish habitat and water quality in a number of ways. The trees, shrubs, and grasses provide shade, insect habitat, and bank stabilization and the litter contributes nutrients and large woody debris to the stream. The plants also slow and dissipate high flows and flood events, reducing or preventing streambank erosion. Large woody debris (LWD) in the stream diverts flow, slows runoff, and increases the channel complexity. This provides pools and gravel areas for fish spawning, resting, and feeding. Large woody debris also traps plant litter that provides food for aquatic insects, which then provides fish feeding opportunities.

Methods

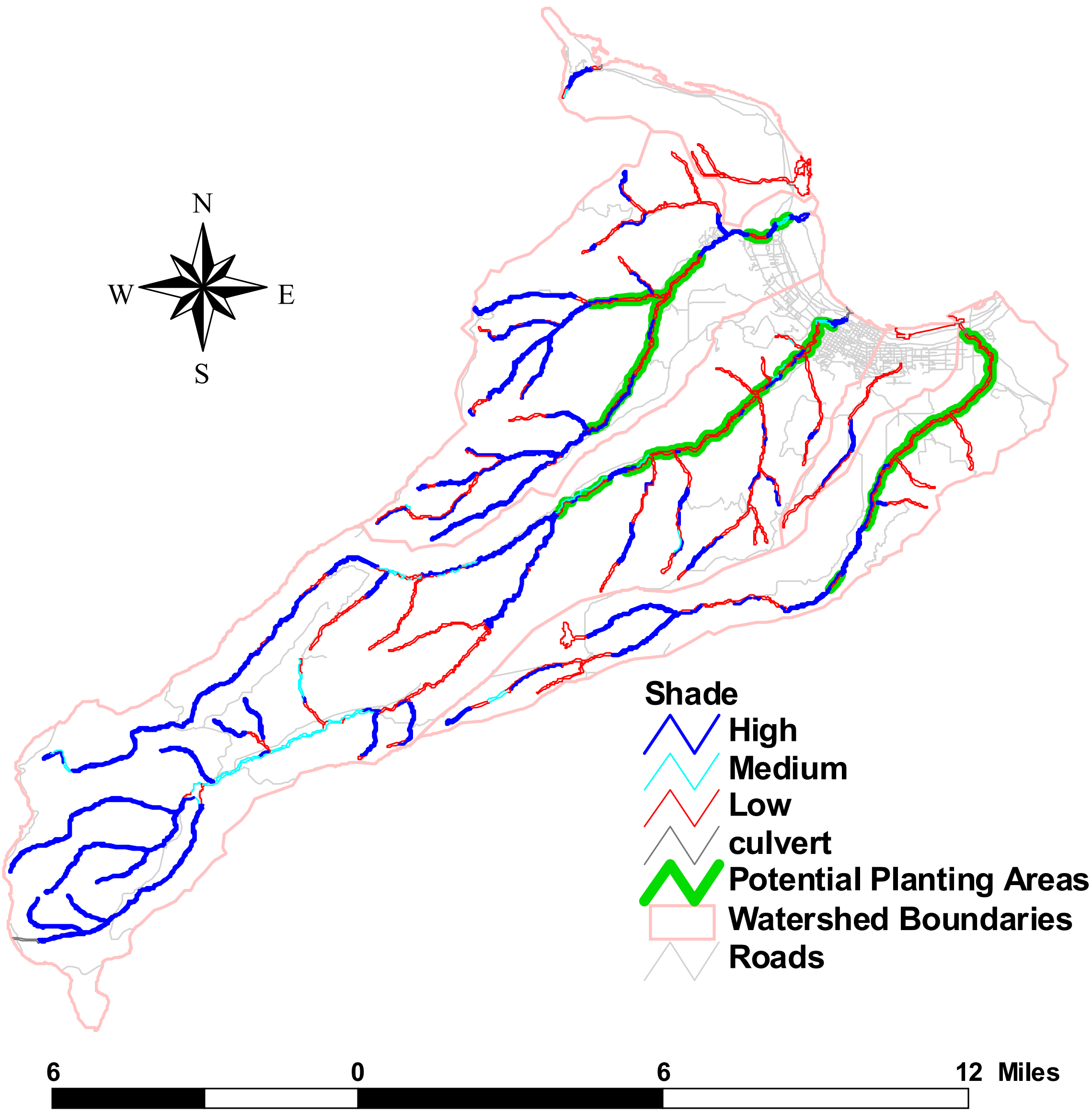
For this portion of the assessment, aerial photos and the CHT data layer was used to break the streams into sections in which the vegetation type, size, and density were similar. The sections, or Riparian Condition Units (RCUs), were differentiated for each bank separately. A distance of 100 feet from each bank was used as the riparian condition unit zone. The type of vegetation was determined from aerial photos and field verification. The vegetation types were classified as hardwood, conifer, hardwood/conifer mix, brush, and no vegetation. The amount of the stream visible in the photo was used to determine the amount of shade provided for the stream. Where more than 70% of the stream was covered the shade was labeled high, medium was 40% to 70% stream cover and less than 40% was considered low shade. Where possible, field verification was carried out to confirm the photo assessment. The type and density of the vegetation found along the stream was used in this component to determine the potential for LWD recruitment. Areas that had dense cover of large trees were determined to be the most likely to provide LWD. Those areas that had sparse cover or small trees or brush were determined to not be good LWD potential areas.

Discussion

The vegetation in the riparian areas consists mostly of a mix of conifers and hardwoods. Conifers occur on 30% of the stream bank length, hardwoods make up 25%, and mixed forest occurs along 26% of the stream banks. The remainder of the riparian corridor consists of non-wooded areas and brush.

Although there are trees within most of the riparian zones of the RCU’s, there are many places that the vegetation is not situated near the stream and is not available for shading (map 7.1). Much of the hardwood and mixed tree cover consists of small oaks, cottonwoods, alders, and willows, which do not provide much stream cover. High shade areas account for 47% of the stream length in the watershed, while 47% of the stream length has low shade. Just over 1% of the stream system runs through culverts. The remainder of the stream length has medium shade.

Map 7.1: Stream Shading and Potential Planting Areas. Source: 1995 Aerial Photos



For the most part, the high shaded areas are in the upper reaches of the streams with over half of the highly shaded reaches in USFS land, although there are a few scattered patches along the streams in this area that have been cleared of trees. Much of the low shade reaches occur in steep seasonal drainages that are comprised of grasslands or small oak trees with no natural riparian area. This is also true for most of the medium shade reaches. On the other hand, a large portion of the low shade reaches are in the lower parts of the watershed. These are due in large part to clearing for homes, pastures and agriculture. In these lower stretches of the streams, where there is more likely to be some water flow most of the year, shade would be expected due to large, naturally occurring willows, alders and cottonwoods (Watershed Professionals Network, 1999 – Ecosystem Appendix, Eastern Cascades Oak-Conifer Ecoregion).

Large Woody Debris (LWD) recruitment opportunity is low throughout the lower reaches of the streams in the watershed. This is primarily in the areas that have been cleared for agriculture and homes, or that were historically not wooded. Of the approximately 300 miles of stream bank, 54% have adequate LWD recruitment potential. Note that this is double the stream length as each bank is considered separately. The recruitment opportunity and shade availability are closely related, so reaches of streams with inadequate recruitment potential also have low shade availability. In some places this is not a concern, as some of these areas would not normally be expected to have shading or LWD in place. In other places, for shade and organic material inputs as well as bank stabilization and to create a buffer zone, plantings could be carried out to restore some riparian vegetation. Some of these areas are noted on map 7.1 as “Potential Planting Areas”.

Wetlands

Wetlands provide a means of storage, filtering, and slowing water movement during high flow events, and may provide habitat for fish or other aquatic life. Wetlands also provide a means of recharging the groundwater table, thereby helping to maintain streamflow in a channel that receives input from underground springs. The most effective wetlands for slowing and storing floodwaters are in the middle elevations. Here they are far enough from the stream to create a delay in the release timing and low enough to collect significant amounts of water (Roth, et. al., 1996).

Sediment, excess nutrients, and some toxins may be trapped in wetlands from the filtration process but this ability has limits as the wetland may be filled by sediment or become eutrophic from excess nutrients. The eutrophic condition is detrimental to fish and other aquatic life as well as potentially hazardous to humans.

Eutrophication occurs when there are too many nutrients such as phosphates and nitrogen from fertilizer runoff or natural sources. Algal blooms then become excessive and, since the algae are oxygen-using plants, they will deplete the dissolved oxygen in the water. As the wetlands become stagnant and nonproductive they become less aesthetically pleasing and may give off foul odors. Toxins can form and it is possible for these to eventually find their way into the water table that is used for drinking water.

A wetland is delineated by the soil type and plant species that exist in the area as well as by the amount of time annually that the area has a high water table or saturated soil. The soil in a wetland is termed hydric. This is a soil that shows the characteristics of being in anaerobic conditions (lacking oxygen) and is composed of fine particles and organic material. The deposition and standing water contribute to the making of a hydric soil. Some plant species are adapted to living in or near wet conditions and hydric soils. Some of these are cattails, rushes and willows. To be classified as a wetland, an area must have all three of the criteria of hydric soils, wetlands plants and saturated conditions for a part of the year.

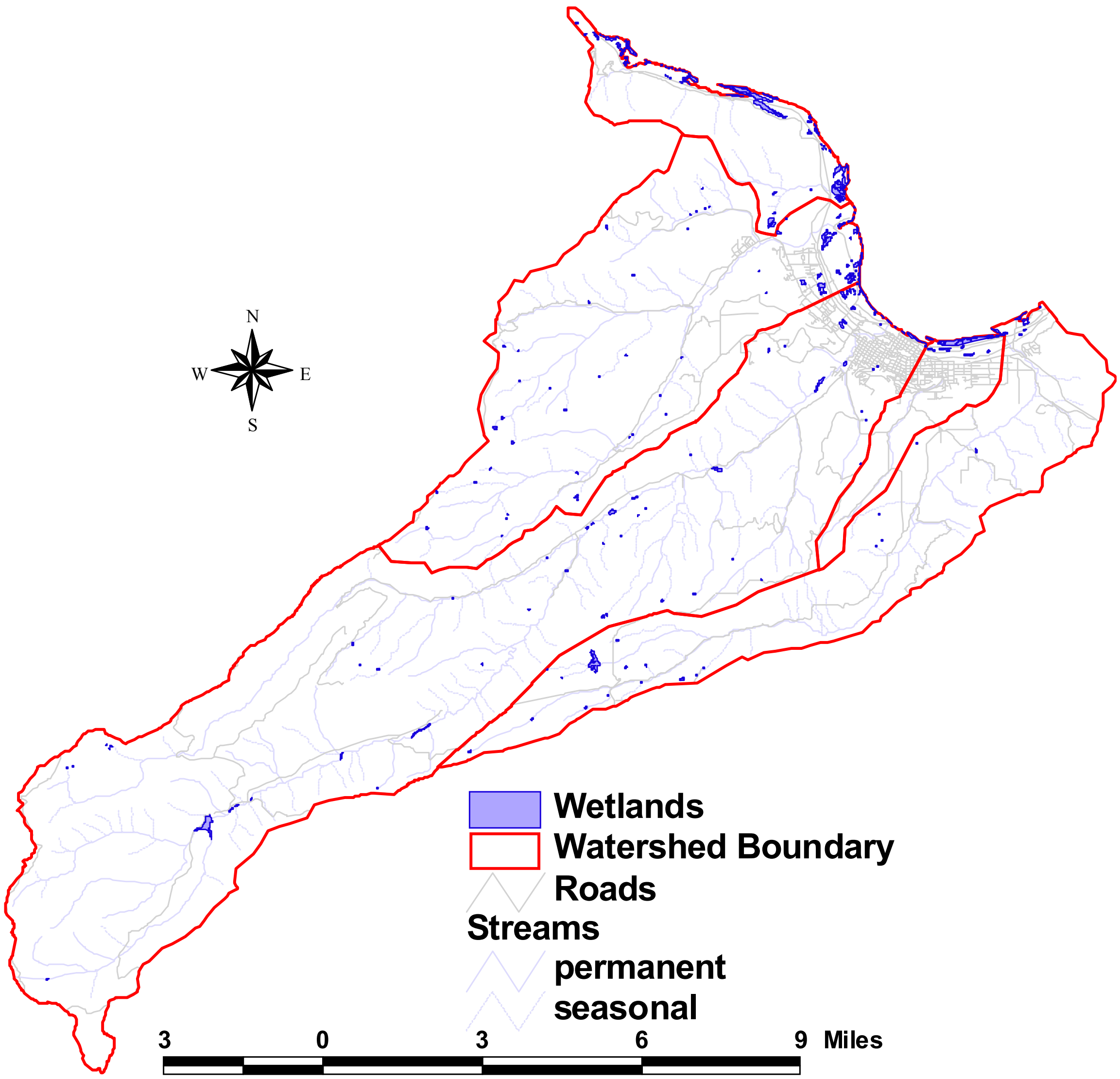
Methods

The wetlands data was obtained from the National Wetlands Inventory (NWI) and the existing streams data layer. The NWI data includes information regarding the type of wetland (constructed vs natural), vegetation, seasonality of the wetlands and hydric soil information. NWI data includes not just “swamps”, but also open water, such as reservoirs, farm ponds, lakes, etc. Wetlands information material was obtained from the Oregon Division of State Lands.

Discussion

There are 489 acres of wetlands in The Dalles Watershed (map 7.2). Of these, 169 acres are listed as being permanent, 56 are semi-permanent, 180 acres are seasonal, and 54 acres are listed as temporary.

Map 7.2: Wetlands. Source: National Wetlands Inventory



Much of the wetland area is along the Columbia River and at the mouths of streams. Most of the rest of the wetlands are in the middle elevations in Chenowith and Mill Creek watersheds. The majority of the wetlands are diked, which indicates that they may have been created or enlarged from springs or smaller existing wetlands. A small portion have been excavated, including farm ponds, sediment basins etc. Less than 20% of the wetlands may have all of the characteristics and functions of a naturally occurring wetland.

8) Sediment Sources

Sediment sources that were considered for this assessment are related to roads, land use practices, slope instability, and soil types.

Sediment in streams comes from soil erosion on uplands and stream banks. Streambank erosion may be due to side-to-side meandering of the stream or downcutting of the streambed. In a naturally functioning watershed there will be some sediment inputs due to these processes. Fine particles can obscure spawning beds and aquatic insect habitat. Suspended sediments also cloud the water, which prevents fish from feeding and may cause damage to the gills. Larger deposits or smaller deposits over an extended period of time may cause pool filling or spawning bed burial. Sediment deposition and stream channel modifications are natural processes as the stream is in a dynamic state and meanders within its floodplain. Adding or subtracting to this system by introducing additional sediment sources or preventing the channel movement may work against the natural processes.

Occasional high flow events can move large amounts of soil to the stream. This is often caused by a landslide on steeper slopes. Vegetative cover can be a factor in whether a slope will be resistant to landslides and erosion. The root systems of plants help to anchor the soil and once they are removed, the soil is more susceptible to wind and water erosion including mass land movement. Removal of the vegetative leaf cover will expose the soil to the effects of raindrop splash and wind erosion. Raindrop splash is the movement of sediment as it is thrown into the air by the force of the raindrops striking bare ground.

The building and use of roads can have a major impact on sediment movement into a streambed. The treatment of runoff from the road, including placement and proper sizing of culverts, water bars and drainage ditches, can contribute to or lessen sediment inputs. Water bars are raised sections of the roadway that divert water and prevent it from running down the traveled surface. If these features are not in place or not of sufficient capacity or frequency, sediment-laden water can enter adjacent streams or the road may fail, causing mass movement of soil downslope.

Cropland sediments

Methods

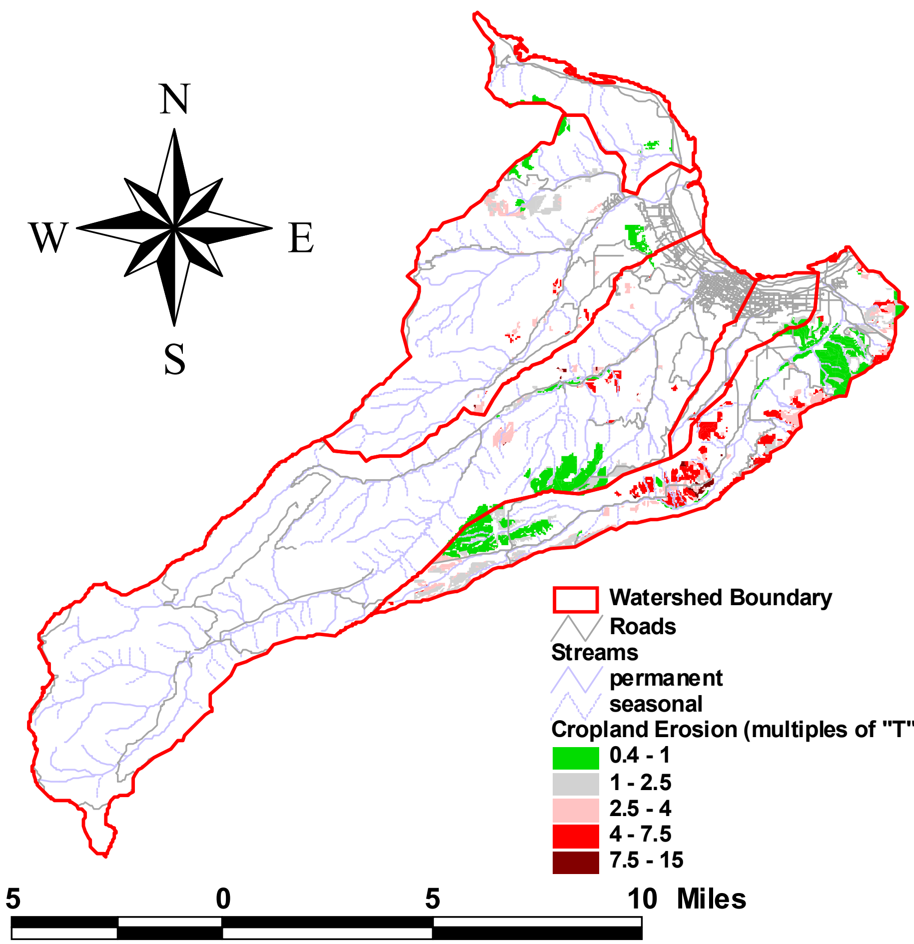
USDA soils data was utilized to determine the erodibility of the soils on croplands. In the Northern Wasco County Soil Survey, each soil type has an erodibility factor (K) assigned to it. The OWEB manual procedure was enhanced by using methods adapted from the NRCS Revised Universal Soil Loss Equation (RUSLE). RUSLE is an equation for soil loss through sheet and rill erosion processes on overland flow areas. In addition to the K factor, rain equivalent (Req), length of slope/steepness (LS), and cropland management (C) factors are used in the equation K x Req x LS x C = A (soil erosion in tons/acre/year). Req values relate to rainfall erosivity due to the amount and type of precipitation in an area, LS factors show the combination of slope and the average length of the slope, and C factors represents the crop and related soil disturbances associated with farming practices (NRCS Field Office Technical Manual). Using this method, "A" values were split into five classes: 0-2, 2-5, 5-10, 10-15, and 15 tons/acre/year and greater. The soil loss tolerance for deep soils in Wasco County is 5 tons/acre/year, while shallower soils have soil loss tolerances as low as 1 ton/acre/year. Soil loss tolerance ("T") is defined as the amount of erosion a field can experience without long-term loss of productivity. Five tons/acre/year is the standard in the proposed Lower Deschutes Agricultural Water Quality Management Area Rules (OAR-603-095-0640(2)(a)(C)). Those areas with erosion rates less than their soil loss tolerance.

<u>Discussion</u>

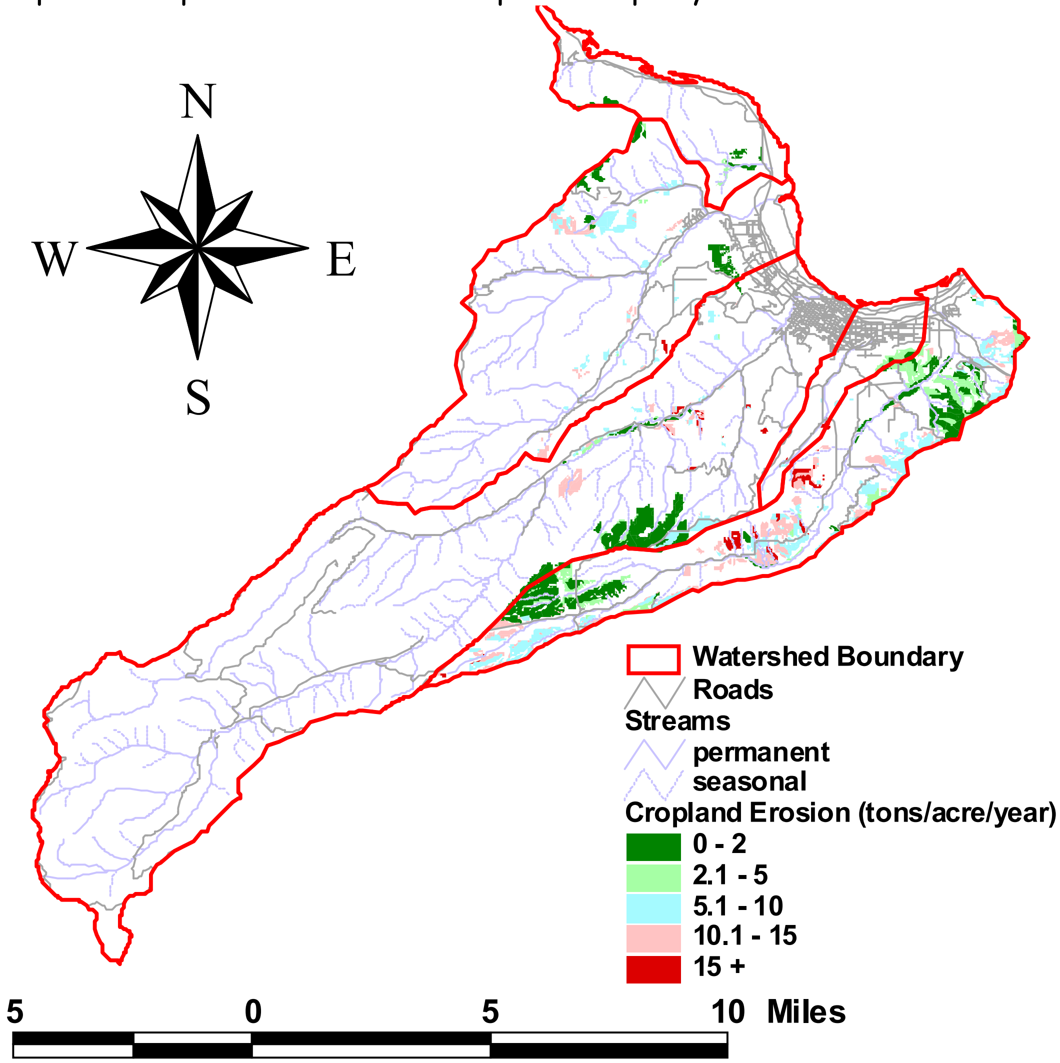
Croplands account for 7,184 acres in The Dalles Watershed. The erosion factors of the agricultural areas in the watershed show that 41% (2,945 acres) of the croplands have erosion rates less than their soil loss tolerance (map 8.1). Other fields are eroding at rates as high as 15 times their soil loss tolerance. 16% of all crop fields (1,153 acres) have average annual erosion rates more than 4 times their soil loss tolerance.

Map 8.2 shows erosion rates in tons per acre per year. The lower numbers are almost exclusively related to fields that are in CRP or no-till conditions. The higher values generally reflect minimum-till farming practices and higher rainfall amounts. Croplands under minimum tillage may also have low erosion rates if the land has a low slope.

Map 8.1: Cropland Erosion as a multiple of Soil Loss Tolerance ("T"). Source: USDA data.



Map 8.2: Cropland Erosion in tons per acre per year. Source: USDA data



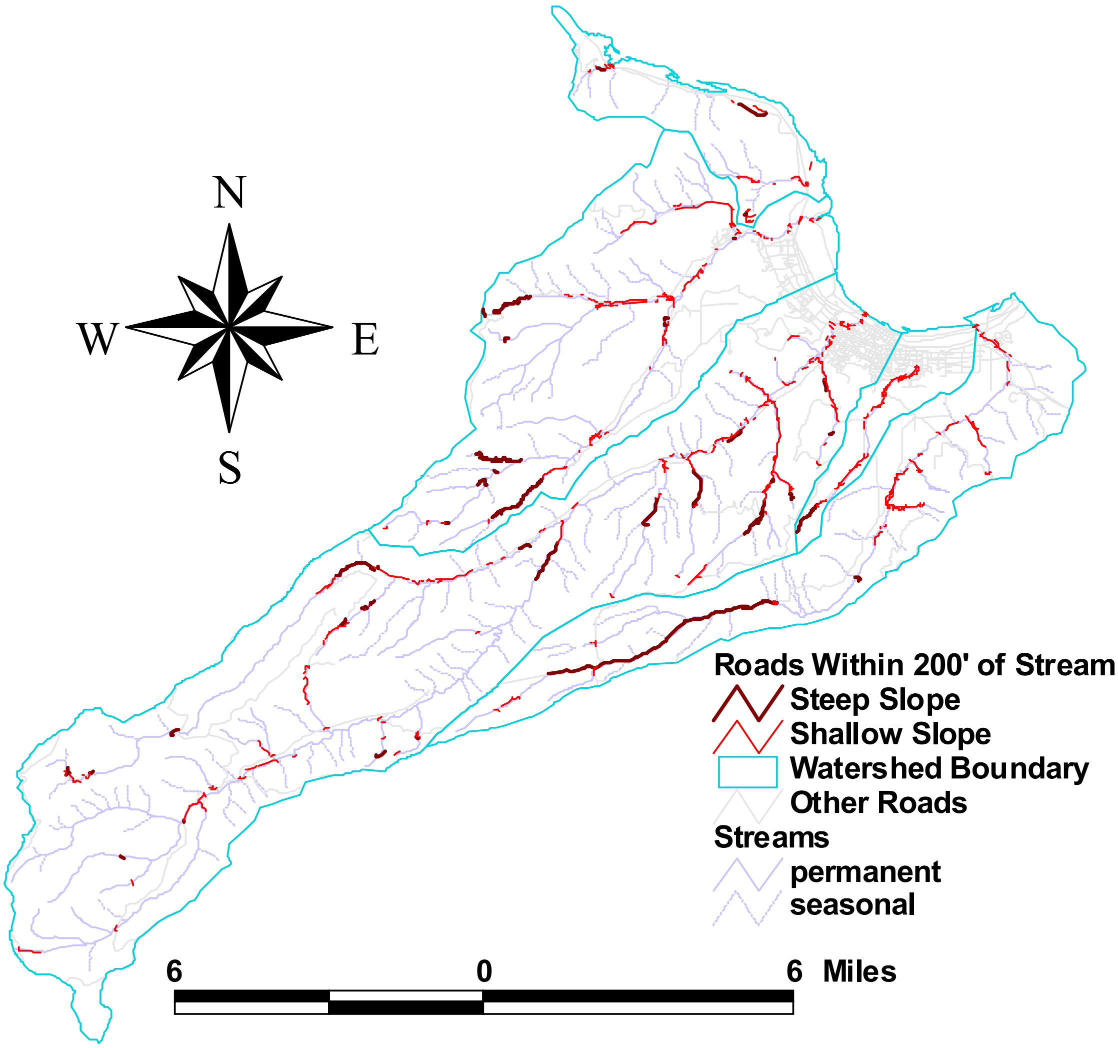
Road sediments

Methods

Sediment source areas were mapped by creating a buffer zone in the streams data layer that captured the land and roads within 200 feet of the stream. Buffers of 100, 50, 25, and 10 feet were also created to further pinpoint sediment potentials. The road data layer was then clipped to view just the roads within the 200-foot buffer zone. Sediment contribution potential for the roads was determined by the slope of the land in the riparian area. Those sections of riparian road that that are on land with more than a 50% slope were considered to have a high potential for sediment entering the stream. Roads were not surveyed for condition or surface type.

Points where roads cross streams were inventoried. These points were not surveyed to determine what type of crossing was installed at that point, nor its condition.

Map 8.3: Riparian Roads. Source: 1995 Aerial Photos and USGS Topographic Maps



<u>Discussion</u>

There are a number of riparian roads that can be considered potentially high sources of sediment to the streams. Of the 67.5 miles of riparian roads, 27% (18.18 miles) are on steeper slopes and therefore considered high risk for sediment contribution to the streams. Mill Creek had the most high-gradient roads, with 29.9 miles of the roads on steep gradients (map 8.3). A number of the roads on these steeper gradients have a low volume of traffic. Therefore, these figures may not reflect the actual amount of sediment that enters fish-bearing streams except during storm events. Many of the riparian roads along the more heavily traveled corridors are paved and situated on more moderate slopes.

There are 218 stream crossings in the watershed. Almost half of these are in the Mill Creek watershed and most of the rest are in Chenowith and Threemile. There are 59 crossings in the reaches of streams that have been identified as fish bearing. Many of these are bridges but the actual numbers have not been verified. Ninety-six of the crossings are on roads that are traveled on a regular basis. The remaining 122 are on private drives, jeep trails, or in forested areas.

9) Channel Modification

Channel modification describes areas that have had structures placed in the stream to divert or contain it. Some of the modifications are diversions, channelization, and dams.

Diversions are used to take water from the stream for municipal, agricultural, commercial, or residential uses. Examples include ditches, canals, and pipelines. Channelization is the practice of straightening and/or deepening a stream channel by adding armor to the streambank or constructing a dike so that the channel cannot meander. Straightening a channel will increase the velocity of the stream and can lead to scouring of the streambed and bank destabilization. Natural causes such as an unusually large flood flow can lead to downcutting also, which has the same effect as intentional channelization. Dams create reservoirs generally for storage or power generation. They may reduce stream flow below the structure and they trap sediment in the reservoir. Dams may be fish passage barriers if they are not equipped with ladders and screens. Dams may also be used to stabilize stream flows by releasing flood storage during the summer months, as is done in the South Fork Mill Creek with Crow Creek Reservoir. Although this is primarily for reliable flow to the water treatment plant, it has also made some very nice habitat conditions for fish and wildlife.

Restoration activities often include the use of LWD or large boulders for channel modifications to return a stream to a more natural state. These practices are used to create meander, pools, and to encourage the deposition of sediment.

<u>Methods</u>

Channelization was determined based on landuse data and aerial photos. A portion of a stream that didn't appear to follow the contour lines or was associated with a homestead, road, or cleared field is an example of one that may have been channelized and/or armored.

Points of diversion are one common type of channel modification that occurs over too short of a distance to identify on an aerial photo. The points of diversion were obtained from Oregon Water Resources Department, which does not classify the points by the type of diversion. Points of diversion may include wells, dams, pumps, and irrigation diversions. Placing the data into the GIS layer with the streams data and using aerial photos, a best guess was made about each point of diversion as to whether it was a dam with or without a reservoir, in or near a stream, or within a wetland. A point that was in the uplands and away from the stream, and not associated with a wetland, was assumed to be a well. Some of the points were verified by field observations.

<u>Discussion</u>

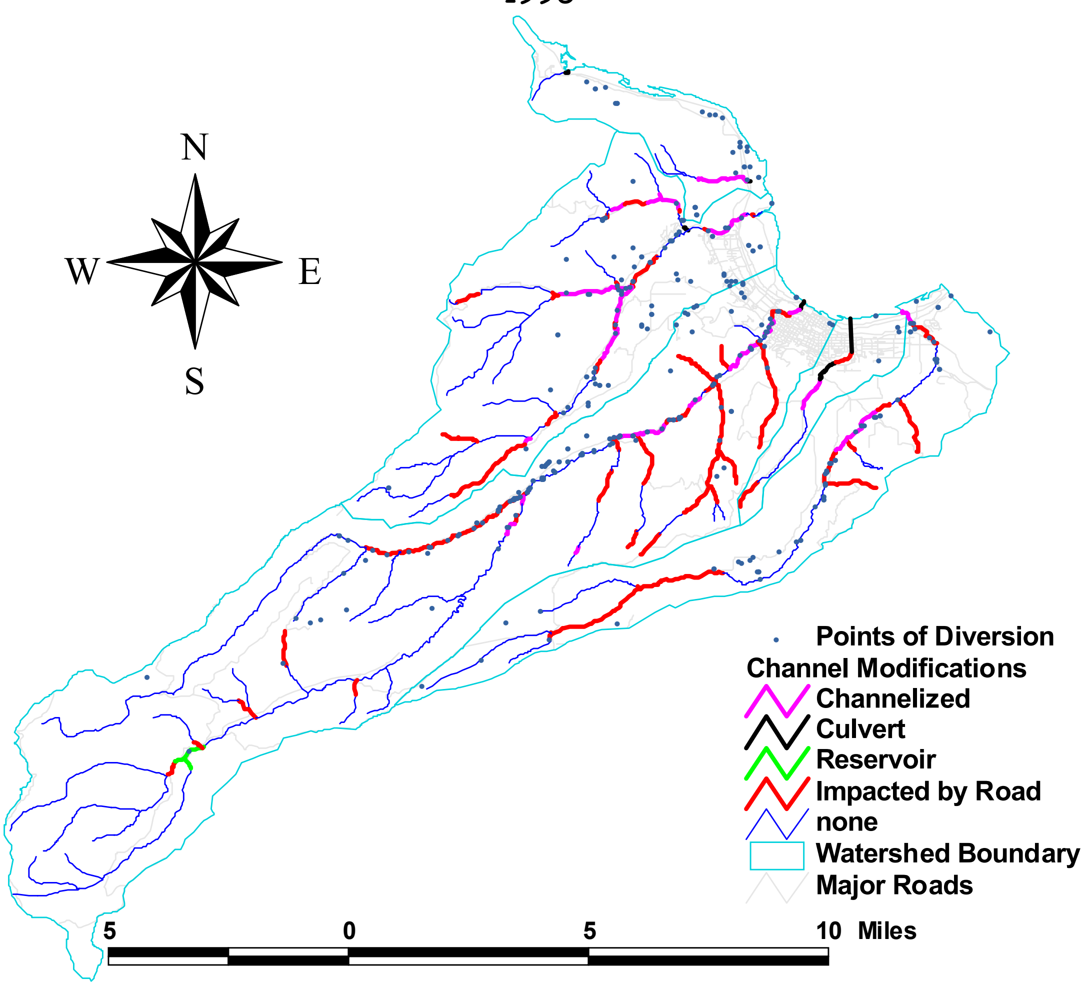
Generally, the most common modification is channelization due to road construction. Dry Hollow had the highest percentage of modified channels (table 9.1). 25% of the channel of Dry Hollow has been diverted into culverts or the city storm sewer system, and 14.5% have been channelized. Threemile Creek had the second highest percentage of modified channels. 38% of the channels in Threemile have been channelized to some extent by road construction. Roughly 30% of the channels in Mill Creek, Chenowith Creek and Rowena have been modified in some manner.

Table 9.1: Modified Channels (in miles) by Subwatershed. Source: Aerial Photos, 1995.

	Channelized due to Road	**Channelized for other reasons**	**Culverts**	**Flooded by Reservoir**	**Unmodified**	**TOTAL**
Threemile *%*	8.8 *38.0%*	1.7 *7.3%*	*	*	12.6 *54.6%*	**23.1**
Chenowith *%*	6.1 *16.6%*	5.7 *15.3%*	0.1 *0.3%*	*	25.0 *67.8%*	**36.9**
Dry Hollow *%*	1.1 *22.6%*	0.7 *14.5%*	1.3 *24.6%*	*	2.0 *39.3%*	**5.1**
Mill *%*	19.3 *24.0%*	3.8 *4.7%*	0.2 *0.2%*	0.9 *1.1%*	56.1 *70.0%*	**80.3**
Rowena *%*	0.0 *0%*	1.1 *25%*	0.2 *4.5%*	*	3.1 *70.5%*	**4.4**
Total ***% Total***	**35.3** ***23.6%***	**13.0** ***8.7%***	**1.8** ***1.2%***	**0.9** ***0.6%***	**98.8** ***66.0%***	**149.8**

*not totaled

Map 9.1: Modified Channels in The Dalles Watershed. Source: Aerial Photos, 1995



There are 377 points of diversion, 240 of which are located far from streams and thus probably represent wells (map 9.1). Of those near streams, 79 are clearly in the stream, while 51 are near to the stream and may or may not represent surface water diversions. 4 points of diversion are from a pond or wetland and 3 represent dam sites. Some of the instream points may be dams as well but this was not confirmed.

The three dams identified were Crow Creek Dam, Evans Reservoir, and a dam about 3 miles up the stream in the Threemile drainage. None of the dams have fish passage structures in place. Evans Reservoir is located on Dutch Flat, upstream of all known fish presence. Crow Creek Reservoir is 3 miles upstream of Mill Creek Falls, a natural barrier to anadromous fish. The dam on Threemile Creek might be a migration barrier during critical times of the year.

The diversion on the South Fork Mill Creek that supplies the Wicks Water Treatment plant has recently had a fish screen installed to protect the downstream passage of fish and a fish ladder is planned for construction in 2002 for upstream travel.

The City of The Dalles has undertaken a program of removing known fish passage barriers on Mill Creek, as opportunity and funding arises.

10) Water Quality

This chapter identifies water quality concerns in The Dalles Watershed based on available information. Concerns about the quality of the water in streams in the Watershed are based on concerns about the potential impacts on the beneficial uses in the Watershed. The designated beneficial uses listed for the waters in The Dalles Watershed are: public and private domestic water supply, industrial water supply, irrigation, livestock watering, anadromous fish passage, salmonid fish rearing, salmonid fish spawning, water contact recreation, aesthetic quality and hydro power (OAR 340-41-522).

Aquatic life, particularly salmonid spawning and rearing, is considered one of the most sensitive beneficial uses. Water quality parameters which can have a significant impact on aquatic life include temperature, dissolved oxygen, sediments and toxics. In the Mill Creek Watershed, public water supply is also an important beneficial use to consider since Mill Creek provides drinking water for the City of The Dalles. Water quality parameters which can have an effect on human health and consumption include pathogens, turbidity, minerals and toxics.

The Oregon Department of Environmental Quality (DEQ) is required by the Federal Clean Water Act (1972) to establish water quality standards to protect the beneficial uses of the State's waters. Based on the water quality standards, DEQ is then required to: identify stream segments where the standards are not being met; develop a list of these water-quality limited water bodies (called the 303(d) list from Section 303(d) of the Clean Water Act); and develop a Total Maximum Daily Load (TMDL) allocation for each water body included on the 303(d) lists. The TMDL describes the maximum amount of pollutants (from all sources) that may enter a specific water body without violating water quality standards. The most recent 303(d) list for Oregon that has been approved by EPA is dated 1998, although a 2002 list is currently out for public review and will be released before the end of 2002.

In 1998, none of the streams in The Dalles Watershed were included on the 303(d) list. Data collected since 1998 has resulted in the inclusion of several streams on the draft 2002 303(d) list (Table 10.1). A TDML for stream temperature in the The Dalles Watershed area is slated for completion in 2003. Streams in the The Dalles Watershed were not listed for other parameters, either because of lack of data, or because the data showed that listing was not warranted.

Table 10.1: Water Quality Limited Streams in The Dalles Watershed (DEQ draft 303(d) list, 2002)

Stream Segment	Listed Parameter (season)	Criteria
Chenowith Creek	Temperature (summer)	Salmonid Rearing (64°F)
	Temperature (October 1-June 30)	Salmonid Spawning (55°F)
Mill Creek	Temperature (summer)	Salmonid Rearing (64°F)
	Temperature (October 1-June 30)	Salmonid Spawning (55°F)
South Fork Mill Creek Creek	Temperature (summer)	Salmonid Rearing (64°F)
Threemile Creek	Temperature (summer)	Salmonid Rearing (64°F)
	Temperature (October 1-June 30)	Salmonid Spawning (55°F)

Temperature

The most commonly documented water quality problem in the state of Oregon is temperature. Elevated water temperatures are detrimental to cold water fish species and other aquatic life. Elevated temperatures can kill fish directly through the breakdown of physiological regulation of vital bodily processes such as respiration and circulation (Heath and Hughes, 1973). The most common and widespread cause of thermally induced fish mortality, however, is attributed to indirect effects, such as: interactive effects of decreased or lack of metabolic energy for feeding, growth or reproductive behavior; increased exposure to pathogens (viruses, bacteria and fungi); decreased food supply (impaired macroinvertebrate populations); and increased competition from warm water tolerant species (Brett, 1952; Hokanson et.al., 1977). Cold water fish include trout, salmon and steelhead, all of which are present in the The Dalles Watershed. Warm water fish include bass and carp, non-native species found in the Columbia River, as well as the native, northern pike minnow.

Stream temperature is affected by a number of factors, such as climate, geographic location, the temperature of the groundwater and springs feeding the streams, stream flow volume, stream morphology, and levels of shade afforded by streamside vegetation. While climate and geographic location are outside of human control, riparian condition, channel morphology and stream flow volume are affected by land use activities. Specific land use activities which can increase summertime stream temperatures in The Dalles Watershed include:

- Riparian vegetation disturbance reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface;
- Reduced summertime stream flows from in-stream withdrawals for irrigation or domestic water supply;

- Localized channel widening increases the stream surface area exposed to solar radiation
- Impoundment of water behind dams alters the natural thermal profile of the water downstream of the dam depending on how and water is released from the dam.

Given that a stream is fed by a spring with a fairly steady year-round temperature, water will heat up more the longer it is exposed to air and sunlight. A stream with lower flows or less shade will heat faster than a stream with higher flows or more shade. In addition, channel morphology affects the rate of heat transfer. Given the same volume, a wide, shallow stream will heat faster than a narrow, deep stream, due to the greater surface area exposed to air and sunlight. Lateral erosion during a high flow event can create wide, shallow stream channels with minimal vegetation, and thus cause an increase in the summer temperature of the stream. Recovery occurs over time as riparian vegetation is reestablished, reinforcing the banks and narrowing the active channel.

Temperature Standard

The stream temperature standard is designed to protect cold water fish rearing and spawning as the most sensitive beneficial use. Several numeric and qualitative trigger conditions invoke the standard. Numeric triggers are based on temperatures that protect various salmonid life stages, such as 64^{o}F for salmonid rearing and 55^{o}F for salmonid spawning, egg incubation and fry emergence. The salmonid spawning period is defined as occurring from October 1-June 30 in the portion of the Hood Basin which includes The Dalles Watershed (DEQ, 2002). These numeric triggers are based on a seven-day moving average of the daily maximum temperatures. The use of this type of average recognizes that fish can likely tolerate a day or two of higher temperatures, as long as elevated temperatures are not sustained for a longer period of time (such as a week).

Qualitative triggers specify conditions that deserve special attention, such as the presence of threatened or endangered cold water species, dissolved oxygen violations and/or discharge into natural lake systems. The occurrence of one or more of the stream temperature triggers will invoke the temperature standard.

Once the temperature standard is invoked, a water body is designated as water quality limited for temperature (Table 10-1). For such water quality limited water bodies, the temperature standard specifically states that "no measurable surface water temperature increase resulting from anthropogenic activities is allowed" (OAR 340-41-525(2)(b)(A). In the development of a TMDL for temperature, the natural thermal dynamics of the system and anthropogenic contributions to stream heating are assessed.

Methods

The Wasco County SWCD, DEQ, The Dalles Public Works Department, and the Mount Hood National Forest (MHNF) have collected summer temperature data in The Dalles Watershed since 1999 or earlier (Table 10.2)

Table 10.2: Temperature Monitoring Locations in The Dalles Watershed

Stream	Location	Monitoring Organization	Years
Chenowith Creek	Near mouth	DEQ	1999-2000
Mill Creek	Above 6th Street bridge	SWCD with The Dalles High School	1999-2001
	4 miles upstream from mouth	SWCD with The Dalles High School	1999-2001
North Fork Mill Creek	Near mouth	DEQ	1999
South Fork Mill Creek	Near mouth	DEQ	1999-2000
	Above Wicks treatment plant	The Dalles Public Works	1996-2000
	Downstream Crow Creek Reservoir	MHNF	1994-1996, 1999-2001
	Upstream Crow Creek Reservoir	DEQ/MHNF	1999-2000
Crow Creek	Near mouth above Reservoir	DEQ/MHNF	1999-2000

Discussion

Charts 10-1 through 10-3 show 1999 and 2000 data for Chenowith Creek, Mill Creek and Threemile Creek. These figures demonstrate that the summer temperatures in Chenowith Creek and Threemile Creek exceed the salmonid rearing criterion of 64^{o}F at all sites for some portion of the year. It also shows that the salmonid spawning criterion of 55^{o}F was exceeded in these creeks at all sites for some portion of the spawning period (October 1-June 30). In Mill Creek, salmonid rearing and spawning criteria were exceeded at sites in the lower portion of the watershed, while those sites at higher elevation near Crow Creek Reservoir did not exceed either criteria.

It is interesting to note that the temperatures in Mill Creek were lower at the Sixth Street site than they were further upstream. The same is true to some extent in Threemile, with temperatures at Hwy 197 somewhat lower than those further up the creek at Steele Rd. In general, temperatures tend to increase as one goes downstream. The reverse heating pattern observed in the lower reaches of Threemile Creek and Mill Creek may be due to the influence of underground springs with a constant, cooling temperature. Dave Anderson, City of The Dalles Water Quality Manager, suggested that natural springs may be feeding into Mill Creek through the storm drains (The Dalles Watershed Council, 10/15/02). All of the areas monitored for temperature in the lower portions of the watershed coincide with low shade conditions found in the RCU section of this assessment.

Chart 10.1: Stream temperatures in Threemile Creek. Source: DEQ and SWCD.

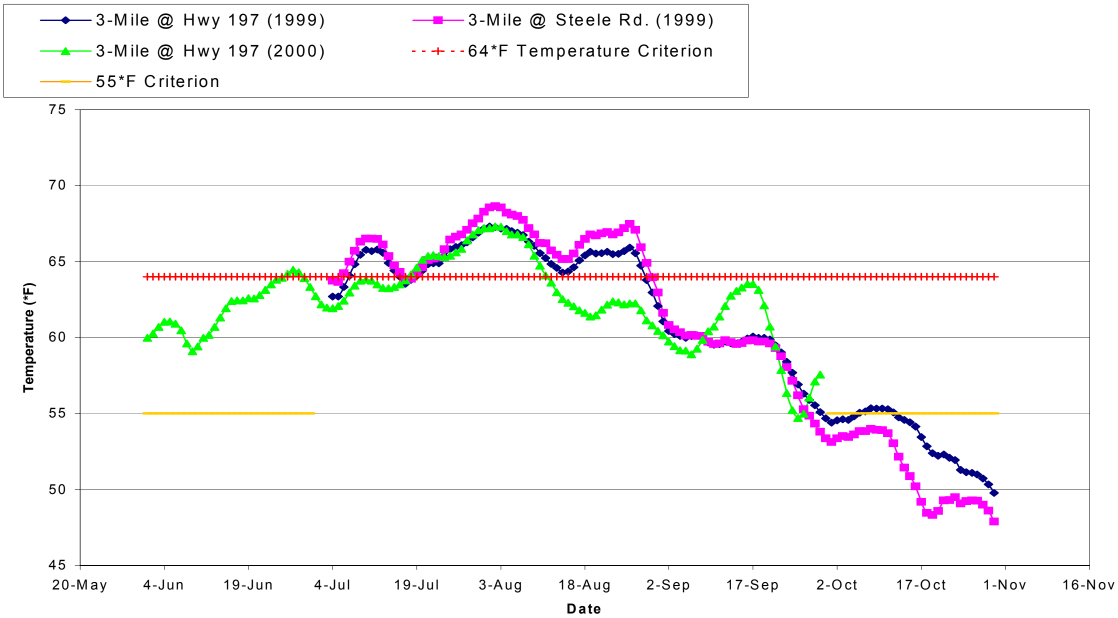


Chart 10.2: Stream temperatures in Mill Creek. Source: DEQ, MHNF and SWCD.

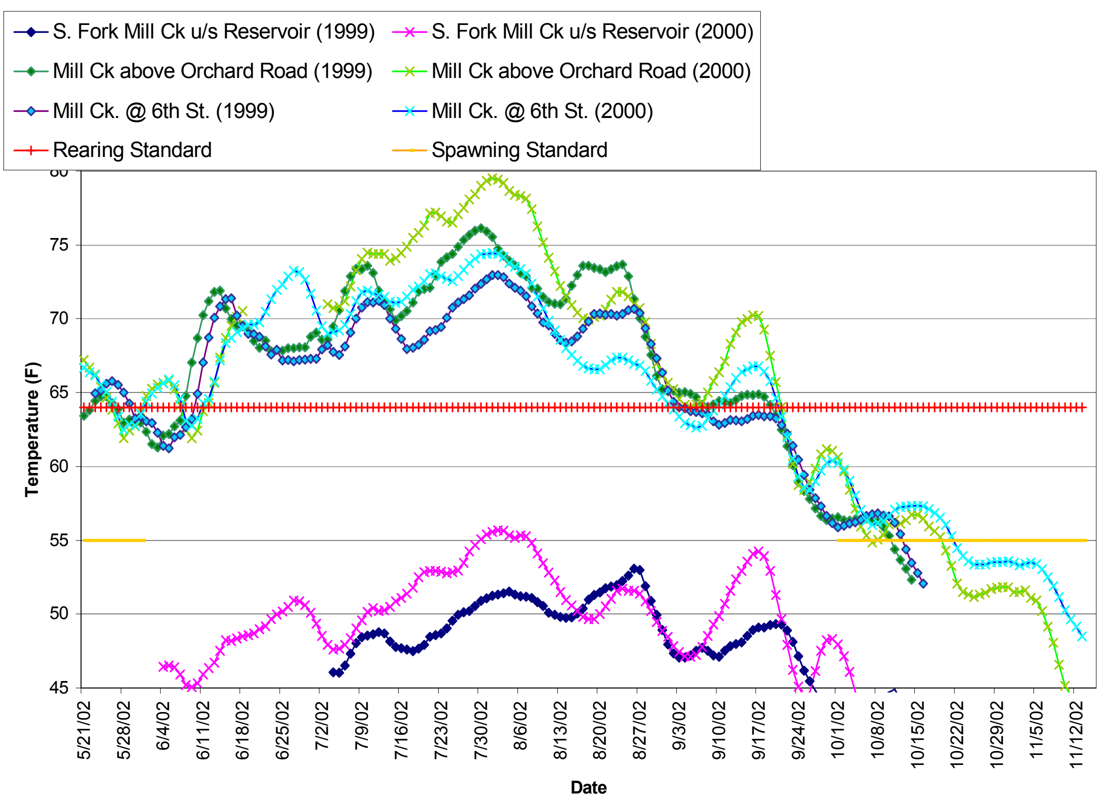
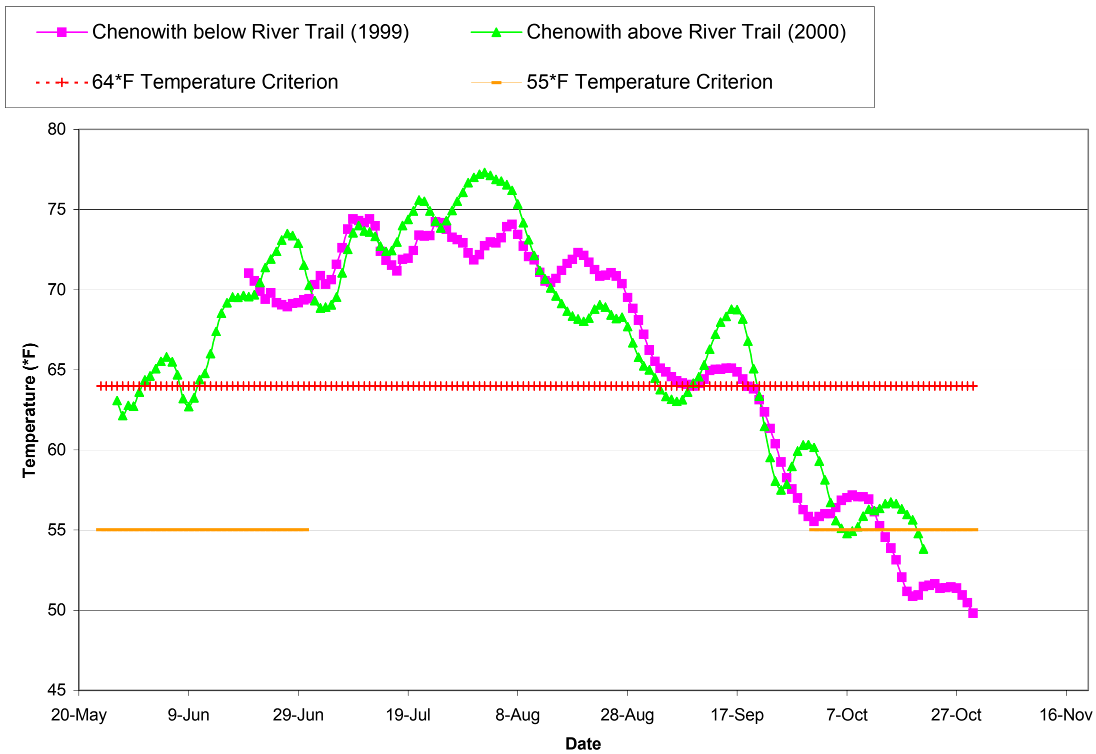


Chart 10.3: Stream temperature in Chenowith Creek: Source: DEQ



Turbidity

Turbidity is a measure of water clarity using light penetration through a water sample. In many streams, turbidity can serve as a surrogate for measuring suspended sediment. Sediment is a water quality parameter of concern because of the effects it can have both on aquatic life and human health. Suspended sediment can interfere with the sight-feeding ability of fishes and can damage gill tissue. Deposition of sediment can fill in pools or gravel interstices and affect salmonid incubation and invertebrate communities. Fish require clean gravels to spawn. They lay their eggs in the gravel, in riffles, where the oxygenated water can flow through the gravel, and the eggs and fry can breath. Where excess sedimentation has occurred, fry may die of asphyxiation. Suspended sediment can also carry other pollutants and may interfere with other beneficial uses such as recreation, irrigation, drinking water quality, and aesthetics.

The state standard for turbidity (DEQ 1999) specifies that: "…no more than a ten percent cumulative increase in natural stream turbidities as measured relative to a control point immediately upstream of the turbidity causing activity." This standard is useful when assessing a point source (i.e. end of pipe) discharge, but does not fully address nonpoint source (i.e. runoff) concerns. The Oregon Watershed assessment manual recommends using an evaluation criteria of 50 NTU as the level at which sight feeding of salmonids is negatively affected.

The only turbidity data collected to date was data collected by the Wicks Water Treatment Plant on the South Fork Mill Creek above the plant. In addition to turbidity and temperature data, pH and color were also collected at this site from 1996 to 2000. A turbidity monitoring program is planned for The Dalles watershed during the winter of

2002/2003. The Dalles Watershed Council will collect turbidity samples in winter 2002-2003 at two site on Mill Creek and four sites on Chenowith Creek, specifically targeting winter storm events. The goal of this monitoring program is to begin to collect baseline turbidity samples for the watershed and assess the impacts, if any, of the Sheldon Ridge fire.

Because little data has been collected to date, only the Wicks Water Treatment Plant data was evaluated in this assessment. With the exception of the extremely high flows seen in the storm event of February 1996, turbidity at this site was within acceptable limits both as a water supply and for support of salmonids. The increases of turbidity at this site appear to be associated with natural occurrences and probably fit into the stream's equilibrium at that site. The large increase in turbidity in February of 1996 (chart 6.1) contributed to the water treatment plant being taken offline until flows had fallen.

Pesticides

In April of 2002 the Wasco County Fruit and Produce League (WCFPL) initiated pesticide monitoring in Mill Creek. The monitoring is to assist the WCFPL in evaluating the effectiveness of their Integrated Fruit Production (IFP) practices in reducing the broad spectrum organophosphates that are used as pesticides. Another object of the monitoring is to evaluate the direct effects of the pesticides on the fisheries. The monitoring will consist of water sampling, analyzing macroinvertebrates and tissue samples from caged hatchery steelhead. DEQ will analyze for a total of 24 pesticides.

11) Fish and Fish Habitat

Salmonids (includes salmon, trout and steelhead) are typically the fish species most sensitive to habitat condition changes. As such, they serve as an indicator of watershed functions. The distribution of salmonids (map 11.1) reflects the habitat conditions of the various reaches of the streams in the watershed. Channel Habitat Types (CHT's) are a good indication of where fish populations may naturally be found. Upper reaches with steep gradients are not likely to provide good spawning or rearing habitat for fish. Barriers to fish passage will limit the range of anadromous fish (those that migrate to the ocean and back). The reaches of streams above barriers like waterfalls or dams are areas where only resident populations will be found.

Some of the fish found in The Dalles Watershed include cutthroat trout (*Oncorhynchus clarki*), resident rainbow and winter-run steelhead trout (*Oncorhynchus mykiss*), sculpin (*Cottidae*), and other nongame fish. Coho salmon (*Oncorhynchus kisutch*) and chinook salmon (*Oncorhynchus tshawytscha*) often enter the lower reaches of some of the streams but are not believed to range into the upper reaches (ODFW, pers. comm. 2002). The cutthroat trout in Mill Creek are believed to be primarily resident fish but anadromous individuals may be present below Mill Creek Falls.

Steelhead trout are included in the Mid Columbia evolutionary significant unit (ESU) and have been listed since 1998 as a threatened species under the Endangered Species Act (ESA). Cutthroat trout are a state sensitive species and were considered for protection under the ESA in Southwest Washington and the Lower Columbia River. In 2002 the US Fish and Wildlife Service decided that listing is not warranted at this time.

Steelhead trout life history information for the streams of The Dalles Watershed is scanty but an extensive amount of information has been collected in the Hood River Basin, approximately 20 miles to the west. This information is assumed to be similar to conditions in The Dalles (ODFW, pers. comm. 2002). Winter steelhead adults enter the Hood River in mid winter through early spring and spawning generally occurs from March through mid-June. The juvenile steelhead spend from one to four years rearing before migrating to the ocean as smolts in the spring. The majority of the adults spend from two to three years in the ocean before returning to spawn. A limited number of fish survive spawning to return as repeat spawners. Cutthroat trout probably spawn in the spring and the anadromous individuals typically return in the late fall.

Discussion

Map 11.1 shows the known distribution of anadromous and resident fish. Data was obtained from the ODFW from fish surveys in Mill and Threemile Creeks and from the Oregon Department of Forestry (ODF) on fish distributions in Chenowith and Threemile Creeks, and the Mill Creek Watershed. ODFW personnel took samples by electrofishing in the streams of the Mill Creek drainage and Threemile Creek. Surveys were also done by ODFW in Crow Creek reservoir by gill netting. Winter steelhead spawning data was obtained from Mount Hood National Forest report of 2002.

Chenowith Creek

Fish distribution in Chenowith Creek has not been extensively studied, but appears to be limited by the extent of perennial flow. Neither Brown's creek, nor Chenowith Creek upstream of the confluence with Brown's Creek are perennial streams, and fish have not been documented in these reaches. On the other hand, steelhead have been noted spawning near the mouth of Chenowith Creek (personal observation, 2002).

Threemile Creek

ODFW personnel conducted a field inventory at three sites in Threemile Creek on December 2, 1986. The sites were at river mile (RM) 0.25, RM 2.25, and RM 3.5. The sample areas were 100 feet in length, 200 feet, and 300 feet, respectively. All fish were released alive after identification. In all, a total of 87 salmonids were captured between the three sites, with 44% of these found in the lower site, one-quarter of a mile from the mouth at the Columbia River. There were also 12 nongame fish found at the lower site but none occurring upstream. It was found from the sampling that cutthroat trout were the most numerous species in lower Threemile Creek but some adult coho salmon spawn in the lower portions. These populations appeared to be strong and self-sustaining. Due to the populations found in the survey of 1986 and the land uses along the stream, the sampling team was of the opinion that Threemile Creek is worthy of vigorous habitat protection. (ODFW 12/1986)

Mill Creek

High quality spawning and rearing habitat is limited throughout most of the Mill Creek basin as well as in the rest of The Dalles Watershed. This is the result of several anthropogenic factors including urbanization, agriculture, and forest practices. These activities can contribute to a loss of riparian vegetation, particularly large trees, and stream modifications. Some of these modifications may reduce stream cover and help to destabilize stream banks. This can add to warming of the water above optimum rearing and spawning temperatures and to sedimentation of spawning and feeding areas.

The South Fork Mill Creek from the Wicks Water Treatment Plant diversion upstream to the Mill Creek Falls has some of the most pristine habitat conditions in the Mill Creek Watershed. Flow augmentation from Crow Creek Reservoir ensures excellent summer baseflows. Improved fish access into this habitat will likely increase the production of salmonids within the basin.

Eight areas in Mill Creek and the South Fork Mill Creek were sampled in 1984 by the ODFW for fish presence and abundance. One site was above the Crow Creek reservoir, two were above the Mill Creek Falls, four sites were between the falls and Wicks Reservoir on the South Fork, and one site was in the main stem of Mill Creek below the confluence of the North and South Forks.

All of the sites, except the two nearest downstream from the Crow Creek reservoir, showed good to fair populations of rainbow trout, cutthroat trout, and sculpin. The site closest to the Reservoir on the downstream side showed no fish at all and the next site, four miles downstream, showed just one cutthroat trout and seven sculpin.

On the North Fork Mill Creek in the National Forest area, personnel from the Mount Hood National Forest (MHNF) reported finding steelhead in 2002. In addition to finding 8 adults at about river mile seven, there were also 3 redds (gravel spawning nests) and 2 additional redds at about river mile nine (MHNF).

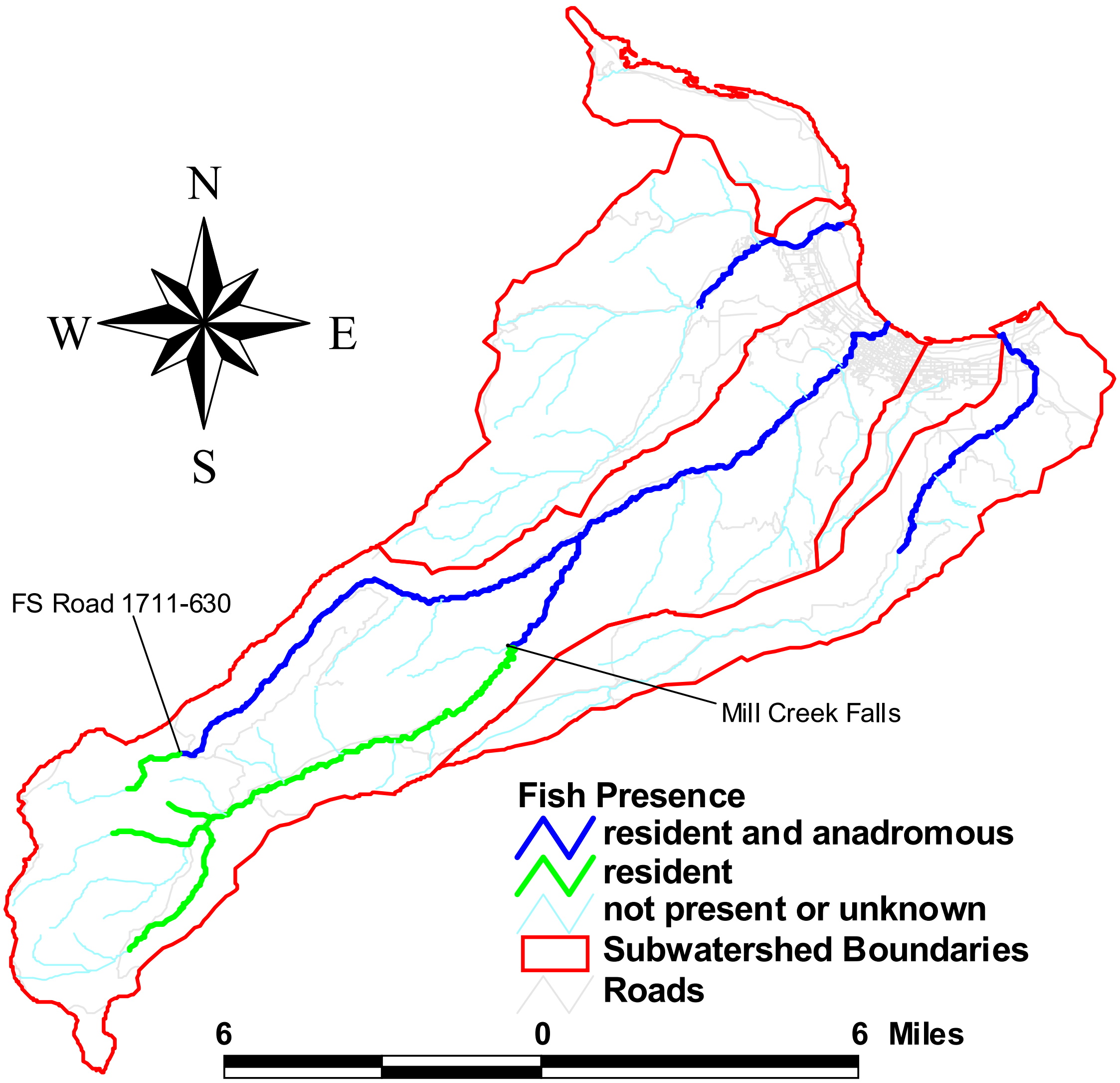
The larger trout collected downstream from Crow Creek Reservoir had a poor body condition for their age group. While no apparent reason was visible for the condition it is possible that it was from repeated, long-term exposure to copper sulfate. At that time it was suggested that the use of copper sulfate for algae removal in the Crow Creek Reservoir might have contributed to the elimination and continued depression of fish populations below the reservoir. Other possible causes include disease, parasites, or the rigors of spawning. (ODFW 1/10/84)

On April 24, 1989, gill nets were used in John's Mill Lake, more commonly known as the Crow Creek Reservoir, to sample the fish population. The bulk of the trout among those captured were small, with only five of the 68 individuals exceeding 11 inches in length. The fish were also very slender with the 66 fish samples yielding an average condition factor of 0.82. This is considerably lower than the optimum condition factor of 1.00 to 1.20 for cutthroat trout.

On August 22, 1989, a follow-up sampling of the fish population in Crow Creek Reservoir was taken. A total of 26 cutthroat trout were found and, was the case in April, the population consisted of small, rather slender fish. In this sample, 7.7% of the fish were over 11 inches compared to 7.4% in the previous sample. The average condition factor was 0.89, which is not significantly higher than the 0.82 of the previous sample. The length frequencies of the captured fish indicated that their growth rate was fairly slow. It is possible that trout have entered the reservoir via the aqueduct from Dog River, a tributary of the Hood River. This aqueduct diverts water from Dog River for the City of The Dalles water supply. (ODFW 8/23/89)

In the Biological Assessment for the City of The Dalles Mill Creek Fish Ladder Project conducted by the ODFW in 2001, a proposed fish ladder at the site of the Wicks Water Treatment Plant intake was assessed. The ladder would provide a passage around a passage barrier currently present at the site. Species affected by the barrier include cutthroat trout, rainbow trout, steelhead trout, sculpin, and other nongame fish. A fish screen went on line in May of 2002 to provide safe downstream fish passage. The ladder was proposed for the bank opposite the fish screen.

Map 11.1: Fish Distribution. Source: ODF, ODFW and USFS



The ODFW Assessment found that the proposed fish ladder would significantly improve upstream fish passage and the existing fish screen will greatly improve the survivability of fish moving downstream. While the construction of the fish ladder has the potential to temporarily increase sediment input and turbidity to the stream, the action would occur during the ODFW approved in-stream work period from July 1 through September 30. In addition, all construction activities will be required to utilize best management practices so little or no adverse impacts should occur to the fish or habitat. Upon completion of the project the area will be replanted with native vegetation (ODFW 2001).

12) Watershed Condition Evaluation

Generating an awareness of watershed issues within the community and soliciting the support of landowners are very important to achieving restoration or monitoring work. To make the health of the watershed a matter of community pride, and to spread out the workload, it may be necessary to increase public involvement and provide educational opportunities for the general public. The Watershed Council should be able to find assistance for generating public interest in watershed health through agencies such as the Oregon State University Extension Service.

Table 13-1. Major issues identified by watershed assessment and potential responses.

Issue	Where	Why	Potential Responses
Rural Roads	Dry Hollow	4.4% of watershed is covered by road surface, indicating moderate level of concern	Zoning considerations, extra attention to road placement and maintenance, closure and restoration of unused roads
Riparian Conditions	Main stems at lower elevations	Inadequate canopy does not provide shade for water quality or large woody debris for habitat	Replanting, establishment of buffer zones.
Cropland Erosion	36% of crop fields	Erosion rates over 5 tons per acre per year are above the tolerance for local soils	Promote direct seed and no-till cropping techniques.
Sediments from Roads	Threemile, Mill Creek, Chenowith	Roads follow creeks, and are located on steep slopes	Survey for road and culvert condition, identify roads for maintenance or removal, culverts for maintenance or replacement.

Past restoration projects could be studied for ideas and demonstrations of the feasibility of such plans. The US Forest Service, Wasco County Soil and Water Conservation District and the Wicks Water Treatment Plant are potential sources of information.

It will ultimately be a community effort that has a meaningful and lasting effect on the health of the watershed. Continued maintenance through cleanup, conservation and continued monitoring will require the cooperation of a large part of the local population.

Table 13-2. Data Gaps and Recommended Further Studies.

Road and Culvert Conditions – targeting areas identified as high potential sediment sources in chapter 8. General road conditions, ditches, water bars, filter areas, adequate culverts and other methods of deterring sediment movement to the streams.
Continued Water Quality Monitoring, including temperature, turbidity, nutrients, pesticides and macroinvertibrates.
Reaches that have fish or that have a history of fish could be assessed for possibilities of riparian area restoration or conservation. Landowners in those areas might be approached regarding riparian buffer programs. Information is lacking on density, abundance, and life history information on both resident and andromous fishes. Fish survey information is needed to direct fish habitat protection and restoration efforts.
The current status of modified channels should be inventoried in the field. Reaches should be identified and prioritized for restoration. Comprehensive physical stream inventory information is lacking on most watershed streams. This information is needed to better understand current conditions, assess changes, and make recommendations for future stream restoration activities.
Wetlands could be inventoried and if any are found to be in a degraded condition, or to be at risk, options may be considered for restoration or protection. Areas that were once wetlands and could be restored might be identified and looked into.

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