Yamhill Basin Council

Mill Watershed Assessment

December 30, 1999

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Abbreviations and Acronyms

Bureau of Land Management	BLM
Channel Habitat Types	CHTs
Coliform forming units	CFU
Coarse Woody Debris	CWD
Cubic feet per second	cfs
Department of Environmental Quality	DEQ
Department of Geology and Mining Industries	DOGAMI
Dissolved oxygen	DO
Division of State Lands	DSL
Environmental Protection Agency	EPA
Geographical Information Systems	GIS
Large Woody Debris	LWD
Micrograms per liter	ug/l
National Wetland Inventory	NWI
Nephelometric turbidity unit	NTU
Oregon Department of Fish and Wildlife	ODFW
Oregon Department of Forestry	ODF
Oregon State University Extension Service	OSUES
Oregon Watershed Assessment Manual	OWAM
Oregon Watershed Enhancement Board	OWEB
Polk Soil and Water Conservation District	PSWCD
Resource Assistance for Rural Environments	RARE
River Mile	RM
Soil and Conservation Service	SCS
State Center for Geographical Information Systems	SCGIS
Total Maximum Daily Load	TMDL
United State Army Corp. of Engineers	USACE
United States Geological Survey	USGS
Water Resources Department	WRD
Water year	WY
Yamhill Basin Council	YBC
Yamhill Soil and Water Conservation District	YSWCD

Cover Photograph: Photograph of log flume being constructed in 1906. Photographs provided by John Crucikshank, a Gooseneck Creek resident. Additional photographs are found prior to Appendices section.

Executive Summary

Methodology

The Mill watershed assessment was conducted to determine how well the watershed is working to produce clean water and healthy fish and wildlife habitats. The assessment process consolidated all known information on the watershed including historical records, scientific data, federal, state and local agency reports, and personal interviews with long time residents. This information was then used to identify specific areas in the watershed where restoration or preservation efforts should be focused. The assessment also identifies specific areas of the watershed where data gaps exist and where we have very little information about the overall watershed condition.

The Oregon Watershed Enhancement Board's *Oregon Watershed Assessment Manual* (1999) methodology was used to conduct the assessment. We utilized information from a variety of sources in order to complete this assessment, with an important data source being the Bureau of Land Management's *Rowell Creek/Mill Creek/Rickreall Creek/Luckiamute River Watershed Analysis.*

The availability of data drives the assessment process and therefore specific problems are only identified where information exists. In the Mill watershed, a significant portion of the data available was collected in the upper part of the watershed, which may give the appearance that the only areas of concern are in these upper reaches. Areas of the watershed where data gaps occur should be weighted equally with regards to the restoration and protection process.

This assessment begins with an Introduction chapter that reports general watershed information such as: climate, population, geology, agricultural production, fire histories, and vegetation. The watershed condition assessment then consists of ten components including Watershed History, Channel Habitat Types, Fish, Riparian and Wetland Conditions, Channel Modifications, Hydrology and Water Use, Water Quality, Sediment Sources and Restoration Efforts.

In each of the components, a brief description of the methodology is followed by a list of information and procedures that were or were not covered during the assessment process. The findings from each assessment component were then used in a decision matrix to identify specific areas of the watershed where protection, restoration, or more information is required.

Summary

Historically, the Mill watershed had been an area of significant change. Starting in the 1800s the combination of a large fire and substantial timber harvesting caused the forested areas of the watershed to change from a generally mature forest to that of a younger, less diverse ecosystem. As agriculture became more prevalent, riparian vegetation along the stream banks was thinned in order to maximize agricultural production. At the same time stream, banks were stabilized in order to protect against erosion of croplands and flooding of rural residential buildings.

During the 1890s to the early 1900s, several large-scale projects influenced the Mill watershed. These projects included the diversion of Gooseneck Creek, the construction and use of a mill race to the town of Sheridan, the development of a sawmill that included a large dam, and 10 mile long flume. Splash dams were also thought have been used in an estimated 70 separate locations of the watershed's headwaters. Beginning in the 1800's wetlands and fields were drained and tiled in order to provide additional land for agriculture and rural residential uses. These activities may have influenced the watershed's peak and low stream flows.

The first step in the OWAM is to quantify how the setting and structure of the landscape influences the shape of the stream channels. The Mill watershed was divided into stream segments in order to understand how land use impacts can alter the channel form, and to identify how different types of channels will respond to restoration efforts.

There are seven different channel habitat types in the Mill watershed. Generally, the headwaters and upper portions of the watershed consisted of stream channels with gradients that ranged from moderate to steep. Channel confinement ranged between moderate to highly confined with a majority having non-erodible, bedrock stream banks.

The lower portion of the watershed, which makes up roughly one quarter of the total watershed area, is typified by low gradient, highly erodible stream banks and channels that ranges from low to moderate in confinement. Much of the present day channel confinement in this lower watershed appears to have been created by historical floodplain terraces that were isolated from the active channel by a significant drop in the channel bed.

There are many wildlife species, both native and non-native, that utilize habitats in the Mill watershed. Of specific concern, the Winter Steelhead (*Oncorhynchus mykiss*), a salmonid recently listed as threatened by the federal government, is considered native to the watershed. Spawning habitat has been identified for this species in the lower portions of both Mill and Gooseneck Creeks. Fish barriers with both natural and human causes have also been identified; including a potentially significant barrier located at the junction of state highway 22 and Gooseneck Creek.

Beginning in the 1950s, there were several species of fish that were hatchery stocked in the watershed to enhance sports fish populations. These species included Rainbow trout (Oncorhynchus mykiss), Coho salmon (Oncorhynchus kisutch), and winter Steelhead. A BLM report described the overall fish habitat for the Mill watershed as being poor or "at risk." The reported cited the lack of deep pools which provide fish with cover from predators and from high winter flows, in addition to the low quantity of large woody debris contributed to this overall rating. With the exception of some segments on Gooseneck, Cedar, and Mill Creeks, most of the watershed has never been surveyed for fish or fish habitat. Consequently, there are significant data gaps in our understanding of both fish populations and their locations in the Mill watershed.

Present day riparian vegetation was assessed using recent aerial photographs, field verification and existing agency reports. The lower sections of both Mill and Gooseneck Creeks had the most highly impacted riparian zones in the watershed. These areas are affected mostly by the adjacent land uses and highly active stream bank erosion. Average riparian widths for this lower portion were less than 50 feet and consisted primarily of young, small diameter, hardwood species.

Riparian zones in the upper portions of the watershed showed widths greater than 50 feet and consisted of mostly mixed and conifer tree species. Areas with poor riparian cover were mapped to show specific locations to focus replanting and streamside restoration activities. There are significant portions of the lower watershed where little to no riparian cover exists.

Wetlands were identified by using National Wetland Inventory (N.W.I.) maps of the watershed. A majority of the wetlands that were identified are located in the lower section of the watershed near Mill

Creek's confluence with the South Yamhill River. There are roughly 42 separate wetlands consisting of a total of 111 acres. Of these known wetlands, roughly 30% have been drained over the years to provide additional land for farming and rural residential use. Information on additional small-scale wetland areas is considered a data gap for the Mill watershed.

Historically, there have been numerous modifications made to the Mill watershed's stream channels. Modifications include small-scale diversions, dike building, dredging, and instream structures such as splash dams. One of the most significant of these historical modifications was the diversion of Gooseneck Creek from its historical path to its present day course. During the late 1800's, the stream channel was altered by hand and horse to provided additional land for agricultural.

The stream channel beds in the watershed and specifically of both Mill and Gooseneck Creeks have seen considerable change over the years. The lower portions of these creeks show substantial downcutting of the channel bed with estimates of between 10-15 feet since 1936. Presently, there are no known large-scale modifications in the Mill watershed. It is estimated that there are many small-scale modifications including rip-rapped banks, culverts and ditch diversions. However, information about specific locations of these modifications is a considered a data gap.

There are six major floods reported to have occurred in the Mill watershed since the 1800s. The two most significant of these occurred during the winter months of 1964 and 1996. Both events were considered greater than 100 year flood events with actual flows exceeding 5000 cubic feet per second (cfs). Stream flows recorded on Mill Creek between 1958-73 showed average annual peak flow of 2105 cfs. The daily average discharge was 148 cfs while the average annual 7-day low flow was 4.2 cfs. Present day stream flows is considered a significant data gap in understanding the current water yield and flows.

An assessment of water rights in the watershed revealed 135 surface water permits totaling 16.34 cfs during the irrigation season (April – September). A majority of water rights were issued for irrigation (93%) totaling 15.25 cfs. Instream water rights for both fish habitat and pollution abatement have been established, but are considered junior to a majority of the surface water rights in the watershed. A comparison made of actual stream flows in Mill Creek to total quantity of water rights revealed a significant deficit in water available to honor these permits as well as maintain instream rights for fish habitat. This situation of more permits for water than actual water in the stream is one of the significant challenges in the Mill watershed.

The Mill watershed contains streams with water quality concerns. Mill Creek is listed on the Department of Environmental Quality's (DEQ) 303(d) list of water quality limited bodies from the mouth to the headwaters for exceeding acceptable levels of fecal coliforms and summer stream temperatures. Mill Creek was also listed as a 'water bodies of concern' for sediments, flow modification, and habitat modification by DEQ. Gooseneck Creek was listed from the mouth to the headwaters as a 'water body of concern' for flow modification and sediments.

Summer temperature data collected during the 1998 –1999 summer seasons revealed many of the streams in the watershed exceeded the 64 degree Fahrenheit temperature standard set by DEQ. Additional water quality parameters, including nutrients, dissolved oxygen, pH and turbidity, were assessed using existing data and all were found to range within acceptable standards. With the exception of the recently collected temperature data, water quality information has not been collected in the Mill watershed since the late 1980s. The lack of current water quality data, however, is a considered a significant data gap.

Areas where fine sediments may be entering the streams in elevated levels were identified using landslide, slope stability, and road maps of the Mill watershed. Road runoff, natural and human caused landslides, and erosion from croplands were estimated to be the primary sources of sediments in the watershed. A BLM estimate of the 1996 storm event showed landslide rates in the Mill watershed of one slide for every 494 acres.

Rural roads are also predicted to contribute significant amounts of sediments to the watershed with a large portion of the rural roads being less than 200 feet from active stream channels. Erosion from agricultural land uses is also predicted to be a significant contributor of fine sediments to the system. This is based on both the location of highly erodible soils in agricultural areas and field observations, however, there currently exists very little information to either substantiate or refute this estimate which is considered a major data gap.

Condition Summary

A condition matrix was constructed using the assessment information in order specifically identify stream segments in need of protection, restoration or those requiring additional information. Streams were divided segments using the channel habitat types determined during the course of this assessment.

Areas in need of 'restoration' were identified mainly along Gooseneck and Mill Creeks and particularly in the lower segments. Specific concerns along these stream segments included: elevated stream temperatures and fecal coliform contamination, narrow or non-existent riparian cover for fish habitat and stream shading, a high potential for fine sediment contributions from agriculture and road runoff, and an increased occurrence of channel modifications including rip-rapped and confined channels.

Of particular interest to the Gooseneck Creek resident group is the restoration of the potential fish barrier at the state Highway 22 and Gooseneck Creek junction. Additional information is required regarding other fish passage barriers including a better understanding of where and to what extent culvert and road crossings prevent fish passage in these stream segments.

Areas with 'more information required' made up the remainder of the assessed streams in the Mill watershed. Additional information is required in order to properly assess these higher order streams. Major data gaps include fish distribution and habitat information, water quality data including temperature, fecal coliform concentrations, and turbidity measurements, culvert and road fish passage barrier locations, rural road and land use sediment contributions, current stream flow data, and the locations of any channel modifications.

Areas in need of 'protection' were not identified during the course of this assessment. It is hypothesized that some of the areas designated 'more information required' are in fact areas in need of 'protection'. Additional information will be required before a 'protection' designation can be assigned to any stream in the Mill watershed.

1.0 Introduction

The Yamhill Basin Councils *Watershed Action Plan for Yamhill River and Chehalem Creek* includes action items for water quality, fish, and wildlife habitat improvement and watershed stewardship. One of the first actions the Council implemented in 1996 was an inventory of riparian, or streamside, vegetation along the Yamhill River and its two forks. Recognizing the need to look at more than just riparian conditions, the Council began a project in 1997 to assess conditions of the entire watershed.

The Oregon Watershed Enhancement Board (formerly the Governor's Watershed Enhancement Board - GWEB), also recognizing the need for a common assessment methodology began developing a manual to aid watershed councils in 1997. The Yamhill Basin Council was awarded grant funds in 1997 to hire a consultant to complete the assessments. After reviewing the draft manual, the Council decided that it would be more effective to hire a project manager through the Resource Assistance for Rural Environments (RARE) program at the University of Oregon.

The Council hired Robert Bower through RARE to manage its first watershed assessments in January 1999. The second draft of the Oregon Watershed Assessment Manual was released in February 1999. The final Oregon Watershed Assessment Manual was released in July 1999.

The purpose of watershed assessments is to determine how Yamhill Basin watersheds are working. The Council in partnership with the Yamhill and Polk Soil and Water Conservation Districts hopes to use this information to determine where to focus protection, restoration, and enhancement efforts. A secondary purpose is to involve the landowners in these watersheds. While the assessment process may leave us with more questions than answers, we feel that it is an important first step in managing our local watersheds.

This is our first assessment using the final manual. Our previous assessment of the Willamina watershed was completed using previous drafts of the manual. We plan to continue watershed assessments throughout the Yamhill Basin.

Where possible the raw data are included in this report or appendices. A preliminary list of stream segments in need of restoration and/or additional information is included in the Watershed Condition Summary Section. This Condition Section also acts as the Executive Summary for the assessment results. The next step will be to take this information and collaboratively develop a strategy with the landowners, businesses, and agencies in the Mill watershed**.**

Melissa Leoni, Watershed Coordinator

Yamhill Basin Council

1.1 Purpose

The Mill watershed assessment was prepared for the Yamhill Basin Council (YBC) and watershed residents and landowners. It contains technical information about the past and present watershed conditions. The primary purpose of the assessment is to evaluate how natural and human processes influence the watershed's ability to produce clean water and suitable habitat for aquatic life. It will serve as a baseline for developing and prioritizing restoration activities. The information collected in this assessment is intended to aid the YBC and the community in developing restoration projects and monitoring plans for the Mill watershed.

1.2 Background

1.2.1 Physical Location

The Mill watershed is located in the Yamhill River Basin in the northwestern part of the Willamette Valley. The 33,920-acre watershed is situated on the eastern slope of the Coastal Mountain range and generally flows north toward the South Yamhill River. With the exception of a small section in Yamhill County most of the watershed lies within the northern part of Polk County. See Figure 1 for watershed location.

Elevations in the watershed range from 195 ft above sea level near mouth of Mill Creek to 3589 ft on Laurel Mountain with an average elevation of 1753 ft. Other major geographical features include the Rickreal Ridge, Condenser Peak (3100 ft.), and Dorn Peak (2849 ft.). Streams in the watershed include Mill, Gooseneck, Panther, Tillaston, South Branch Mill, Bear, Wind, Cedar, Coffee, Pine, Shumway, Camp, Coldwater, Rowell, and Glenbrook. Additionally there are hundreds of unnamed creeks located throughout the watershed. We have divided the watershed into four sub-watersheds: Upper Mill, Middle Mill and Lower Mill and Gooseneck (Figure 2).

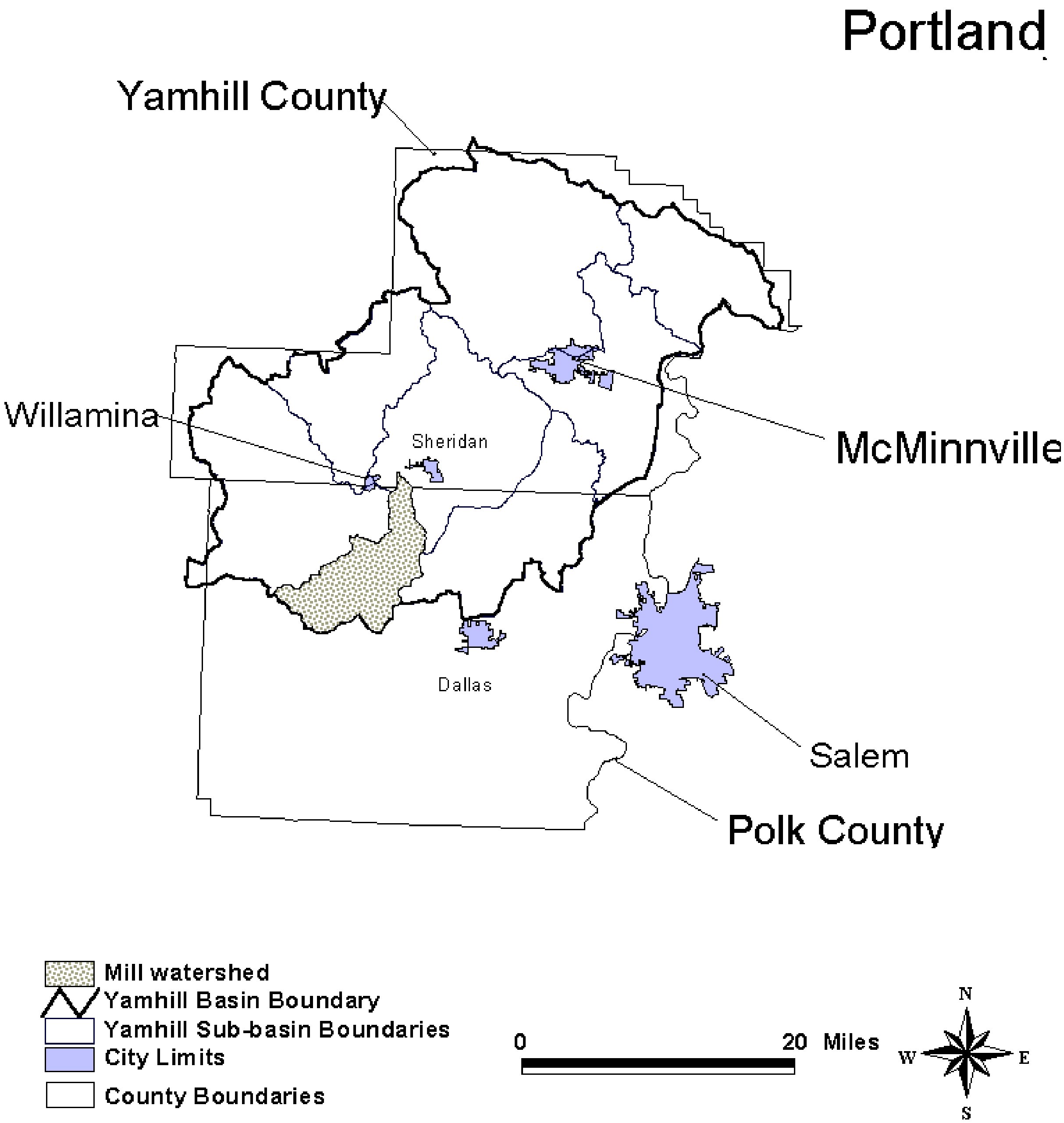
According to measurements done by the BLM, there are a total of 336.7 miles of streams in the Mill watershed (BLM, 1998). Blue stream segments shown in Figure 2 depict the mainstem or perennial[1] streams that were the focus of this assessment. The red stream segments shown in Figure 2 are considered the balance of the streams that were not included in this assessment due to their intermittent nature. It was observed that roughly half (165.3 of 336.7 miles) of Mill watershed's total stream miles were considered to be these lower order streams. These smaller streams should be taken into consideration in any further assessment efforts, monitoring, or restoration plans.

1.2.2 Population

The human population density of the watershed is concentrated mainly in the Lower Mill sub-watershed. There are no major towns located in the Mill watershed. There are two small communities, (Willamina and Sheridan) located just north of confluence of Mill Creek and the South Yamhill river. Using the LandView III Environmental mapping software (USDC, 1995) population was estimated at 812 for the Mill watershed. This 1990 census information listed 292

[1] Also known as 'blue line' stream, which refers to the streams, recorded (in blue) on USGS topographical maps.

Figure 1. Mill Watershed Location



households in the watershed area of 53.46 square miles (See Table 1). Using the 1967 watershed population estimate of 341 persons indicates a population increase of 22 per year (MWVCG, 1969). Due to limitations created by water availability and land use zoning, there is little growth expected for the watershed in the near future. Most of any anticipated growth will most likely be centralized in the Lower Mill sub-watershed near the state highways 22 and 18.

Table 1. Mill Watershed Census Data

Mill Sub-basins	***Population***	***Number of Households***	***Land Area (sq. miles)***
Gooseneck	89	33	15.49
Lower Mill	557	197	8.27
Middle Mill	58	22	14.07
Upper Mill	108	40	15.63
Totals:	812	292	53.46

1.2.3 Climate and Topography

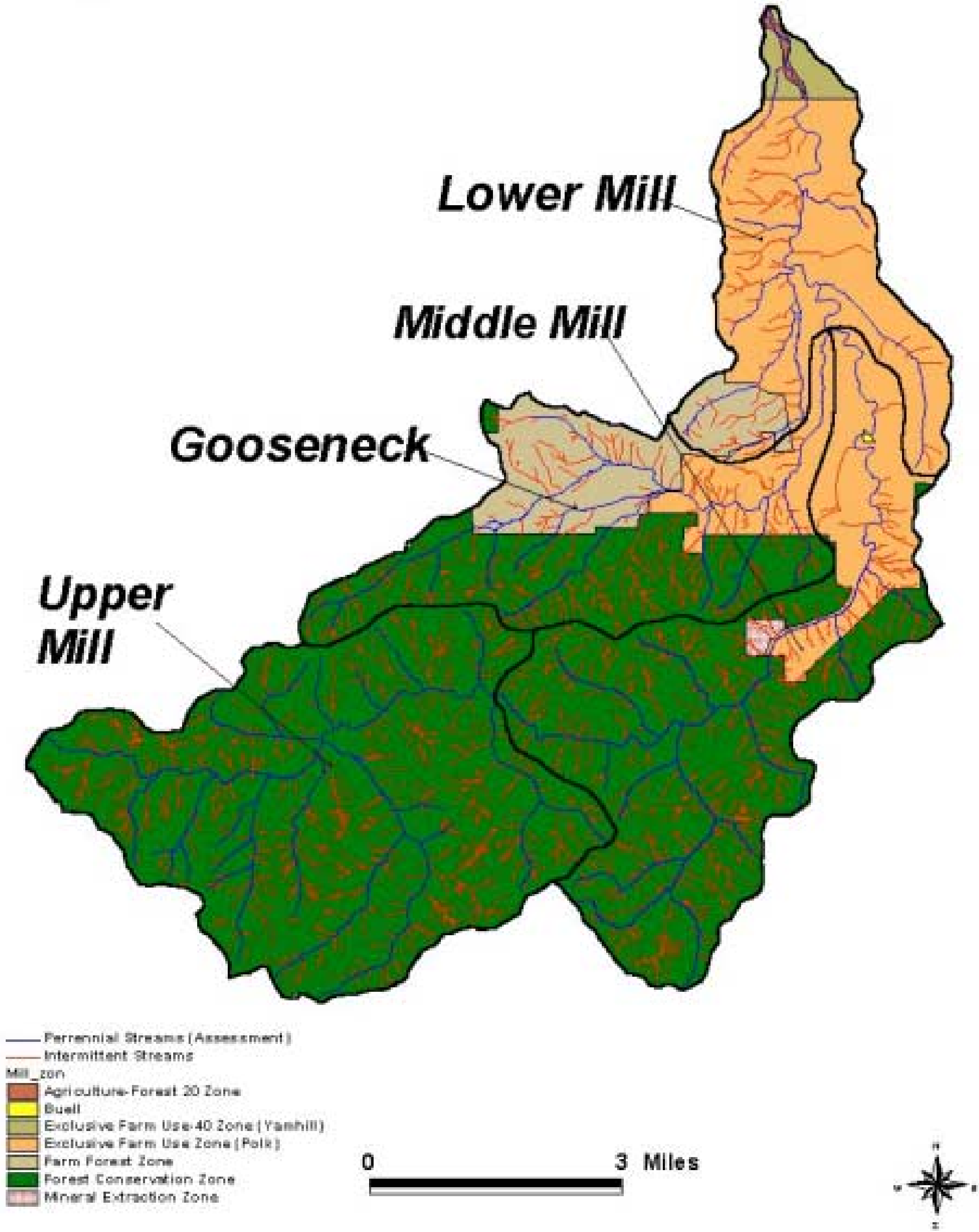
The climate in the Mill watershed is marine-influenced with extended winter rainy seasons; summers tend to consist of long periods of hot and dry weather. Snow and ice does accumulate in the higher elevations and usually melts within a few days. 'Rain on snow'[2] events are relatively infrequent due to the low number of days during the year when sufficient snow accumulates. However, during the 1964 and 1996 winter storms, snow had accumulated in the Mill watershed enough to contribute to the record flooding that occurred.

Estimates of rainfall were made using an Average Annual Precipitation Map (Oregon Climate Service, 1990). Rainfall for the Mill watershed varies according to elevation. Results show that the lower elevations of the watershed have annual precipitation ranging from 40 to 60 inches per year[3] while the higher elevations average between 100 to 140 inches[4] with an average of 105.99 inches (WRD, 1999). In 1996, Laurel Mountain received 204 inches of total precipitation. This was the highest recorded rainfall for any station in the state of Oregon (BLM, 1998). The nearest measurements for precipitation and temperature are currently recorded in the towns of Willamina and Dallas and can be obtained by contacting the Oregon Climate Service located at Oregon State University. Figure 3 shows the average monthly temperatures and precipitation recorded in Dallas from 1961-99, which are assumed to reflect conditions for the lower elevations of the watershed.

Temperature data recorded in Dallas (1961-present) and on Laurel Mountain (1978-present) was used to approximate the climate of the watershed. Records in Dallas indicate a mean annual daily temperature of 52.1 ^{0}F, a mean annual maximum of 63.7 ^{0} F, and a mean annual minimum

[2] 'Rain on Snow' events occur when heavy snow accumulation is followed by intensive spring rains and can increase the magnitude of flooding.
[3] Data collected in the nearby town of Willamina (1948-1999) showed an average annual rainfall of 50.7 inches and an average annual snowfall of 10.25 inches. Willamina data would be useful to approximate conditions in lower elevations of the Mill watershed.
[4] Data collected on Laurel Mountain (1978-1999) showed an average annual rainfall of 125.21 inches and an average annual snowfall of 118.3 inches. Data from Willamina and Laurel Mountain stations courtesy of Oregon Climate Service.

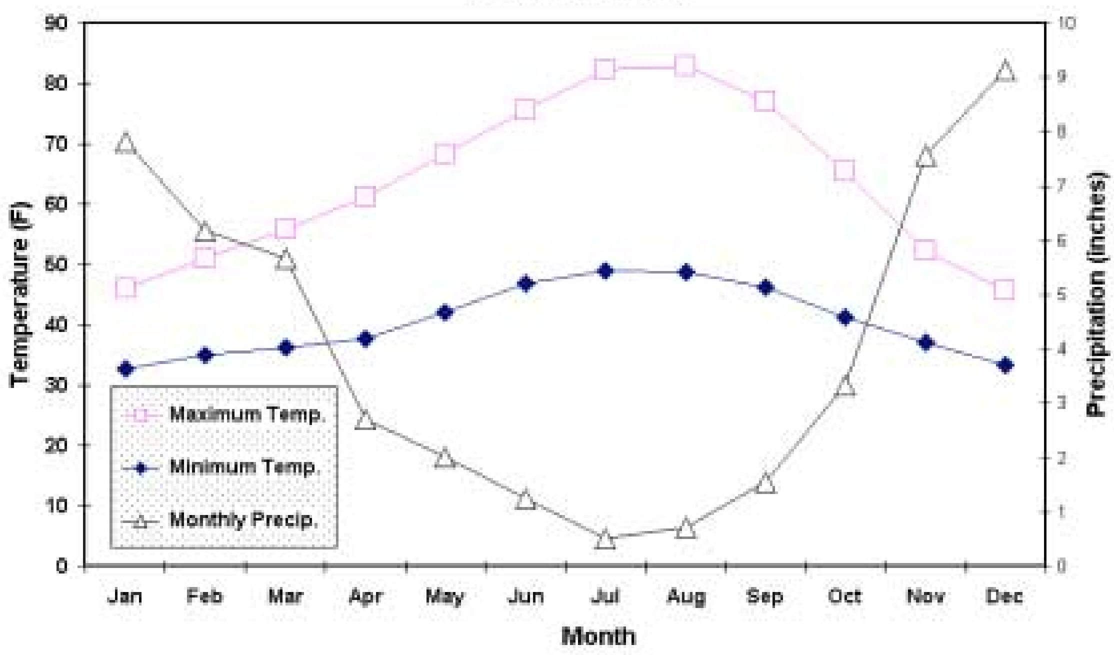
Figure 2. Land Use and Subwatersheds



temperature of 40.6 ^{0}F. The highest and lowest temperature recorded in Dallas during this period were 106 ^{0}F and –2 ^{0}F, respectively. Laurel Mountain temperature data showed an average maximum temperature of 56.5 ^{0}F and an average minimum temperature of 37.9 ^{0}F. The highest and lowest temperatures recorded on Laurel Mountain were 92 ^{0}F and –11 ^{0}F, respectively.

The topography of the watershed differs dramatically from the mouth to the headwaters. The lower Mill sub-watershed is generally characterized by broad rolling pastures and low lying hills. Elevation ranges from around 195 to approximately 1000 feet. The three remaining sub-watersheds are characterized by narrower valley bottom pastures and meadows, steeper slopes and relatively larger hills. Elevations range from around 400' to 3589' at the top of Laurel Mountain on the southwestern edge of the upper Mill watershed.

Figure 3. Monthly Average Temperature and Precipitation Data (Dallas, 1961- 99)



1.2.4 Geology

The Mill watershed geological materials consist mainly of sedimentary and volcanic rocks. These rocks were formed during the Eocene and Oligocene ages of the Tertiary period. The sedimentary rocks generally consist of shale, claystone, sandstone, and siltstone. The volcanic material consists mainly of basaltic lava and tufts. The sedimentary rocks tend to be found near the soil surface while the underlying bedrock is made up mainly of these volcanic constituents (SCS, 1982).

The Soil Survey for the Polk Area (SCS, 1982) lists five primarily soil associations for the Mill watershed. The areas located near the stream in the Lower Mill sub-watershed are classified as both the Salkum-Briedwell and Bellpine-Suver-Hazelair associations. Salkum-Briedwell is found mainly in the lower elevations adjacent to the main branch of Mill Creek. This association consists mainly of poorly drained silty-clay and silt loams. The Bellpine-Suver-Hazelair in Lower Mill sub-watershed is located mainly in middle to upper elevations of the Lower Mill sub-watershed. This association consists of deep to moderately deep, well to poorly drained silty clay loams.

Gooseneck sub-watershed consists of soils from all five major associations found in the watershed. In the lower elevations, the association is Salkum-Briedwell (described previously). Through the mid-section of the sub-watershed, the associations are Bellpine-Suver-Hazelair (described previously), Peavine-Honeygrove-McDuff, and Kilchis-Klickitat. Peavine-Honeygrove-McDuff consists of moderate to deep, well-drained silty clay loams while Kilchis-Klickitat soils show from shallow to deep, well-drained stony loams and gravelly clay loams. The upper section of Gooseneck sub-watershed consists mainly of the Kilchis-Klickitat (described previously) and Valsetz-Luckiamute, which consists of moderately deep to shallow, well-drained stony and very shaly loams.

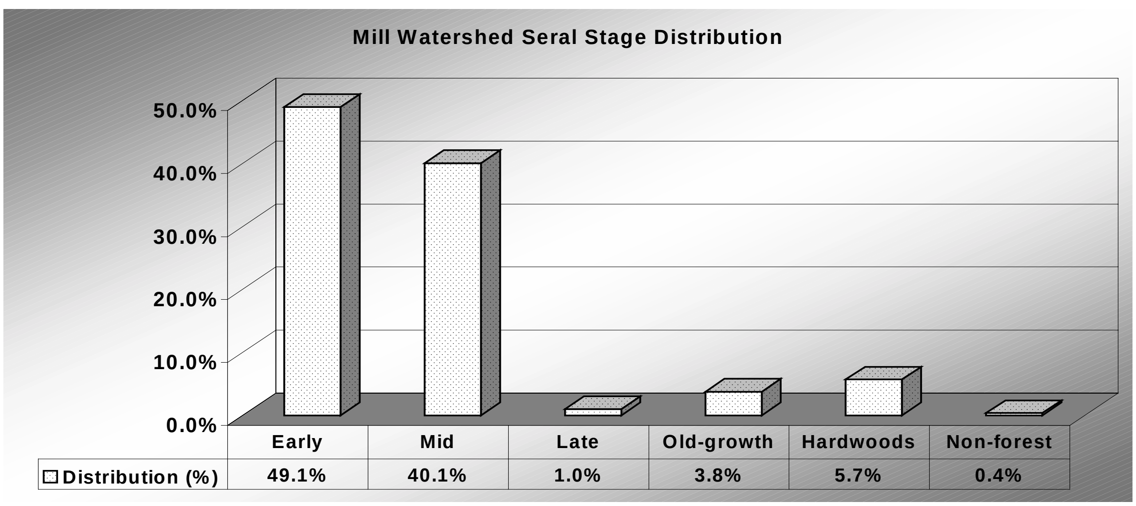
The Middle and Upper Mill Sub-watersheds consist mainly of Kilchis-Klickitat and Valsetz-Luckiamute soil associations (described previously). More information on soil conditions can be found in the Sediment Source section of this document.

1.2.5 Vegetation

The Mill watershed is mostly forested with the exception of the Lower Mill sub-watershed, which are mainly agricultural crops and rural residential lands. A majority of the forest acres are found in the Upper and Middle Mill, and Gooseneck sub-watersheds. Mixed conifer forests make up the majority of the current forests within the watershed. Most of the hardwood forests (with the exception of the riparian zones) areas lie within the Lower Mill and Gooseneck Sub-watersheds.

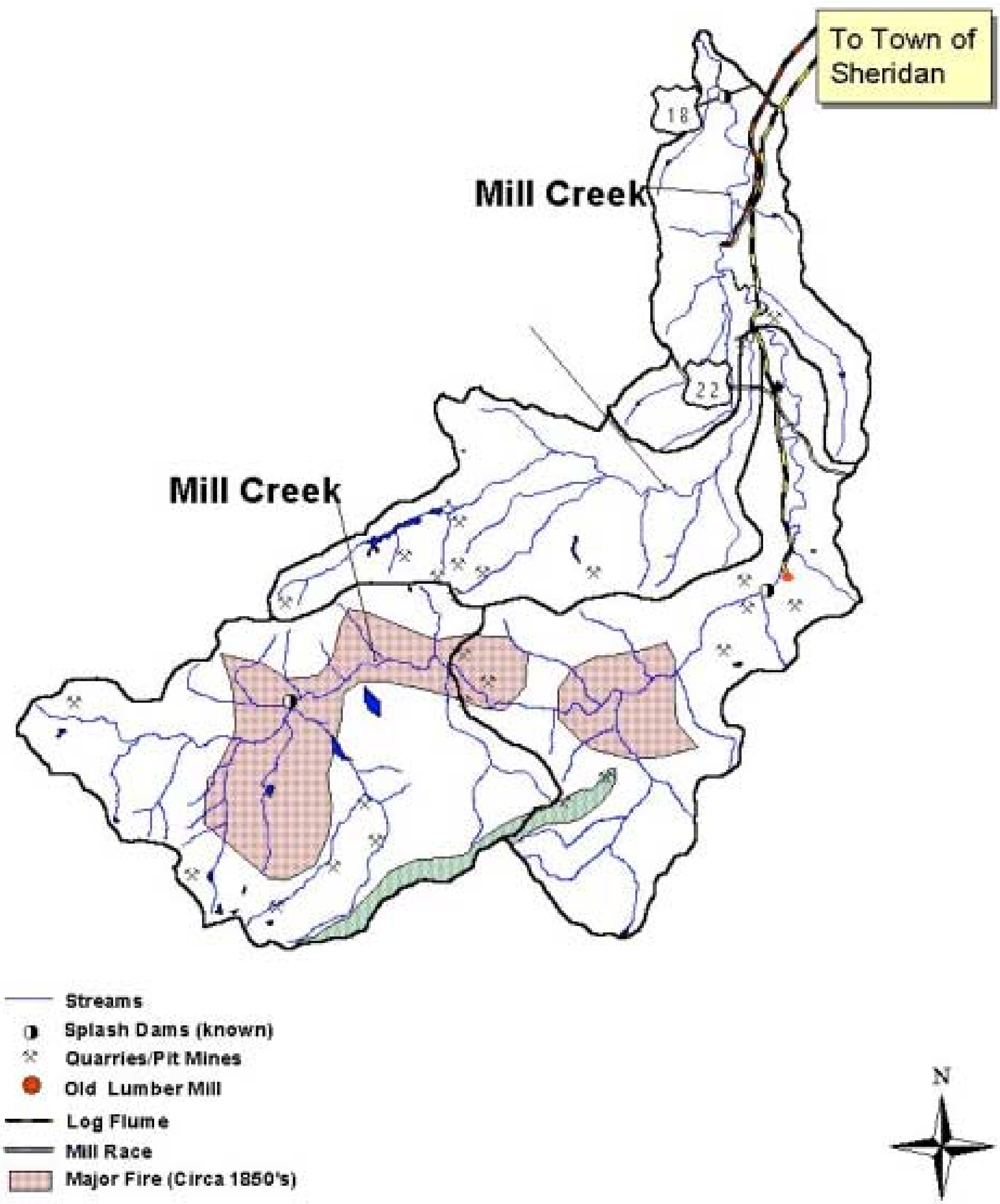
Figure 4 shows the seral stage and age class distribution of vegetation in Mill watershed. The BLM system classifies 'Early' seral stage as vegetation between 0-39 years which includes mostly

Figure 4. Vegetation Seral-stages and Age Distribution



agricultural and recently replanted-forested lands in the watershed. The 'Mid' and 'Late' seral stages are considered between 40-79 and between 80-199 year age classes respectively. Old growth is defined as vegetation known to be greater than 200 years old. A majority of the early, mid, late and old growth classifications are mixed conifers. The Non-forest is defined as areas such as rock outcroppings, ponds, parks, meadows or other areas where seral ages could not be assigned.

Figure 5 Historical Information



A BLM analysis of the Mill watershed area noted a "greatly reduced structural diversity and species composition" when comparing the current to historical vegetation conditions (BLM, 1998). The report notes that these conditions are primarily due to forest management activities such as 80 year rotations; leaving few to no snags per acre after regeneration harvest; retaining small to no buffer zones adjacent to streams (in contrast to the Northwest Forest Plan); prioritizing harvest on older snags; removal of suppressed trees, wind-thrown timber, coarse woody debris and snags; planting monotypic stands; and slashing and burning units post-harvest (BLM, 1998).

With regards to vegetation diversity, conifers, and Douglas-fir, are considered to be the most dominant tree species. Western red cedar and western hemlock are also common with some noble fir present at the higher elevations. Grand fir can also be found in sparse pockets along streams and at the lower elevations of the watershed.

Red alder, bigleaf maple, black cottonwood, Oregon ash and white oak and several types of willows make up a majority of the hardwood species in the watershed. Red alder is the most dominant of these hardwood species and is predominantly found along the streams and wetlands of the watershed. The majority of understory vegetation consists of vine maple, salmonberry, salal, and swordfern.

An increasing problem found throughout the Oregon Coast Range and is thought to be present in the Mill watershed is the presence of a fungus known as laminated root rot (*Phellinus weirii)*. This root rot specifically attacks Douglas-fir and Grand fir and often causes mortality in whole tracts of forest lands. Hardwood species have been shown to increase resistance to this problem.

1.2.6 Terrestrial Habitats

A landscape is commonly defined by the presence of the following three elements: matrix, patches, and corridors. Matrix vegetation is mainly a function of the region's climate, soil, and topographical interrelationships. While patches, either disturbance or remnant, are the result of agents such as fire, wind, and water. Streams and riparian areas define a corridor component.

According to the BLM 1998 analysis, both historical and current land management practices have created a terrestrial wildlife habitat that lacks this matrix vegetation component. Historically the watershed had a vegetation matrix of mainly late seral to old growth forest habitats consisting primarily of Douglas-fir, western cedar, and hemlock. Over time, this habitat was replaced by a landscape dominated by varying forest ages and size classes. The absence of the historical matrix conditions creates a less than desirable terrestrial habitat for many of the native animal and plant species. Streams, riparian zones, and roads now provide the only connectivity between the historical vegetation patches (BLM, 1998).

Due to the significant differences in inter-watershed habitats, the types of and species populations vary throughout the watershed. Common animals found in the upper elevations of the watershed include black tailed deer, Roosevelt elk, black bear, mountain lion, bats, beavers, mink, river otter, raccoon, nutria, quail and grouse. In the lower to mid elevations you can also find a variety of frogs, toads, salamanders, snakes, raptors, geese, and duck species.

The BLM has identified one area along the southern border of the watershed as an 'Area of Critical Environmental Concern' (ACEC). This area located on and named the Rickreall Ridge ACEC (Figure 5) is " particularly distinctive in supporting a wide diversity of plant species within a relatively small area. Several Willamette Valley species reach their upper elevational limits here, and typical Coast Range plants can also be found here. The area harbors some plants and animals that are more characteristic of southwestern Oregon, and it appears to be a disjunct refugium for species that had spread northward during a past warmer and drier climatic period." (BLM, 1998). There have been several studies conducted in this area of unique strains of butterflies, the Indian Paintbrush plant, and a population of dwarf white oak. The BLM's management objective for this area is to maintain, protect, or restore relevant and important values with the ACEC (BLM, 1998)

1.2.7 Fire History

Prior to the last 50 years, the fire history in the Mill watershed has been largely local and anecdotal. Forest fire information was gathered for this assessment from several primary sources, which are listed in the introduction's References and Resources. In addition to these primary sources, Yamhill basin fire history was also gathered by talking to historians, residents, and other historical documents.

Fires in the Mill watershed have been the result of both natural and human-induced causes. Natural fires are produced by lightening strikes "but the frequency of thunderstorms in the Willamette Valley ranks among the lowest in North America" (Zybach, 1988). Thus, the relative frequency of these natural fires is thought to be extremely low with high intensity, stand-replacing fires occurring at irregular intervals of 150-400 years (Teensma, 1991).

Human-induced fires were caused by both regional Indians and settlers. Kalapuyan Indians, estimated to live in the watershed for thousands of years, used fire for a number of practical applications including agriculture, hunting, communications, warfare, visibility, safety and sanitation (Zybach, 1988: Boyd, 1985). This fire use created a grassy and oak-savannah type habitat typical of the Willamette valley and foothills.

Native fire use was used consistently on a year-to-year basis until 1782 when European explorers and settlers began to arrive to the area. Settlers introduced diseases like smallpox and malaria to the Kalapuyan populations, which quickly dwindled between 1782 -1849. Consequently the frequency of widespread valley fires dropped and was replaced the less periodic settler's uses, which included trail building, amusement, agriculture, camping and hunting, logging slash and incendiary (Zybach, 1988). Early vegetation maps show that the forested fringe began to slowly replace the once open grasslands because of the less frequent fire regime.

Since the 1840s, there have been two catastrophic fires in the region that may have affected areas in the Mill watershed. The first was the Nestucca fire which "…burned over 300,000 acres in the late 1840s. Most of the area burned has regenerated naturally and vigorously, except for an area near Mt. Hebo that was burned periodically by homesteaders to improve pasturage" (Teensma, 1991).

A BLM fire history map dated circa 1850s shows a large section of Upper Mill and Middle Mill watershed as having been burnt (Figure 5). The second was the Tillamook fire (1933) possibly caused several localized burns in the western part of the watershed. 1936 aerial photos from Oregon State University and BLM computer maps show a large section of the watershed burnt in the Middle and Upper Mill sub-watersheds.

There have been many smaller localized fires over the years including the most recent regional fire named the Rock House Fire. It was reported to have occurred just west of the town of Dallas in 1987 and burnt an estimated 5,000 acres of forested land in Polk County. Interviews with local residents suggest that there may have also been a large fire (Black Rock fire) that occurred during the 1910-20s. Vegetation maps of the time did not record this burn.

Broadcast burns have been used as a forest management tool by both private and governmental foresters to remove logging slash and control competing ground vegetation. Presently their use in the area is extremely limited by concerns regarding air quality and erosion runoff. The current and long standing fire policy for both private and public lands is to control and extinguish all forest fires that occur in the Mill watershed.

1.2.8 Sensitive Species

The following seven species found in the Mill watershed are either protected by the Federal Endangered Species Act or are of concern due to their low population. This section was researched and written by Tamara Quandt, a Linfield College intern. We have included some information about each species in order to introduce their habits and habitat to the reader. All information on the species listed here have been based on field observations (Oregon Natural Heritage Program (ORNHP), 1998). Several additional species that may live in the Mill watershed have not recently been field verified and thus are not included in this list. These species include the bald eagle, marbled murrlet, clouded salamander, and the pileated woodpecker.

The BLM reported 29 species in the region analysis. They area: earthworms (1), snails (1), slugs (2), amphibians (13), reptiles (1), birds (4), and mammals (7) as being special status species of concern because of their unstable populations (BLM, 1998). While some of these species are listed below others may be present in the watershed, but have not been field verified.

Painted Turtle *(Chrysemys picta)*
Federal Status: Unknown
State Status: Critical, Listing is pending (ODFW)
ORNHP: Global Ranking = 5 Considered widespread, abundant, and secure.
State Ranking = 2 Imperiled because of rarity or because other factors make it vulnerable to extinction.
Date Last Observed: Contact Natural Heritage Program**.**

The *Chrysemys picta*, commonly known as the painted turtle is one of only two species of turtles native to Oregon. It is easy to recognize due to its smooth, flat, olive tinted shell, head, neck, legs, and tail colored with red and yellow markings. The turtles are medium in size, with the female commonly larger than the male.

The painted turtle is omnivorous, feeding on aquatic plants, fish, snails, threatened earthworms, and a variety of insects. During late spring and early summer, the female turtle lays 5-20 eggs in scarcely vegetated upland areas. Many eggs are lost to predators with survival rates at approximately 1 in 5. During the winter months, the turtles hibernate in the sediments of ponds and streams.

The painted turtle's primary habitat is shallow, slow-moving streams, marshes, and ditches. They prefer areas with muddy bottoms and dense aquatic vegetation, and require a plenitude of rocks, stumps, or exposed logs so they may bask daily in the sun. The turtles require heat absorption from basking in the sun in order to mature properly. In Oregon, the painted turtle is found primarily in areas near to the Columbia and Willamette Rivers. In the Mill watershed, the painted turtle would most likely be found in the streams Lower Mill sub-watershed.

Northwestern Pond Turtle *(Clemmys marmorata marmorata)*
Federal Status: Species of Concern.
State Status: Listed as critical by ODFW. It is listed as endangered in both Washington and California.
ORNHP: Global Ranking = 3 Rare, uncommon, or threatened, but not immediately imperiled.
State Ranking = 2 Imperiled because of it's rarity.
Date Last Observed: Contact the Natural Heritage Program.

The *Clemmys marmorata*, commonly referred to as the western pond turtle, is one of only two known Oregon turtle species. The number of existing pond turtles have declined rapidly in recent years due to the loss of habitat and rise in predators such as raccoons, skunks, opossums, snakes, and humans. The pond turtle is generally smaller than the painted turtle and can easily be distinguished because of its less colorful markings. The pond turtle has a brown or black shell with dark and cream colored markings while the head and throat have with darkish spots and lines.

Western pond turtles are similar in both diet and habitat to that of the painted turtle. The pond turtle is omnivorous and requires a freshwater habitat in order to thrive. The pond turtles, like the painted turtles, require sun basking to be a daily activity, and need a habitat that is suited to meet this need. Pond turtles are diurnal, spending their days sitting on a fallen log, basking in the sun, while at night as well as during hibernation periods, they burrow into mud at the bottom of a nearby pond. The destruction of proper habitats for both the painted and western pond turtle has caused a rapid decline in their overall population in the Pacific Northwest.

Tailed Frog *(Ascaphus truei)*
Federal Status: Species of concern. It is currently being reviewed as a candidate for the ESA.
State Status: Considered vulnerable by the ODFW.
ORNHP: Global Ranking = 4 Not rare and apparently secure, but with cause for long-term concern.
State Ranking = 3 Rare, uncommon, or threatened, but not immediately imperiled.
Date Last Observed: Contact the Natural Heritage Program.
The *Ascaphus truei*, commonly known as the tailed frog can be spotted easily by looking for its reddish-brown to gray-yellow skin, covered with small bumps called tubercles. Tailed frogs are relatively small with a vertical pupil and fully webbed toes. Some unusual characteristics of the tailed frog include free floating ribs and an attached tongue. Tadpoles commonly have a white spot on the tip of their tail, making them easier to identify.

Eggs are laid during the early summer with each female producing between 50-60 eggs. The eggs are laid on the underside of submerged rocks in order to protect them from rapid water currents. The tadpoles take 2-3 years to mature and will not breed until they reach ages between 7-8 years. Tailed frogs are nocturnal and feed primarily on both land and water insects.

The most common habitat for tailed frogs is near cold, fast-flowing streams. The frogs tend to live in undisturbed, mature forests where fine silt clogs have not yet begun to occur in the streams. Since, the tailed frog rarely migrates, any disappearance of them is usually suspected to be because of a change in their habitat.

Northern Spotted Owl *(Strix occidentalis caurina)*
Federal Status: Listed as Threatened under the ESA.
State Status: Listed as Threatened by the ODFW under the OESA.
ORNHP: Global Ranking = 3 Rare, uncommon or threatened, but not immediately imperiled.
State Ranking = 3 Rare, uncommon, or threatened, but not immediately imperiled
Date Last Observed: 1996-1999 (Confederated Tribes of the Grand Ronde)

The *Strix occidentalis caurina*, commonly known as the northern spotted owl, is well known in the Pacific Northwest because of the controversy that surrounds it's listing. The spotted owl makes its home in large, dense coniferous forests. Many of these forests are currently being harvested for timber sales, leaving the spotted owl without a home. The old growth forests provide the best habitat for the owls because the thick canopy provides protection and a habitat for their primary prey. The favored food of the owl is the northern flying squirrel, which is located primarily in old growth areas. USFWS has set aside numerous protected areas for the owls, including 7560 acres in the Willamina Watershed (just north of Mill Watershed) designated as critical spotted owl habitat (BLM, 1998). BLM reports roughly 1,200 acres of old growth forest left in Mill watershed. It is not known if there are nesting Spotted Owls in those areas.

Fender's Blue Butterfly: *(Icaricia icarioides fenderi)*
Federal Listing: Proposed Endangered by the USFWS and the NMFS under the ESA.

State Listing: ODFW listing is unknown

ORNHP: Global Ranking = T1 Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation.

State Ranking = 1 Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation.

Date Last Observed: Rediscovered in 1989. Contact the Natural Heritage Program.

Icaricia icarioides fenderi, commonly known as Fender's blue butterfly was thought to have been extinct until 1989 when it was rediscovered in the Willamette Valley. It is endemic to this area and its only known locations are in Benton, Lane, Polk, and Yamhill counties. Male butterflies have silvery-blue wings with small, black dots on the undersides. Females have brown wings and are relatively smaller than the male. The total wingspan of the male blue butterfly is approximately 1 inch in width.

The blue butterfly only has a life span of 9.5 days during late May into early June. Eggs are laid on Kincaid's lupine plants and the caterpillars feed off these necessary host plants. The following spring the caterpillars undergo their transformation into butterflies. The Fender's blue butterfly has a symbiotic relationship with the Kincaid's lupine, which is a sensitive plant species.

The blue butterfly can be found in up-land prairies of the Willamette Valley. It is most likely only found when the Kincaid's Lupine is present. The native grasslands within this area have been used for agriculture, which has caused a decline in both the butterfly and the lupine. Both the Mill and Deer Creek Watersheds have known patches of Kincaid's lupine; thereby creating a likely probability that Fender's blue butterfly exists there as well.

Kincaid's Lupine *(Lupine sulphureus kincaidii)*

Federal Listing: Proposed Threatened by USFWS under the ESA.

State Listing: Listed as Threatened by the ODFW.

ORNHP: Global Ranking = T2 Imperiled because of rarity or because other factors make it vulnerable to extinction.

State Ranking = 2 Imperiled because of rarity or because other factors make it vulnerable to extinction.

Date Last Observed: Rediscovered in 1989. Last observed in Mill and Deer Creek in 1999.

Lupine sulphureus kincaidii, commonly known as Kincaid's lupine was rediscovered in 1989 in the Willamette Valley. This particular species of lupine is distinguishable by its unusual leaves, which are deeply creased in the middle and covered with silvery hairs on their underside. It grows lower to the ground than other species of lupine and typically blooms in late May. The flowers are a yellowish-blue color and are very aromatic.

Individual patches of lupine are usually small and are found in upland prairies and some lightly wooded areas. Patches of lupine were discovered in Deer and Mill watersheds in 1993 and ongoing research is being conducted on both the lupine and the blue butterfly in order to help create stable populations of both in the region. Out of the only 84 native Willamette Valley prairie sites left in Oregon, the lupine is found in of those 51 and the butterfly in only 31 sites. Only 0.1% of the original habitat of these particular species exists today.

1.2.9 Land Use Summary

An estimate of land ownership was conducted using a Land Ownership map provided by Boise Cascade. The majority of the land in Lower Mill and Goosenecks sub-watersheds is owned by private (small) landowners with some county and state lands included. Nearly all of the Upper and Middle Mill sub-watersheds are owned by both the BLM and Willamette Industries, a private lumber company (Figure 2). Forestry and the consequent timber harvesting are the dominant land use in the Upper, Middle and Gooseneck sub-watersheds. Lower Mill sub-watershed is zoned mostly agricultural and rural residential. There are some small-scale animal operations in the drainage including beef cattle, horses, pigs, and other livestock.

1.3.0 Mining

Gravel quarries used for road construction make up a majority of the historical as well as current mining activities in the Mill watershed. A query of Department of Geology and Mining Industries (DOGAMI, 1999) records show a total of 15 quarry permits for the Mill watershed with only 6 of those being considered open or active (Table 2). The only quarry known to be currently in operation is Shenk's quarry located on Mill Creek, near the Mill Creek County Campground.

The Grant of Total Exemption Rule (DOGAMI) states that person(s) disturbing less than 5,000 cubic yards and/or less than one acre in a 12-month period need not apply for a permit with the state. Sites where more than 5,000 cubic yards is being disturbed must apply for a permit with the DOGMAI in Albany, Oregon. This permitting process did not become law until 1974 and records of mines and quarries before that date are largely anecdotal or unknown. The historical maps associated with this document shows the locations of 25 Pits/Quarries termed 'Borrower Pits" on the USGS topographical maps of the watershed, some of which are the quarries listed in Table 2. For more information regarding these quarries, contact the USGS office in Portland.

Table 2. Quarry and Pit Permits

Permit Number	Status	Name of Permit Holder	Type of Permit
27-0002	Permitted	Hampton Resources, Inc	Pit
27-0028	Permitted	Valley Concrete &Gravel Company	Quarry
27-0041*	Permitted	Dan Kauffman Excavating, Inc. (Shenk Quarry)	Quarry
27-0046	Permitted	Braxling and Braxling Logging, Inc.	Pit
27-0047	Permitted	Valley Concrete &Gravel Company	Quarry
27-0049	Permitted	Polk County Road Department	Quarry
27-0001	Closed	Martin Quarries, Polk	Quarry
27-0003	Closed	Buell Pit	Pit
27-0016	Closed	La Creole Lumber and Rock Company	Quarry
27-0020	Closed	Polk County Road Department	Pit
27-0024	Closed	Polk County Road Department	Quarry
27-0031	Closed	Valley Concrete &Gravel Company	Quarry
27-0048	Closed	Braxling and Braxling Logging, Inc.	Pit
36-0047	Closed	Klamath Falls Brick & Tile Company,	Deposit
27-0051	Amendent	Brian and Jock Dalton	?

*** Only quarry known to be currently active.**

1.3.2 Agriculture

Since the organization of Yamhill and Polk Counties in the 1840s, agriculture has been one of the dominant industries of the area. Due to the topographical nature of the Mill watershed, agricultural production was mainly limited to the lower Mill sub-watershed with the exception of small fields and pastures scattered in the mid and upper parts of the watershed. Specific accounts of Mill's agricultural past are limited, and the following information pertains to the larger area of both Polk and Yamhill Counties.

During the initial years following the settlement of the watershed, agriculture consisted mostly of cattle grazing and subsistence farming. During the first 20 years the "the valleys were settled rapidly, the range cattle were pushed back into the hills, and the growing of wheat on the level lands became the dominant industry" (Gross, circa 1960). A census by the United States in 1880 reported wheat, oats, and hay accounted for 99 percent of the agricultural production in area.

During 1880s, clover was discovered to grow successfully in the area and became the dominant cash crop. "By 1900, this crop occupied 1,216 acres, wild grasses 250 acres, tame grasses 8,007 acres, while 3,033 acres of grain were cut green for hay" (Grouse, 1960s). With an increase in clover production the livestock industry flourished. Hops also became a significant part of the local agricultural economy with a 1900 census reporting 1,801 acres in production in Yamhill County alone.

From 1900 to 1910 the dairy industry got its start and gradually expanded in the area. Corresponding with the increase in dairy cattle the production in clover, grasses and hay increased accordingly. By 1909, clover production had increased by nearly 500 % and acres of grain cut green for hay had increased 600%. Fruits and nuts were also getting their start in Yamhill County and made up a sizable part of the agricultural market by 1909. Production of hogs, sheep, goats, and poultry was becoming a significant portion of the region's agricultural economy as well.

A 1919 census report found that of the total agricultural income that year, 35% came from cereals, 21% from fruits and nuts, 17% from livestock, 12% from hay and forage, and the balance from miscellaneous crops. Since 1919, wheat production has decreased while dairy and prune production has increased. By 1925, it was reported that there were 2,864 farms in Yamhill County with an average size of 83.56 acres per farm. The twenty-five year period between 1925 –1959 witnessed a drop in the fruit tree production of apples and pears with filberts becoming a larger share of the fruit and nut market.

Commercial production of berries came into play following World War I. Loganberries, strawberries, raspberries, blackberries, and gooseberries were the initial berry crops introduced with strawberries by far the dominant crop. Walnuts and the Franquette nuts also became an important part of this industry.

During the 1930s, the federal government started to encourage the planting of cover crops during the winter to hold soil. Grass seed crops became important between 1935 and 1939, and the acreage for lawn grass seed has increased up to the present day levels.

The Mill Watershed currently has several dominant crops grown in the Lower Mill, Gooseneck, and Middle Mill sub-watersheds. These crops consist mainly of grass seed, wheat, flower seeds, hay and nursery stocks. Additionally, there is Christmas tree plantations and vineyards in the area. Locations and exact production amounts for crops are difficult to obtain due to variations on a year by year and farm by farm basis. For more information on specific crop information, contact the Farm Service and/or Oregon State University County Extension, both located in Dallas and McMinnville.

Introduction's References and Resources

United States Department of Agriculture, Soil Conservation Service (SCS). 1982. *Soil Survey of Polk County, Oregon.* Polk County NRCS office, Dallas, OR.

Bureau of Land Management, (BLM). 1998. *Watershed Analysis: Mill Creek, Rickreal, Rowell, and Luckiamute River.* Salem District Office, OR.

U.S. Department of Commerce (USDC). 1995. *LandView III Environmental Mapping Software – Census Data.* Oregon State Archives, Salem, OR.

Natural Heritage Program. 1998-9. *Terry Campos – Personal Communications*. Portland, OR.

Polk County, 1985. *Polk County Comprehensive Plan: Background Report Forest Lands.* Polk Soil and Water Conservation District, Dallas, OR.

Mid-Willamette Valley Council of Governments and Boatwright Engineering, Inc., 1969. *A Water And Sewer Plan for Polk County, Oregon.* Polk Soil and Water Conservation District, Dallas, OR.

United States Department of Agriculture. 1978. *Predicting Rainfall Erosion Losses.* Polk Soil and Water Conservation District, Dallas, OR.

Pacific Northwest River Basins Commission. 1969. *Willamette Basin Comprehensive Study: Water and Related Land Resources- Hydrology.* Polk Soil and Water Conservation District, Dallas, OR.

Polk County. 1977. *Background Report: Agricultural Lands.* Polk Soil and Water Conservation District, Dallas, OR.

Polk County. 1978. *Background Report: Natural Resources.* Polk Soil and Water Conservation District, Dallas, OR.

Bureau of Reclamation. 1992. *Willamette River Basin Water Optimization, Oregon – Lincoln, Polk, and Yamhill Counties Working Paper.* Polk Soil and Water Conservation District, Dallas, OR.

U.S. Army Corps of Engineers. 1968. *Flood Plain Information, Willamette River, and Tributaries in Marion and Polk Counties. Volume 1.* Polk Soil and Water Conservation District, Dallas, OR.

United States Department of the Interior. 1965. *Willamette River Project – Red Prairie Division.* Polk Soil and Water Conservation District, Dallas, OR.

Species References and Resources

Casey, Carrie and Paula E. Langguth. "The Bird of Contention." American Forests Sept-Oct. 1991: 28+.

Coho, Kris. "Sensitive Amphibians." Home Page. 29 Sept. 1999 http://www.pond.net/roughly kris/Amphibs/Amphib.htm.

Eastman, Donald C. Rare and Endangered Plants of Oregon. Wilsonville, OR. Beautiful American Publishing Company, 1990.

Jensen, Mari N. "Butterfly May Use Flowery Stepping-Stones." Science News. 25 April 1998: 262.

Knipper, Katie. "*Chrysemys picta.*" 19 April 1996. University of Michigan. 10 Oct. 1999 http://animaldiversity.ummz.umich.edu/accounts/chrysemys/c._picta.

Morey, S. "Tailed Frog (*Ascaphus truei).*" 10 Oct. 1999 http://cdfg.dfg.ca.gov/whdab/cwhr/tfrog.html.

"Northern Spotted Owl Habitat." United States Fish and Wildlife Service. 11 June 1997. 16 Sept. 1999 http://refuges.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Birds/SpottedOwlHabit.

Oregon Natural Heritage Program. Rare, Threatened, and Endangered Species of Oregon.

Portland, OR: Oregon Natural Heritage Program, 1998. www.heritage.tnc.org

"Rare Species Fact Sheet." United States Fish and Wildlife Service. 1999. 10 Oct. 1999. http://www.us-airforce.org/ifbe/rarespecies.htm.

Rosenberg, Stacy and Susan Saul. "Federal Protection Proposed for Butterfly and Two Plants from Remnant Native Prairie of Oregon's Willamette Valley." 27 Jan. 1998. United States Fish and Wildlife Service. 10 Oct. 1999. http://www.r1.fws.gov/news/9808nr.htm.

Scott, Shonene. "Oregon Native Turtles." Oregon State University. 10 Oct. 1999 http://hope.cse.pdx.edu/wetlands/turtles.dir/Ont.htm.

"The Tailed Frog." Home Page. 10 Oct. 1999. http://www.naturepark.com/tfinfo.htm.

2.0 Watershed Characterization and Assessment

2.1 Mill Historical Information

Methodology

Historical information was collected using protocols and sources listed in the OWAM. Information was gathered from numerous sources including the Polk SWCD office library, Polk County Historical Society, Oregon State Library archives in Salem, local historians and residents. A complete list of references and resources is included at the end of this section.

John Cruickshank, a resident of Gooseneck sub-watershed, contributed much of the local history sited in this assessment. John was able to collect copies of historical photos, conducted oral interviews with long time elderly residents and extensive reviews of historical books and newspaper articles. John was also able to contribute his own knowledge of the watershed's history.

Historical Information

The following timeline provides a chronological list of the important events that helped shape the present condition of the Mill watershed. A brief narrative of these major events follows the timeline. Figure 5 shows many of the known historical structures in the Mill watershed.

Mill Watershed Timeline:

Pre-European Kalapuya Indians use fire as a tool; lower elevations of Mill watershed are mostly grasslands with frequent native fire.

1782 Willamette Valley Indians are exposed to smallpox, native populations decline. Valley vegetation burning decreases accordingly.

1800s Large scale fire reported on BLM 1850 fire maps burned in the Upper Mill and Middle Mill sub-watersheds.

1812 Beginning of direct white contact with the Indians of the Willamette Valley (Boyd, 1985).

1831 Malaria outbreak begins in area Indian populations.

1840+ Wetland areas are tiled and drained for agricultural use and residential planning.

1841 Kalapuya population estimated at 600. Malaria outbreak leads to significant decreases in Indian populations and subsequently valley burning. Forest begins to "reclaim" prairie valley habitat.

1848 Nestucca fire potentially burns part of Mill watershed forests.

1849 Kalapuya tribe population recorded at 60 members.

1851 Elias Buell builds mill near present day Mill Creek Park. Dam (200 ft. long x 40 ft. high) build in same location.

1855 Kalapuya, Umpqua, and Takelma Indians moved to the Grand Ronde Reservation. Congress ratifies treaty with Confederated Bands of Grand Ronde.

1861 Large flood on South Yamhill River and tributaries. Magnitude estimate to be similar to 1964 flood levels.[5]

1863 Lumber Mill on Mill Creek washed out and rebuilt in same year.

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[5] Flood information from Yamhill River Flood Plain Information, Yamhill Soil and Water Conservation District Jan. 1976

1883 Mill race built for grist mill in Sheridan. Dam was also built on Mill Creek to supply flow for the race.

1890s Gooseneck Creek diverted from original channel to present day course. Digging done by human and horsepower. Buell store built near present day Mill Creek and HWY 22 intersection. A reported 70 splash dams used to move lumber to mills on Cedar and Mill Creeks over a 27 year period[6].

1900+ Nearly all of Upper, Middle and Gooseneck sub-watersheds are heavily logged creating present day forest stand ages from early (0-39 years) to middle (40-80 years) seral stages.

1906 Log flume built from Mill on Mill Creek to Sheridan Lumber company in Sheridan.

1933 Tillamook Forest fire burns 240,000 acres in region.

1934 Indians of the Grand Ronde Community are chartered; tribal trust lands amount to 440 acres.

1936+ Aerial photographs[7] show Mill and Gooseneck streams having increased channel complexity with braided channels and extensive riparian width and coverage. Combination of channel confinement (rip rapping) and dredging served to reduce channel complexity through the watershed history as document by historical photograph.

1950+ Large hatchery releases of winter Steelhead, Coho, and Rainbow trout to Mill watershed.

1951 Grand Ronde Tribal charter terminated by Congress with 440 acres of reservation acreage sold.

1964 Greatest of recorded floods in Mill watershed.

1980s Hatchery stockings of Winter Steelhead, Coho and Rainbow salmonids ceased.

1988 Congress creates new Grand Ronde Reservation of 12,035 acres in area just a few miles NW of Mill watershed.

1996 Large-scale flood in Mill watershed (100+ year event). DEQ's lists Mill Creek on 303 (d) list of water quality limited streams for fecal coliform and temperature.

1998 Mill watershed's summer stream temperatures recorded as high as 90 ^{0}F. Gooseneck watershed group organizes and begins regular meetings.

1999 Winter Steelhead found in Mill watershed are federally listed as threatened species under the Endangered Species Act.

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[6] BLM report 1998.
[7] Aerial photographs from Oregon State University map archives years 1936, 48, 54, 68, and 74.

Historical Narrative

The Kalapuyan Indians were the original residents of the Mill watershed. The tribe's people were known to be hunters, gathers, and exceptional fishermen. Valley vegetation burning was conducted by a majority of the tribes in the Willamette Valley including the Mill watershed tribes. Burning was conducted for a variety of practical reasons including improved pastures for game habitat, visibility, increased yield of seeds, clear land for planting, and to reduce the threat of snakes and insects (Boyd, 1985).

It is thought that the indigenous people's valley burning kept the Willamette Valley as an oak savanna ecosystem. However due to a series of settler induced disease outbreaks between 1812 – 1849, the Kalapuyan population decreased dramatically as did the vegetation burning. In accordance with this decrease the savannah climax vegetation community was progressively replaced by conifer forests and exotic weed species.

1855 saw the formation of the Grand Ronde Reservation now located in the western section of Yamhill County. Indian tribal members from the numerous tribes in the Willamette Valley including Kalapuya, Umpqua, and Takelma were moved there. During the early 1900s, lands were ceded back to the United States government. In 1956, Congress turned over the remaining tribal assets to a trustee who sold or disposed of the remaining acreage and buildings. In 1988, Congress created a new Grand Ronde Reservation of 12,035 acres. In 1999, the Confederated Tribes of the Grand Ronde signed a land management agreement with the BLM for federal lands upstream from present day reservation lands.

Settlers first moved to and homesteaded in the Mill watershed during 1840's. Elias Buell was one of the areas first European residents arriving in the watershed in 1848. During that first year, Buell established a blacksmith shop and then in September, traveled to California to search for gold that had been recently discovered there. He returned in 1849 with $2,000 in gold, which he used to construct a sawmill and dam on Mill Creek.

The mill facilities were completed in 1851 and included a cookhouse, bunkhouse, family house, blacksmith shop, oil house, office, storage structures and a large barn (Figure 5). The sawmill was washed out by a large flood in 1863 and then rebuild later that same year. The sawmill went through several owners until it was finally bought out by Sheridan Lumber Company in the early 1900s. Another smaller mill and dam was reported to have been built on Cedar creek during this same period, although records of this mill were difficult to obtain.

An estimated 70 splash dams[8] were reported to have been built in the watershed over 27 year period, and while they provided a relatively easy delivery system for timber to the mills, they also caused catastrophic damage to the stream channels on which they were situated. Some remnants of these structures can still be found today on Mill Creek (Figure 5).

Beginning in the 1840's until the present day, wetlands, and low lying areas in the watershed were tiled and drained for rural residential and agriculture uses. In 1848, the Nestucca fire burned large sections of the northwest Oregon coast range. While it is completely speculative as to if it came as far east as the Mill watershed, an 1850s BLM vegetation map shows a large area both the Upper and Middle sub-

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[8] Splash damming (late 1800's into the early 1900's) was commonly used as a tool for moving logged trees to downstream sawmills. Splash dams are created by building instream dams that increase the overall depth and width of the creek. After a sufficient amount of water and downed trees are collected behind a dam, the structure is removed, usually with dynamite and water, logs, and debris move downstream to a collection point or sawmill.

watersheds being burned during that time period. Settlers were also known to use fire to clear land for agriculture and grazing. Fires would often get out control and burn large parts of the Mill watershed; records of specific smaller fires are difficult to find.

There were two structures built and one major diversion in the Mill watershed of historical importance to the natural flow of water. A mill race that supplied hydro-power to a Sheridan grist mill was built in 1883 by Benton Embree (Figure 5). The race consisted mainly of a trench that ran from a dammed portion of Mill Creek to the gristmill located in the town of Sheridan. The race was constructed by Chinese laborers employed regionally to work in the hop fields. The race was eventually phased out and the trench filled in by area residents, however today, its path can still be seen in sections along Harmony Road in Lower Mill sub-watershed.

In 1906, a log flume was constructed from the sawmill on Mill Creek to the Sheridan Lumber Mill in Sheridan. The mill owners needed a good way to transfer lumber to the Sheridan mill, as the road system was inadequate at the time. They considered two possible solutions, build a railroad or build a log flume. The railroad was favored because it would also help local farmers export produce to market. The log flume was considered more practical because there was a plentiful supply of wood and cheap labor available locally.

The decision was made to build the flume, which took roughly two years to complete. The flume was roughly 10 miles long and varied in height from 6 feet below the ground to over 80 feet above and crossed both streams and roads along it's course (Figure 5). A relatively large dam was also built at the sawmill site to supply flume water and was roughly 200 feet long running across the entire valley flood plain with it's highest point on the channel of 40 feet.

Over the years, problems with the flume included sections of the flume being blown down while frequent water leaks and log jams reduced its overall efficiency. Mill watershed residents often planted gardens just below the flume because the leaks supplied year round irrigation. In order to keep the flume running smoothly, two "flume walkers" where employed to walk along the catwalk each day to insure against log jams. They would start each morning on either end of the flume and would meet in the middle and then return to their respective starts. Eventually telephones were installed along the flume so that the walkers could call when there was a jam.

The more adventurous locals would climb the flume and ride planks down for a thrill while sawmill workers were reported to have regularly ridden planks to the Buell store for supplies and then walked back to the sawmill. In 1919, a large windstorm blew down a large section of the flume and the decision was made not to rebuild. The company tore down the flume and the wood was used by local residents to built barns, and homes.

During the 1890's Gooseneck creek was diverted from it's natural channel to its present day course. Remnants of its historical channel can still be seen in areas of the Gooseneck sub-watershed. The diversion was dug by hand and horses to allow easier access to local fields. Throughout the rest of the 20^{th} century settlers continued to move to the area and build farms, churches, schools, mills and homesteads in the watershed. The Buell store was built around the turn of the century along with the Buell post office.

In the later part of the 20^{th} century many different types of fish were both introduced and stocked in the Mill watershed. The state of Oregon began stocking winter Steelhead and Coho salmon in the watershed during early 1960's. Coho salmon, while not native to the watershed, are widely sought after in ocean sport and commercial fisheries. Winter Steelhead while considered being native to Mill watershed was also stocked from Big Creek hatchery. The stocked Steelhead spawn earlier than the natives and were used to supplement natural production. Stocking of hatchery fish continued up until the 1980's when concern over success of the stocking programs and their impacts upon native fish led to the termination of both programs. Today there are no stocking programs being pursued in the watershed.

References and Resources for Historical Conditions

Bureau of Land Management (BLM). 1901, 1936. *State of Oregon Vegetation Map*. Salem, OR.

Ternsma, P. D. A. Oct. 1991. *Preliminary Reconstruction and Analysis of Change in Forest Stand Age classes of the Oregon Coast Range from 1850 to 1940*. US Department of the Interior, # OR-9.

Hanson, D. 1998. *Oak Savanna*. Wampka – The Journal of the Che-ahm-ill Watershed Society, Winter-Spring, Che-ahm-ill Watershed Society.

Moser, S.A, Farnell J. E. 1981. *Yamhill River Navigability Study*. Division of State Lands, Salem OR.

Louie, H. G. 1962. *Yamhill County Agriculture History* – County Extension Agent Notes. OSU Extension Office, McMinnville, OR.

Zybach, B. 1988. *The Great Fires of the Oregon Coast Range: 1770-1933*. College of Forestry, Oregon State University, Corvallis, OR.

Boyd, R. 1985. *Strategies of Indian burning in the Willamette Valley*. Canadian Journal of Anthropology. Salem Archives, Salem OR.

United State Army Corps of Engineers. January 1976. *Flood Plain Information – Yamhill River-North Yamhill River-South Yamhill River*. Portland District Office

Yamhill County Planning Department. 1974 *Yamhill County Comprehensive Plan*. Yamhill County courthouse. McMinnville, OR.

Cruickshank, John. *Personal communications*. 1999. Farmer and landowner in Gooseneck Creek subwatershed.

2.2 Channel Habitat Types

Methodology

The 1999 OWAM draws on several stream classification systems to create a basic group of channel habitat types (CHTs) used for this assessment. CHT classifications enable us to partition the streams into specific segments based on stream gradient, floodplain width, and other channel morphological conditions. These segments will be used later to evaluate the overall condition of the watershed and to identify specific stream segments for restoration efforts. CHTs of the Mill watershed were classified with the assistance of Nick Varnum (PNG Environmental Inc., Tigard).

The process for identifying each stream segment as a specific habitat type involved several steps. The first step was to gather the materials required, including aerial photographs, topographical maps, and stream surveys from ODFW. The next step in the process was to break up the streams of the watershed into segments, depending on channel gradient classes. The third step involved assessing the topography of the channels and determining their confinement. Using these characteristics, CHTs were then assigned to corresponding channel sections. The final step was field verification of the different CHT designations.

Covered:

- Channel gradient designations using "blue line"[9] streams of USGS topographical maps.
- Flood plain width designation using USGS topographical maps and FEMA report.
- Channel habitat types using maps, aerial photographs, and field verification visits.

Not Covered:

- CHTs were only determined for USGS "blue line" streams. CHTs should be determined for many of the smaller streams in the watershed.
- CHTs were not compared with ODFW stream surveys due to time constraints. ODFW surveys exist only for a portion of the Upper Mill Creek area.

Channel Habitat Types

The Mill watershed consists of seven different channel habitat types (Figure 6). Descriptions for each habitat type are recorded in Table 6. Table 3 also summarizes the percentage of CHT distributions in each of the Mill watershed sub-watersheds.

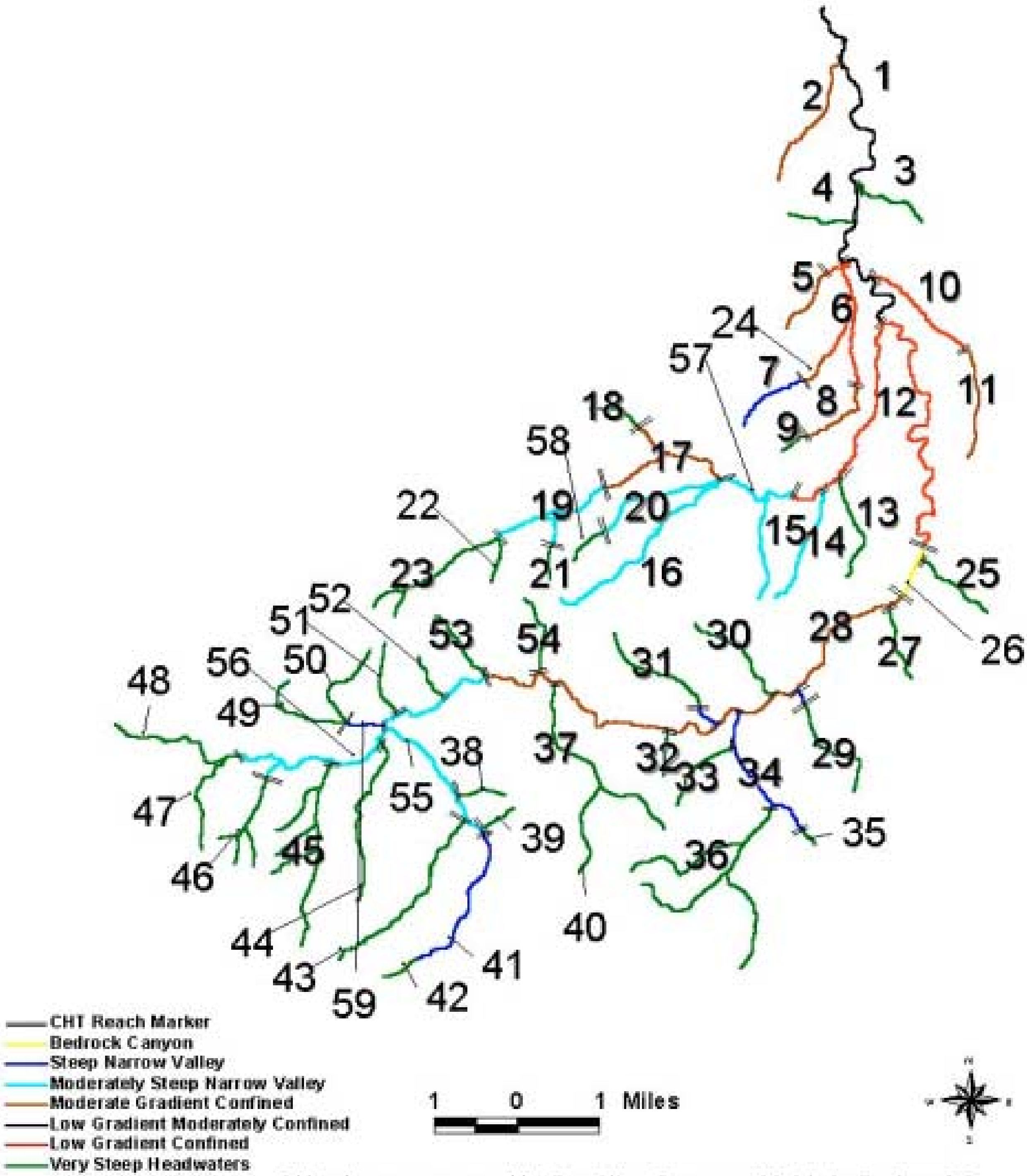
Table 3. Channel Habitat Type Subwatershed Distribution

CHT Designations	Lower Mill	Middle Mill	Upper Mill	Gooseneck
Very Steep Headwater (VH)	4%	32%	64%	75%
Steep Narrow Valley (SV)	6%	0%	9%	9%
Moderately Steep Narrow Valley (MV)	0%	46%	0%	14%
Moderate Gradient Constrained (MC)	31%	6%	22%	3%
Bedrock Canyon (BC)	0%	0%	5%	0%
Low-Gradient Constrained (LC)	28%	16%	0%	0%
Low Gradient Moderately Confined (LM)	31%	0%	0%	0%

A majority of the low and moderate gradient, wide flood plains CHTs (MC, MV, LC, and LM) are found in Lower Mill sub-watershed with some in Middle Mill subwatershed located along Mill Creek. Gooseneck, Middle Mill, and Upper Mill sub-watersheds are made up of CHTs (MV, SV, and VH) that show moderate to very steep channel gradients, and highly confident flood plains.

[9] "Blue Line" streams are those that are recorded on the USGS 7.5-minute quad maps of the Mill area.

Figure 6. Channel Habitat Types



* Numbers correspond to Condition Summary Matrix in Section 3.0.

Table 6. Descriptions of Channel Habitat Types

Channel Habitat Type	Description	Fish Utilization
Low-Gradient Moderately Confined Channel **(LM)**	Low gradient reaches that display variable confinement by low terraces or hill slopes. A narrow floodplain approximately 2-4x width of channel.	Anadromous: potential coho,steelhead spawning & rearing. Resident: Potential spawning, rearing, and overwintering.
Low-Gradient Constrained Channel **(LC)**	Low to moderate gradient hillslopes with limited floodplain, relatively straight valle, partial or complete barriers may occur at bedrock knickpoints.	Anadromous: Potential coho, steelhead spawning & rearing. Resident: Potential spawning, rearing and overwintering.
Moderate Gradient Constrained Channels **(MC)**	Narrow open to moderate v-shaped valley, hillslope constrained or hillslope-terrace constrained.	Anadromous: Potential steelhead spawning & rearing. Resident: Potential spawning,rearing & overwintering.
Moderately Steep, Narrow Valley Channel **(MV)**	Narrow valley, hillslope constrained but can develop narrow floodplain.	Anadromous: Potential steelhead spawning & rearing. Resident: Potential spawning & rearing.
Bedrock Canyon Channel **(BC)**	Very Narrow v-shaped, bedrock constrained, Migration barriers, can occur anywhere within drainage system.	Anadromous: Lower gradient segements may provide rearing. Resident: Limited resident spawning and rearing.
Steep Narrow Valley Channel **(SV)**	Narrow v-shaped, hillslope constrained.	Anadromous: Lower gradient segements may provide rearing. Resident: Limited resident spawning and rearing.
Very Steep Headwater Channel **(VH)**	Narrow v-shaped, hillslope constrained.	Very limited resident Rearing.

References and Resources

U.S. Geological Survey topographic maps (Laurel Mountain, Sheridan, Grand Ronde, and Socialist Valley, OR, 1:24,000, 7.5-minute quadrangle, 1970 photorevised 1975 and 1969, photorevised 1986).

USDA Farm Service Agency. 1998. *1:660 ft. Aerial photographs.* Farm Service, McMinnville, OR.

2.3 Fish

Introduction and Methodology

The main objective of the Fish section is to identify fish species in the watershed, where their occur, what is known about their historical and current populations and what is the condition of their present day aquatic habitat. The focus of this section is primarily on the anadromous salmonid species; winter Steelhead and Coho (silver).

Other fish species such as Sculpin and Cutthroat trout[10] are important parts of the aquatic ecosystem but are not considered as high of a priority at this time due to their relatively abundant populations. An understanding of the current and historical fish habitats can aid us to focus conservation and restoration efforts to have largest impact.

[10] Note: Cutthroat trout are considered a high priority and in fact drive many of our (ODFW) management and regulatory decisions in the watershed because of their wide distribution. They are also frequently used as the best indicator of stream/watershed health (Gary Galovich, 1999).

This section was completed by the author using the 1999 OWAM protocol and by utilizing data provided by ODFW and BLM reports and personnel. Some field verifications were conducted with regards to fish barriers.

Covered:

- Stocking history
- Life history and patterns, important habitat areas
- Known migration barriers
- Some field verification

Not Covered:

- Species interactions at watershed scale
- Specific fish distribution information not available

Fish Background

The Mill watershed has an extensive list of fish species present in its waters (Table 4). This list includes both native and exotic as well as anadromous and resident species[11]. In 1999, the winter Steelhead (*Oncorhynchus mykiss*) were listed as threatened species by the National Marine Fisheries Service (NMFS) under the Federal Endangered Species Act. This listing has the potential to affect current land use and water-related practices in the Mill watershed and Willamette basin.

Another salmonid species present in the Mill watershed is the Coho (silver) salmon. The official ODFW status for Coho salmon in the Mill watershed is: "The few Coho (Silver) salmon (*Oncorhynchus kisutch)* present in the Mill watershed are not included under any listings because they are non-native and are of hatchery origin. Lower Willamette coho were listed but that did not include any Coho in the upper Willamette basin" (Gary Galovich, ODFW 1999).

[11] Anadromous fish are those that migrate to the ocean during their life cycles. See fish life cycles section for more information.

Table 4. Mill Watershed Fish Species
Anadromous:
Steelhead Trout *(Oncorhynchus mykiss)*
Coho Salmon *(Oncorhynchus kisutch)*
Pacific Lamprey *(Entosphenus tridentatus)*
Western brook Lamprey *(Lametra richardsoni)*
Resident:
Cutthroat Trout (*Oncorhynchus clarki clarki*)
Longnose Dace *(Rhinicthys cataractae)*
Rainbow Trout *(Oncorhynchus mykiss)*
Prickly Sculpin *(Cottus asper)*
Reticulate Sculpin *(Cottus perplexus)*
Riffle Sculpin *(Cottus gulosus)*
Torrent Sculpin *(Cottus rhotheus)*
Redside Shiner *(Richardsonius balteatus)*
Sucker (*Catostomus sp.*)

Other fish species such as Cutthroat trout, two species of anadromous lamprey and numerous warm water species also use a significant portion of Mill's streams and tributaries as habitat. While this assessment focuses on the cold water species, these other species should be considered when planning any restoration efforts in the watershed.

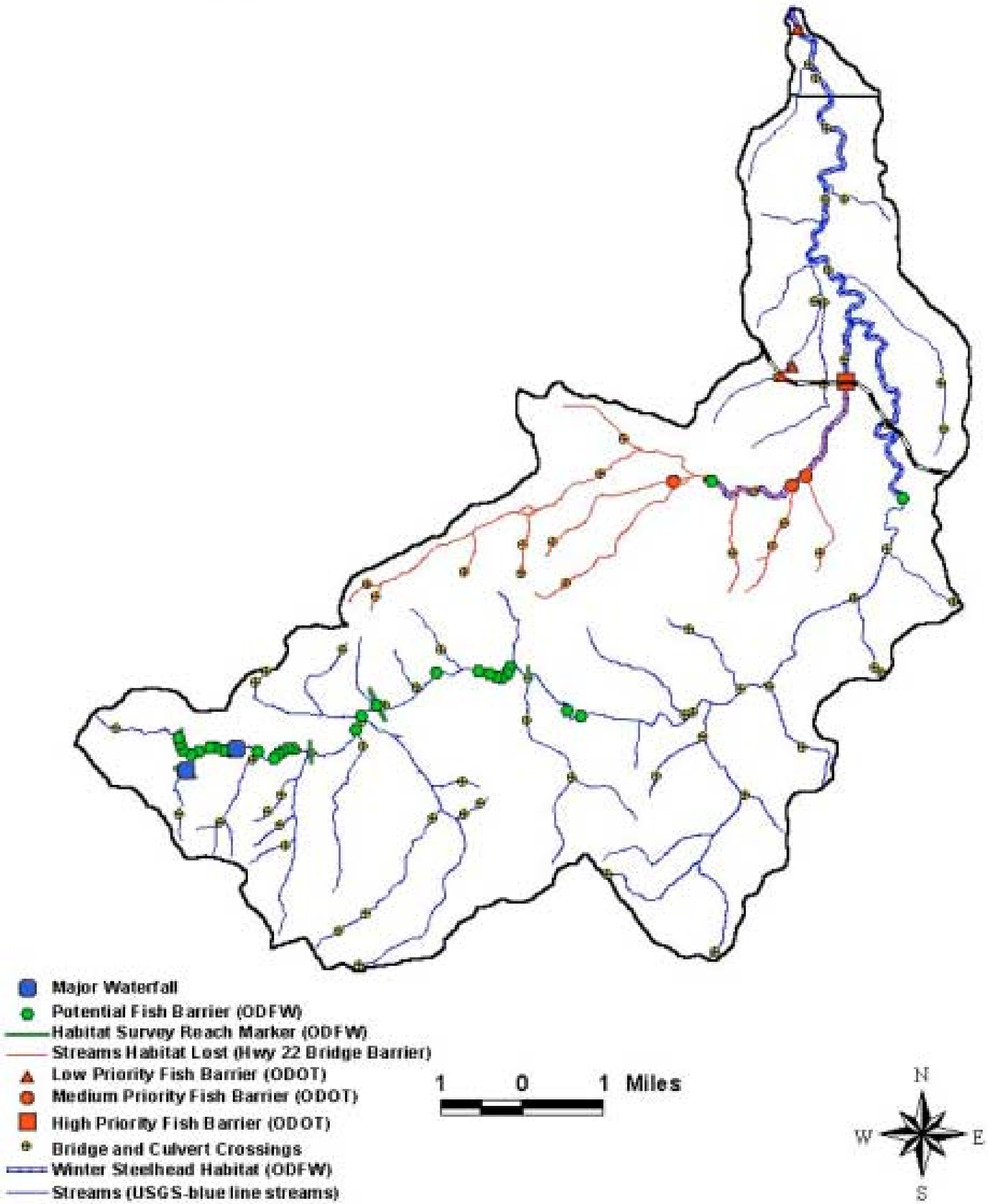
Fish Life Cycles

Understanding where threatened fish live at a particular time of the year is important information for planning restoration and monitoring efforts. Juvenile winter Steelhead (before they migrate to the ocean) prefers to live in the higher gradient streams found in the upper reaches of the Mill watershed. Steelhead generally prefer cold, fast moving water and other habitat characteristics associated with steeper gradient areas. A study conducted in Western Washington, has shown that Steelhead prefer streams with channel gradients of 0.5% or greater (ODFW, 1992).

Adult Steelhead spawn between January and April with a majority of activity occurring in mid-late spring. Winter Steelhead juveniles rear in fresh water for 1 to 2 years and then migrate to the ocean in the spring. Most Steelhead spend approximately 2 -3 years in the ocean. Their ocean behavior and distribution is poorly understood but it appears that they migrate further offshore than other salmon species. The adults return to fresh water to spawn during the winter and may spawn more than once a winter (OSUES, 1998). (Figure 7).

Coho salmon that were hatchery stocked have spawning areas designated by ODFW surveys in the Mill watershed. Their locations coincide with where the stocks were released over the years. Coho juveniles rear in habitat throughout a watershed and tend to live in cooler pools in the summer. Year old juveniles migrate to the ocean during the spring and tend to rear just off the Oregon coast for approximately 2 years. Adults return to fresh water in the fall and spawn in the late fall and winter. The spawning generally takes place in concentrations on gravel bars in the upper parts of watersheds (OSUES, 1998).

Figure 7. Fish Habitat



Cutthroat trout stocks in the Mill watershed are not considered anadromous meaning they do not normally migrate to the ocean during their life cycle. They display two non-anadromous types of life history patterns: resident, where they stay in the local watershed system, and fluvial, where migration occurs between watersheds. Cutthroats are the only species of trout native to the Mill watershed. They tend to spawn using small pockets of gravel in the winter and early spring. They have been reported to spawn more than once during the spawning period and their spawning ages vary. They prefer to spawn in the gradient tributaries and streams of the upper watershed (OSUES, 1998).

Warm water game fish including largemouth and smallmouth bass, white crappie, bluegill, pumpkinseed, yellow perch, and brown bullhead can be found in the lower reaches of the Yamhill river watershed. Non-native bullfrogs are also found. They generally live and breed in the lower reaches of the watershed preferring the warmer slower moving water. Spawning times and locations vary with each species. Their populations are currently considered to be relatively stable (ODFW, 1992).

Fish History

The Mill watershed has a historical record much like the other watersheds of the Lower Willamette valley. Populations of native fish species have been negatively impacted by both the degradation of their aquatic habitat and the introduction of non-native fish species. Introduced warm water fish such as Largemouth and Smallmouth bass, Black and White Crappies, Bluegill, Pumkinseed, Warmouth, Yellow Perch and Brown Bullheads have competed with native species for habitat and are successful predators of the native species. Largemouth bass and panfish have been in the Willamette river basin since their initial introduction in the early 1800s.

With regards to native winter Steelhead populations, ODFW considers the Yamhill Basin to currently be one of the most productive areas in the Coast Range Sub-watershed. The Coast Range sub-watershed makes up the western part of the Upper Willamette Valley (ODFW, 1992). However, historically the Yamhill Basin has probably never supported large populations of winter Steelhead prior to stocking efforts began in the 1950s (ODFW, 1995). The suspected winter Steelhead (*Oncorhynchus mykiss*) spawning areas are located on Mill, Gooseneck and Rowell Creeks shown in Figure 7 (ODFW, 1992). Spawning surveys conducted on Mill Creek (1985-1991) showed an average of 1.8 Redds per mile[12]. Harvest and angling records from 1977-89 show 159 Steelhead tags being returned from Mill Creek. The highest tag return year was 1959 with 59 returned from catches on Mill Creek.

Coho salmon (*Oncorhynchus kisutch*) are considered non-native to the Willamette basin above Willamette falls which would include the Mill watershed area (ODFW, 1992). The resident populations found in Mill watershed are considered introduced from hatchery stocking efforts. They were first introduced above the falls in the 1920s with large releases of hatchery stock occurring from 1950s through the 1970s.

The first reported stocking for Mill watershed was by the Oregon Fish Commission (OFC) in 1954. These stocking effort were terminated when returns did not meet expectations and fears of wild and hatchery stock interbreeding became important (ODFW, 1992). These non-native coho salmon still spawn in areas of Mill, and Gooseneck Creeks (Figure 7).

Cutthroat trout (*Oncorhynchus clarki clarki*) are considered native to the Mill watershed. Stream surveys conducted in 1979 showed a total of 63 Cutthroats with 50 found in Mill Creek and the remaining 13 in Gooseneck Creek. Rainbow Trout (*Oncorhynchus mykiss*) are considered non-native and were introduced

[12] 'Redds' are adult winter Steelhead that take on a red scale color when they return from the ocean to spawn.

to the Mill watershed through stocking efforts. Between 1978-90 more than 50,000 Rainbows were released to Mill Creek between (ODFW, 1992). Data regarding present day populations and spawning locations for both trout species were not available at the time of this report.

It should be mentioned that Oregon has three native species of crayfish, all of which are thought to be present in the Mill watershed. Crayfish are considered the most important freshwater invertebrate to Oregon's fisheries. Because of their hypersensitivity to pesticides and water pollution, they also act as an excellent habitat health indicator. Little is currently known about both the historical and present day populations of these species. However, anecdotal evidence collected from local residents indicates that the populations of Mill watershed crayfish have decreased dramatically during this century.

Fish Habitat

Figure 7 maps the stream sections designated as salmonid habitat and surveyed as spawning areas for winter Steelhead (ODFW, 1992). Most of the Mill watershed 's smaller tributaries and streams have not been recently surveyed for fish habitat. These un-surveyed areas of the watershed should be taken into account as potential habitat and/or spawning areas for salmonids and other aquatic organisms.

The BLM reported that the overall fish habitat condition for this watershed was considered poor (BLM, 1998). The lack of deep pools for fish cover from predators and winter flows in addition to low numbers of coarse woody debris in the system contributed to this overall rating. It was not clear from the BLM analysis if they considered the entire watershed to be in poor condition or just the segments that had been field surveyed. The BLM utilized the stream surveys provided by ODFW.

Habitat conditions in the areas designated as winter Steelhead habitat was assessed for this report by several field visits to the area. While streamside vegetation does exist along the banks of lower Mill and Gooseneck Creeks, there are frequently large sections with little to no vegetation cover. Analysis also indicated that there was very little potential LWD in the riparian zone due to the relatively young stands of trees in the riparian and upland areas. Instream LWD was scare and when present, was usually too small. While more information about pool frequency and quality, and substrate conditions are required for an accurate condition evaluation, the data gathered thus far would indicate an overall poor habitat condition.

Fish Barriers

Fish barriers are either natural or human created obstacles that impede the passage of fish. Barriers include such things as culverts, dams, waterfalls, log jams and beaver ponds. Barriers of these types can pose a significant problem for both the migration and spawning of anadromous and resident fish species. As habitat, population, or water quality conditions change, perhaps even seasonally, fish need to move to watershed locations that have more favorable habitat conditions.[13]

Fish barrier locations were collected from ODFW stream surveys, a fish passage culvert database constructed by ODFW, and are shown in Figure 7 (Mirati, 1999). ODFW habitat surveys were conducted in 1994 on Mill and Fall Creeks in the Upper Mill sub-watershed. Figure 7 shows the reach marker used in the surveys along with the potential fish barriers reported by the survey team. Two major natural waterfalls are also shown on the map. A large number of undetermined types of fish were reported in the ODFW aquatic inventory report (ODFW, 1994) above the most upstream waterfall on Mill Creek.

[13] Gary Galovich, ODFW fish biologist, 1999

Culvert and bridge barriers surveyed and prioritized by ODOT and ODFW are also shown in red in Figure 7. The majority are on Gooseneck Creek with low to medium action priorities. The most significant human created fish barrier in the watershed is located at the Highway 22 crossing of Gooseneck Creek. A large headcut[14] is found immediately downstream of the bridge foundations, which creates a major fish barrier during summer and potentially even in during the high winter flows. Staff from county and state agencies have surveyed the barrier over the years but there are no reported plans to take corrective measures. In Figure 8**,** red stream segments indicate the fish habitat lost as a result of this barrier on Gooseneck Creek and its tributaries. Note that several miles of the ESA listed winter Steelhead designated spawning area in Gooseneck Creek are also lost.

Other public and private bridge and culvert crossings are also identified as potential fish barriers in Figure 8. This information was collected by flagging all of the known 'blue line' stream and road crossings in the Mill watershed. While many of these locations may not be problems for fish, it was frugal to include them as potential barriers until their status can be field verified.

Fish References and Resources:

Bureau or Land Management (BLM). *Rowell Creek/Mill Creek/Rickreall Creek/Luckiamute River Watershed Analysis.* Mary's Peak Resource Area, Salem District, Salem OR. Pages 42-49.

Oregon Department of Fish and Wildlife. (ODFW) 1999. *Oregon Sport Fishing Regulations.* Portland OR.

Oregon State University Extension Service. (OSUES) 1998. *A Snapshot of Salmon in Oregon*. Publications, OSU, Corvallis OR. 97331.

Oregon Department of Fish and Wildlife. (ODFW) 1992. *Coast Range Sub-watershed – Fish Management Plan.* NRCS, McMinnville OR.

Oregon Department of Fish and Wildlife. (ODFW) 1959. *Yamhill System Report*. District Office, Adair Village, OR.

Oregon Department of Fish and Wildlife. (ODFW) 1952. *Mainstem of Yamhill and Tributaries Inventory.* District office, Adair Village, OR.

Oregon Department of Fish and Wildlife. (ODFW) 1990. *Aquatic Inventories Project.* District Office, Adair Village, OR.

State of Oregon Division of State Lands. (DSL) 1999. *Essential Salmon Habitat – Maps.*

Oregon Fish Commission. (OFC). June 1960. *Fish Commission Survey*. ODFW. Corvallis, OR.

Mirati A. (Fish passage coordinator). 1999. *Fish Passage Culvert Database from ODOT and County Roads.* Oregon Dept. of Fish and Wildlife, Portland, OR.

2.4 Riparian Conditions

Introduction

Riparian areas are by definition regions adjacent to streams, rivers, and wetlands with characteristic plant and animal species that are unique to this habitat. Riparian areas generally have higher levels of moisture in the soil than do the adjacent upland areas. These elevated moisture levels generally support a more abundant and diverse ecosystem and there are varieties of hydraulic, geomorphic and biotic processes that determine the riparian area or zone.

[14] 'Headcut' is generally defined as a place in the river where the streambed is eroding downward usually caused by an obstacle or barrier upstream.

Riparian vegetation influences fish habitat and water quality in many different ways. It provides shading which helps to decrease the daily fluctuations in water temperature and provides fish cover from predation. It stabilizes stream banks, which decreases erosion and prevents downcutting. It provides habitat for insects and macro-invertebrates, which are a food source for fish. It also provides detritus or organic litter to the stream, which provides vital nutrients to the entire ecosystem. Riparian areas are also an important source of large wood recruitment to the system that is vital for fish habitat. The large wood provides cover for fish and also diverts channels and obstructs flow, which thereby increases channel and habitat complexity.

Methodology

Riparian conditions for the Mill watershed were determined using the OWAM. The manual uses a six-step method to determine the quality and quantity of the riparian vegetation. The first step is the collection of materials, including base maps, ecoregion designations (see channel habitat typing for details), aerial photographs (provided by the USDA Farm Service Agency), land use maps, conversations with ODFW personnel, and other watershed information resources. The second step divides the watershed into riparian condition units, based on the condition of vegetation, shading, canopy cover, stream size, sub-watershed, large woody debris recruitment, and channel habitat types. The third step is a field verification of the preliminary condition evaluations, as well as the areas not covered by aerial photographs. The fourth step is the evaluation and mapping of the riparian recruitment conditions. Step five is to produce a shade map, based on the shade characteristics determined in step two. The final step is to evaluate the overall confidence in the riparian assessment.

The numbered segments in Figure 8 correspond to the sections of the watershed where we were able to evaluate the riparian area using the OWAM protocol. Appendix A reports the data for each of those number segments. The unnumbered sections were evaluated using just the riparian widths due to the difficulty in finding aerial photographs that covered the Upper and Middle Mill sub-watersheds. Shade estimates were obtained from the BLM Watershed Analysis, 1998. Chris Lupoli, a Linfield College intern co-authored this section of the assessment.

Covered:

- Topographical and land use maps
- Conversations with ODFW personnel and ODFW stream surveys
- Aerial photographs
- BLM watershed analysis (BLM)
- Field verification on main stems of Mill and Gooseneck Creek

Not Covered:

- Information from private landowners was not available
- Field verification of some results
- RA_2 zones evaluation (from OWAM) not included.
- Riparian recruitment zones not determined due to lack of information
- Field verification not conducted on most tributaries
- Shade map not included in assessment as it reiterates assessment shown in Figure 8.

Riparian Conditions

Lower Mill

The Lower Mill sub-watershed has the most impacted riparian areas of the watershed. As noted in the Table 5, Lower Mill has the thinnest riparian widths at an average of 43 feet with the major vegetation being hardwoods (68%) (Figure 8). The riparian zones in this lower sub-watershed were one to two trees wide and consisted mostly of hardwood tree and herbaceous species. The encroachment of rural residential and agricultural land uses have diminished the quantity of riparian habitat along these lower Mill riparian corridors. Aerial photos revealed that a majority of the exposed soil and or grassy areas were being utilized for cropland and grazing uses. Riparian vegetation in this subwatershed consisted almost entirely of small to medium-sized hardwoods with very few conifers along the banks (Table 5). Vegetation was sparse and noncontiguous with younger stands being typical. The overall shade quality and large woody debris recruitment potential was estimated to be low.

Table 5. Sub-watershed Riparian Vegetation Widths and Types

	Mill Sub-watersheds			
	Lower Mill	Middle Mill	Upper Mill	Gooseneck
Average Riparian Width (feet)	43	49	61	79.5
Riparian Vegetation Types (% of total)				
Hardwood	68	60	13	34
Grassland/Agriculture	9	18	0	8
Mixed (Conifer/Hardwood)	5	10	5	15
Conifer	4	0	65	34
Exposed Soil	14	12	17	9

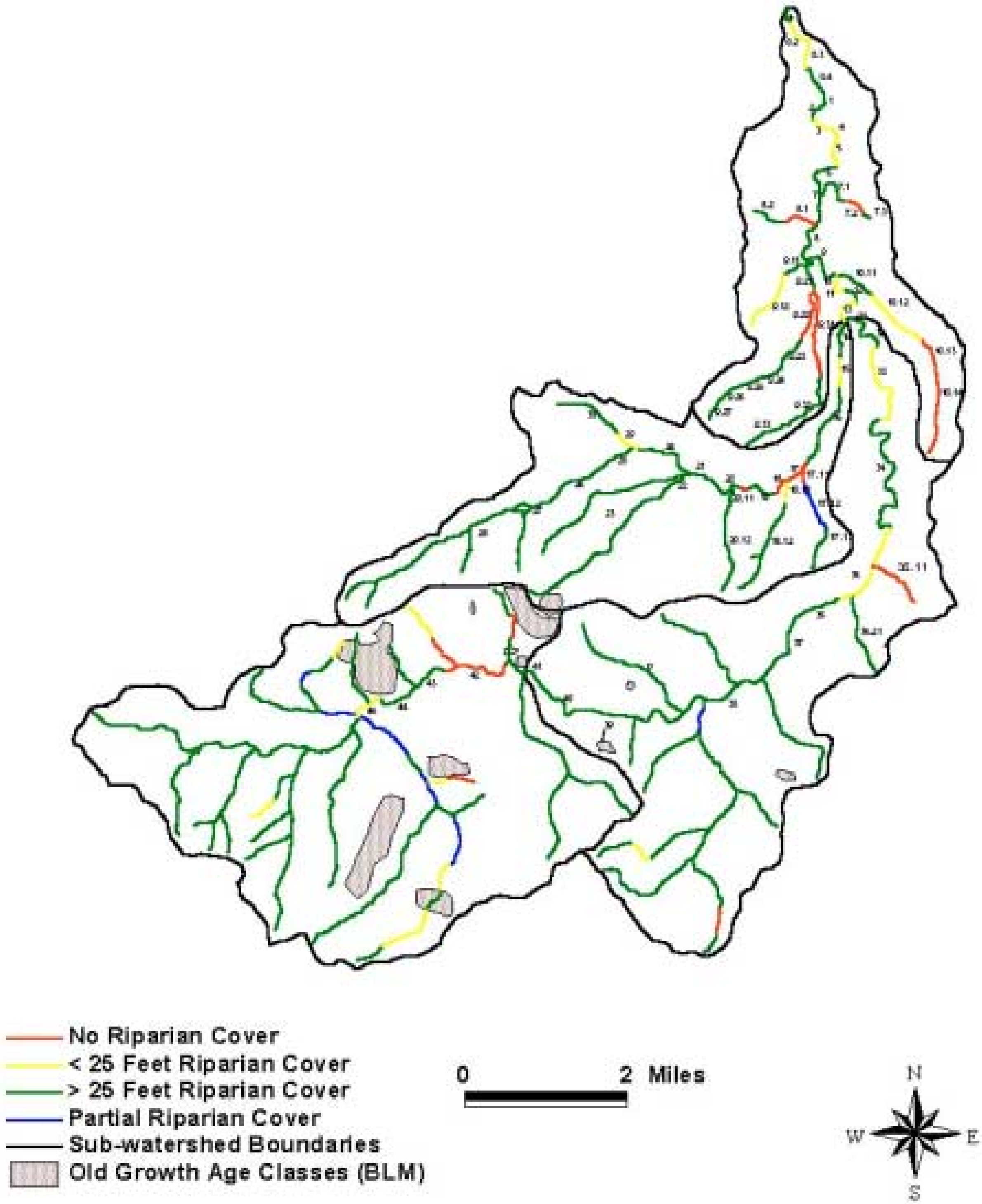
Middle Mill

Table 5 reports that Middle Mill sub-watershed has slightly wider riparian zones than the Lower Mill area with an average width of 49 feet (Figure 8). A majority of the riparian vegetation consists of hardwoods (60%) and a mixture of hardwood/conifers (10%). Many of its riparian sections along the main channel of Mill Creek are one to two trees wide, with some areas of wider and denser riparian zones. Riparian vegetation along the steeper tributaries and headwaters areas tended to be in better condition than sections along the main channel and roads. Overall, shade quality was estimated to be generally low in this sub-watershed with the exception of some small segments. Riparian LWD recruitment potential was low to medium, due to the lack of large diameter trees within the riparian zone.

Upper Mill

The riparian condition continuous to improve as we move up Mill Creek with the average riparian width for this subwatershed estimated at 61 feet. (See Figure 8) Exposed soil (12%) in riparian areas is still prevalent. The cause was generally from logging and rural roads. Nearly all of these exposed soil areas identified from the 1999 aerial photographs resulted from adjacent timber harvesting. Riparian

Figure 8. Riparian



hardwood species (13%), dominant in Lower Mill, are replaced by conifers (65%) as the stream and surrounding upland slopes become steeper and more constrained. The density and vegetation size classes are more robust in this subwatershed. In particular, the higher order stream segments are densely forested and riparian zones consist of a hardwood and conifer mix. Shade quality was quite low in stream segment near timber harvest and roads, and higher in older stand areas. Very little large woody debris was observed, possibly due to the lack of large trees. Nearly all of the forest vegetation in the subwatershed appeared to be in early to mid seral age stages with very few mature or old growth stands.

Gooseneck Creek

Gooseneck subwatershed had the widest average riparian widths in the Mill watershed estimated from aerial photographs at 79.5 feet. Generally, the riparian zones were narrowest along Gooseneck Creek where rural residential and agriculture land uses tend to reduce the quantity and size of vegetation. The steeper gradient tributaries to Gooseneck Creek tended to have wider more substantial riparian zones. There was less timber harvesting and road activity in this sub-watershed.

The types of riparian vegetation, while all relatively young, small stands, were evenly divided into hardwoods (34%) and conifers (34%) with an additional 15% being a mix of the two (Table 5**).** The headwaters of Gooseneck was densely forested along most streams and surrounding hills, with riparian zones of over a 100 feet and consisted mainly of a hardwoods and conifers mix. Shade quality ranged from low to medium in the lower reaches to medium to high conditions in upper areas. Riparian recruitment potential was relatively better in Gooseneck subwatershed, however larger trees were not commonly observed.

Final Riparian Assessment Quality Maps

The OWAM protocol includes an analysis of the shade and large woody debris (LWD) recruitment conditions. Shade quality was difficult to judge from aerial photographs and data from a BLM shade map was difficult to recreate and therefore was not generated for this assessment.

Figure 8 illustrates the overall riparian vegetation conditions assessed from aerial photos and some field verification. Four categories were established including; ‘no riparian’ – where no riparian vegetation was observed, ‘partial’ – where one bank lacked riparian vegetation, ‘Thin’ – where riparian zones was less an average of 25 feet or less and ‘full’ – where riparian vegetation zones were greater than 25 feet and present on both banks.

Extensive riparian recruitment information was not available at the time of this report. Field visits coupled with limited information provided by ODFW stream surveys indicate that the LWD recruitment conditions are fair to poor in the Mill watershed with very few large diameter trees located in the riparian corridor.

References and Resources for Riparian Conditions

Oregon Department of Fish and Wildlife. (ODFW) 1990. *Aquatic Inventories Project.* District.

Bureau or Land Management (BLM). *Rowell Creek/Mill Creek/Rickreall Creek/Luckiamute River Watershed Analysis.* Mary’s Peak Resource Area, Salem District, Salem OR. Pages 42-49.

2.5 Wetland Conditions

Introduction

Wetlands are defined as areas that are saturated or annually inundated with water for periods long enough to support particular types of ‘water loving’ vegetation and hydric soils types. The most obvious of these areas are often referred to as swamps, marshes, or bogs and they provide important biological functions in watersheds, such as absorbing floodwaters, filtering pollutants, recharging groundwater, and providing habitat for wildlife.

Wetlands can also be inconspicuous areas such as wet meadows, swales, seasonal seeps, and sometimes even ditches. Wetlands can sometimes be dry during the summer months and difficult to determine. Wetlands are typically associated with streams and rivers, however they may also be isolated features in the landscape, often resulting from topographic depressions, heavy impermeable soils, compaction, and/or perched water table**.**

Wetlands in the state of Oregon are regulated by the Oregon Division of State Lands (DSL), the US Fish and Wildlife Service, and the U.S. Army Corps of Engineers (USACE). In order to be considered jurisdictional wetlands they must meet two of the three criteria established by the Corps. The criteria are hydric soils, hydric vegetation and/or the presence of water for designated times of the year.

Methodology

Source information included the USGS topographic quadrangles for the Mill watershed, the Soil Survey of Polk Area, Oregon (SCS, 1974), the National Wetlands Inventory (NWI) maps, 1986 black and white aerial photographs at a scale of 1” = 660’ from the Division of State Lands (DSL), Salem and local knowledge.

The U.S. Fish and Wildlife Service, as part of the National Wetlands Inventory (NWI) program, has mapped wetlands in the study area (Figure 9). The NWI maps are generated primarily based on interpretation of relatively small-scale color infrared aerial photographs (e.g., scale of 1:58,000) with limited ‘ground truthing’ conducted to confirm the interpretations.

Wetlands shown on the NWI maps[15] were transferred to a GIS base map, along with their Cowardin classification code. Other features such as springs, ponds, streams, and waterfalls were transferred from the USGS maps to the base map. The classification of wetlands as defined by plants, soils and the frequency of flooding is described in “Classification of wetlands and deepwater habitats of the United States” (Cowardin, et. al. 1979). The codes are broken down into three components, the Ecological System (P), Classes (EM, SS, FO, PC, AB, UB) and the Special Modifiers (f, h, x).

Due to time constraints, the Wetland Ecological systems type Riverine (R) was not included in this assessment. This designation refers to the wetlands found along the riparian zone and their condition was assessed in the riparian condition section of this assessment. Note that the USFWS considers these areas as wetlands and their presence is widespread throughout the Mill watershed.

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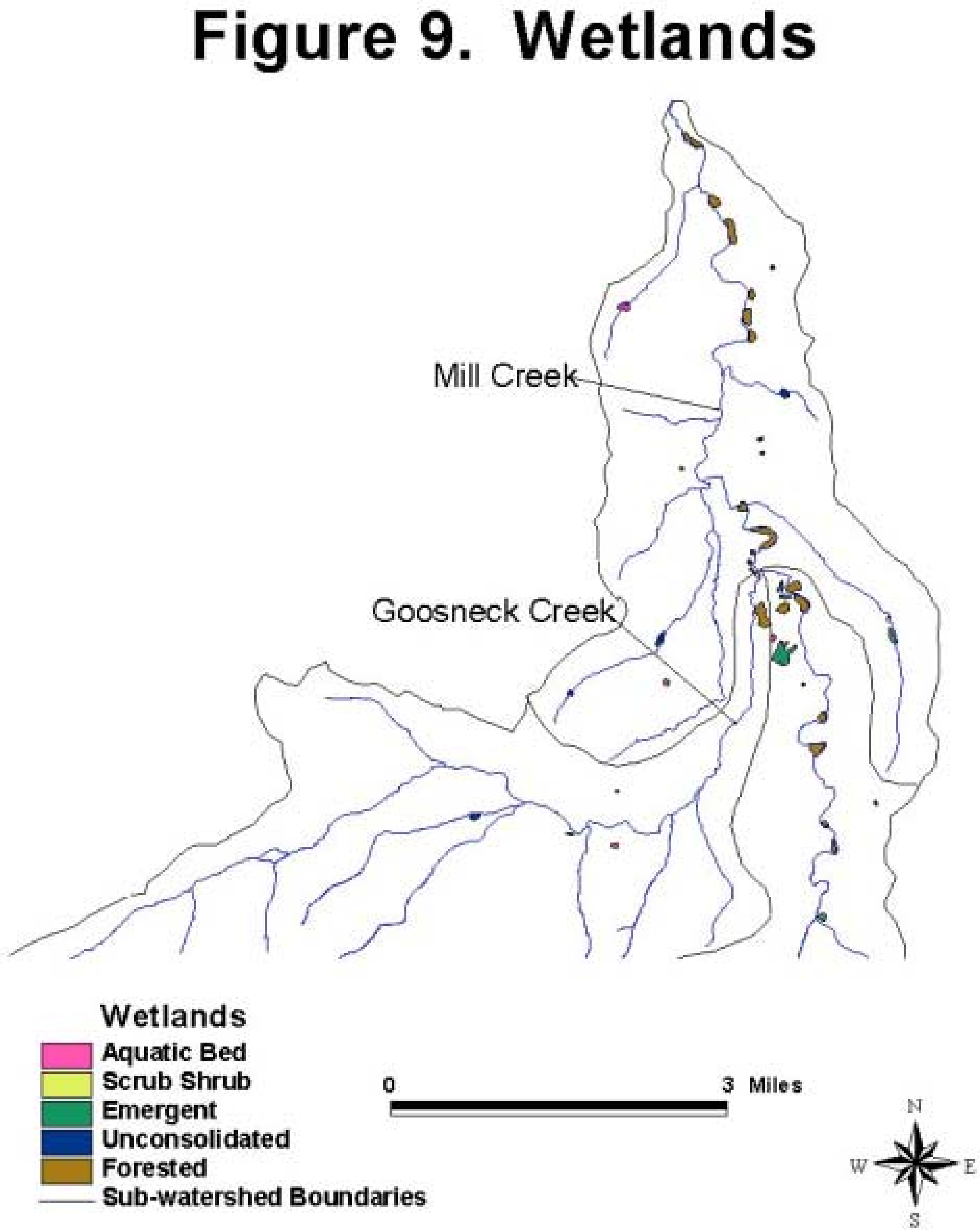
[15] NWI maps use the Cowardin classification system to designate wetlands.



Ecological System:

Palustrine (P)
All non-tidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens and all such wetlands that occur in tidal areas where salinity is less than 0.5%. This includes areas traditionally called swamps, marshes, fens, as well as shallow, permanent or intermittent water bodies called ponds.

Classes:

Aquatic Bed (AB)
Wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season during an average year.

Emergent Wetland (EM)
These wetlands have rooted herbaceous vegetation, which stand erect above the water or ground surface.

Scrub-shrub Wetland (SS)
Wetlands dominated by shrubs and tree saplings that are less than 20 feet high.

Forested Wetland (FO)
Wetlands dominated by trees that are greater than 20 feet high.

Unconsolidated Bottom (UB)
Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%.

Special Modifiers:

Farmed (i)
Farmed wetlands are wetlands which have been manipulated and cropped before December 23, 1985, but which continue to exhibit important wetland values. In addition, farmed wetlands include areas which pond water for 15 or consecutive days during the growing season. Farmed wetlands are subject to federal wetland jurisdiction.

Diked/Impounded (h)
Created or modified by a manufactured barrier or dam that obstructs the inflow or outflow of water.

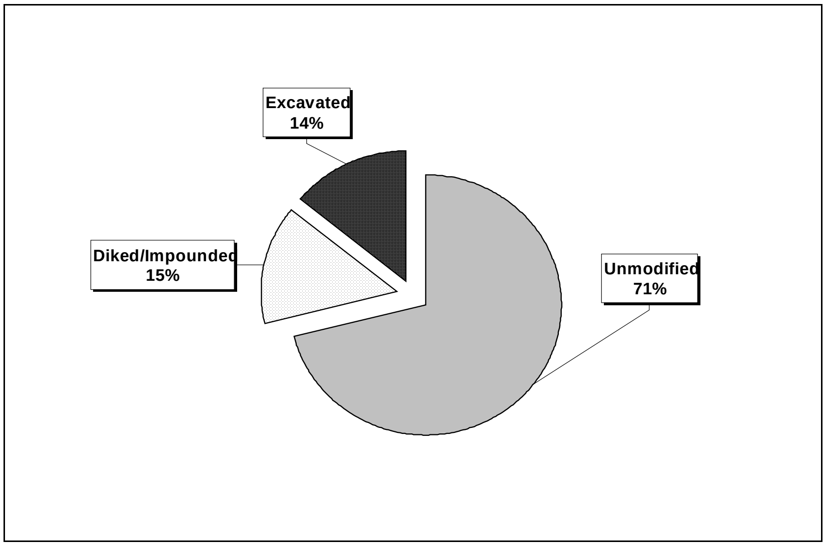
Excavated (x)
Lies within a basin or channel excavated by human means.

Mill Wetland Distribution and Alterations

The NWI maps showed that the Mill watershed has approximately 42 separate palustrine wetlands totaling 111 acres. Figure 9 shows that a majority of these wetlands are located in the Lower Mill sub-watershed. The wetlands are divided by Ecological System and Class type which reveals 63% (roughly 71 acres) as forested wetlands (PFO), 12% (roughly 13.2 acres) as being unconsolidated (PUB), 18% (20 acres) are emergent (PEM), 2% (roughly 5.8 acres) as aquatic bed (PAB), and 1% (roughly 1.4 acres) Scrub-shrub wetlands.

NWI designated wetlands were also divided into groups by modifications shown in Figure 10. Note that nearly a third (29%) of palustrine wetlands in the Mill watershed have been altered by human activities. Additionally field verification is required to locate unreported wetlands and to verify the status of the existing NWI designated wetlands.

Figure 10. Wetland Modifications in the Mill Watershed



References and Resources

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of wetlands and deepwater habitats of the United States*. U.S. Fish and Wildlife Service, Office of Biological Services, FWS/OBS-79/31. 103 pp.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual (Technical Report Y-87-1). (U.S. Army Corps of Engineers).

Federal Register. 1982, Title 33: Navigation and Navigable Waters, Chapter 11, Regulatory Programs of the Corps of Engineers, Vol. 47, No. 138, p3l810, US Government Printing Office, Washington, D.C.

Reed, Porter B., Jr. 1988 (May). *National List of Plant Species That Occur in Wetlands: Northwest (Region 9).* Prepared by the U.S. Fish and Wildlife Service, St. Petersburg, FL. NERC-88/18.37.

USDA Soil Conservation Service. 1982. *Soil Survey of Polk County, Oregon.* Dallas, OR.

USDA Soil Conservation Service. 1974. *Soil Survey of Yamhill Area, Oregon.* McMinnville, OR.

USDA Soil Conservation Service. 1996. *Hydric soils of Yamhill County, Oregon.* McMinnville, OR.

U.S. Fish and Wildlife Service *National Wetlands Inventory maps (Laurel Mountain, Socialist Valley, Sheridan, Grand Ronde, OR*, 1:58,000 1981 CIR aerial photography, overlaid on USGS quadrangle).

*U.S. Geological Survey topographic maps (Laurel Mountain, Socialist Valley, Sheridan, Grand Ronde, OR, 1:24,000, 7.5-minute quadrangle, **1970** photorevised 1975 and 1969, photorevised 1986).*

USDA Farm Service Agency. 1978. 1:660 ft. *Aerial photographs.* Farm Service, McMinnville, OR.

USDA Farm Service Agency. 1994. 1:660 ft. *Aerial photographs.* Farm Service, McMinnville, OR.

2.6 Channel Modifications

Introduction

The purpose of the channel modification section is to investigate and map locations in the watershed where the stream channel has been modified or disturbed. For the purposes of this assessment, channel modification is defined as "any human-caused physical alteration or activity that influences the channel morphology (shape) and changes the stream from its natural state" (Bruener, 1998).

Land management activities such as damming, dredging, and rip-rapping to stabilize stream banks alter the physical and biological characteristics of streams. These changes also have the potential to alter the habitat characteristics of aquatic ecosystems. The degree to which the modifications impact these characteristics depends on the type of modification, the degree to which it influences the streams natural processes and the locations of the channel modification.

Methodology

The channel modification assessment was conducted by both the author and by John Cruickshank, a resident of the Gooseneck Creek sub-watershed. The assessment process included gathering all of the known historical and present day information regarding channel modifications in the Mill watershed. Modification information was then prioritized and field verifications were conducted on stream segments that could be accessed.

A majority of the channel modifications noted from aerial photos and stream surveys were not field-verified due to inaccessibility through adjacent private lands or located in steep ravines. A map recording the location of field-verified channel modifications was drafted with the results. (Figure 11.)

Covered:

- Federal Emergency Management Agency (FEMA) 100-year flood plain maps.
- USGS quadrangle maps 7.5-minute scale.
- Yamhill County road maps.
- Oregon Department of Forestry maps.
- USDA Farm service aerial photographs.
- Historical aerial photographs from OSU map archives.
- Some field verification.

Not Covered:

- Field verifications of areas not directly seen from roads or bridges.
- Historical logging and county road maps.
- Interviews with long-term Mill residents could be conducted further to locate channel modifications located on those areas that were a difficult to reach or were private.

Historical Channel Modifications

Historically there have been numerous modifications made to the stream channels of the Mill watershed. Modifications included small-scale diversions, dike building, dredging and instream structures such as splash dams. These modifications were constructed in the watershed during the late 1800's to early 1900's. Farm management practices that encouraged streams to be diverted and wetlands to be drained in order to create tillable land were embraced up through the 1970's. Tiling[16] to remove water from pastureland is still a practice in use today. Rip rapping of the stream banks for bank stability and reduced erosion has been used through out the watershed.

Historical aerial photographs[17] taken beginning in 1936 through 1974 showed that the lower sections of both Mill and Gooseneck Creeks were more sinuous and braided or had multiple stream channels (Figure 11). Over time, aerial photographs revealed that riparian area widths were narrowed by roads, residential homes and cropland uses. The increased use of stabilizing rock or 'rip rap' along the banks most likely helped to constricted the channel's natural movement and sinuosity[18] forcing the once braided channels into a single straightened channel.

Land management practices in Upper Mill, Middle Mill and Gooseneck Creek subwatershed also most likely contributed to the stream channel degradation with extensive logging and road construction increasing the total amount of water in the channel[19]. "When a sizable area of a watershed is logged (e.g. more than 15 or 20 percent of the forest canopy removed), streamflow typically increases." (Adams, 1994).

The combination of all these land use factors may have played an important part in the extensive streambed downcutting seen today in the lower sections of the Mill watershed. An ODOT survey of the bridge crossing at Highway 22 shows a significant drop (10- 15 feet) in the channel bed between 1934 and 1996. Many channels in the lower the watershed have downcut to the underlying bedrock.

Because of the widespread occurrence of small-scale modifications and lack of written records, a complete list of channel modifications is difficult to produce. Most of the information has been either lost or forgotten. Splash dams were used extensively in the Upper Mill, and Middle Mill sub-watersheds (see historical section). The debris flow of logs and water released from a splash dam no doubt aided in the channel straightening and cleaning in the Mill Watershed.

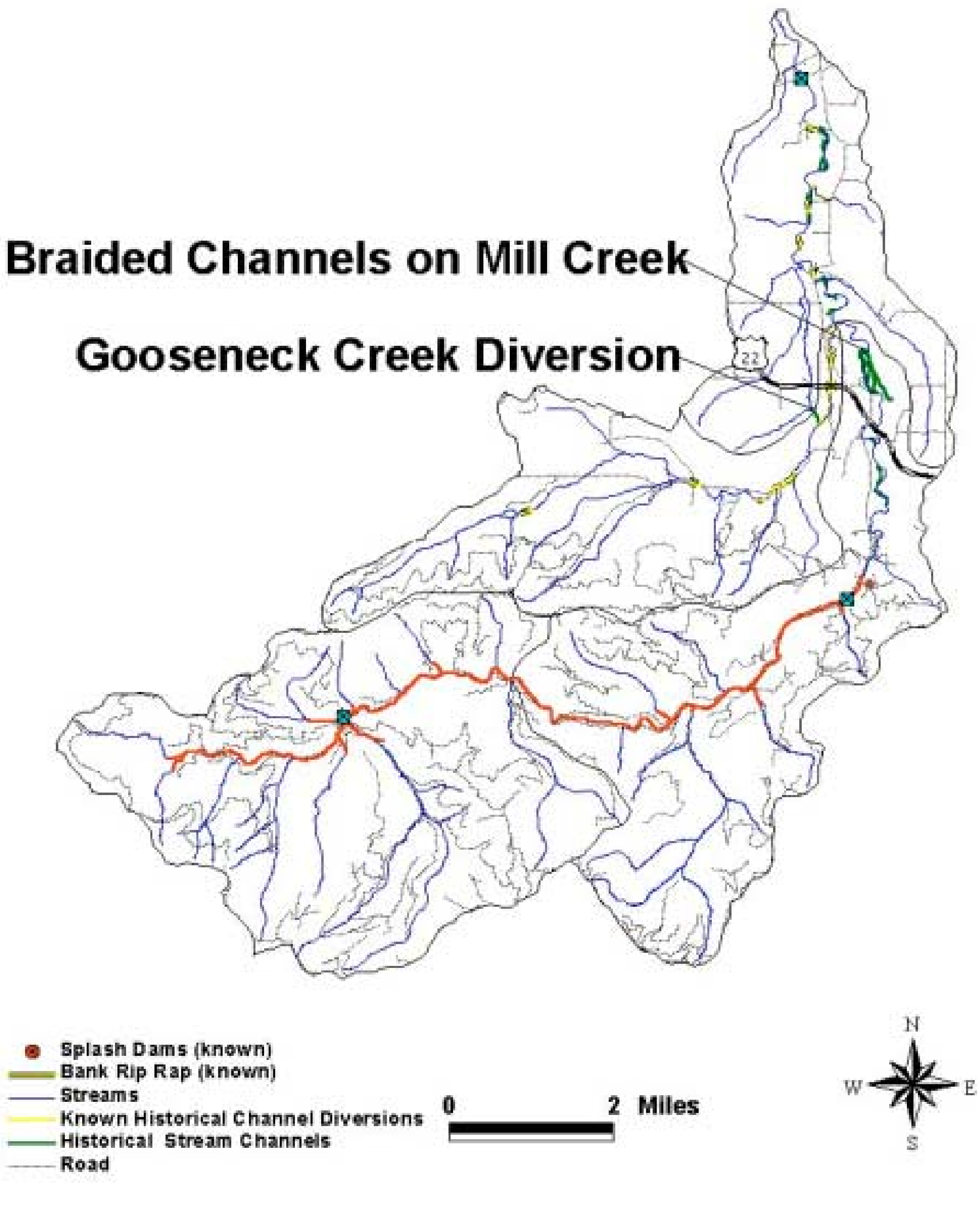
Current Channel Modifications

There is a relative absence of dikes, levees, dams, or channel dredging in the Mill Watershed. This is most likely due to current types of land use and lack of heavy industry along the stream. The most common channel modifications found today are culverts placed at road crossings, and the effects from land management activities in the uplands such as road construction and rip rap.

There are many modifications associated with small landowners including rip rap to stabilize stream banks, driveway culverts, ditch diversions, and riparian zone vegetation clearing. While these small-scale modifications are important in regards to an overall watershed assessment, they are very difficult to locate and quantify. This is due in part to the lack of public records kept for small-scale modifications. In order to address the number and distribution of small scale channel modifications, more information and field verification is required.

[16] Tiling is the use of underground pipes to drain hydric soil areas.
[17] Map archives at Oregon State University, 1936 + aerial photos are available for lower Mill and Gooseneck Creeks.
[18] Sinuosity is the number of bends in a river divided by the straight-line distance.

Figure 11 Channel Modifications



Additional Questions and Concerns

Much of the watershed was inaccessible for field verification and aerial maps are limited in their ability depict small-scale modifications. Sources for additional information on modifications are: ODFW stream and habitat surveys (conducted in the 1950s, 60s and 70s), private industrial land owners records, county records of rip rap and culvert locations from ODOT and county records. Time constraints limited our study of these additional resources.

Channel Modification References and Resources:

Adams, P. W. et. al.. April 1994. *The Effects of Timber Harvesting & Forest Roads on Water Quality & Quality in the Pacific Northwest: Summary & Annotated Bibliography.* Forest Engineering Department, Oregon State University, Corvallis, OR.

U.S. Geological Survey topographic maps (Niagara Creek, Springer Mountain, Stony Mountain, Sheridan, Grand Ronde, OR, 1:24,000, 7.5-minute quadrangle, 1970 photorevised 1975 and 1969, photorevised 1986).

USDA Farm Service Agency. 1994. *1:660 ft. Aerial photographs.* Farm Service, Dallas, OR.

Aerial Photographs, 1936- present. Oregon State University, Valley Library – Map Archives, Corvallis, OR.

Cruickshank, John. 1999. Farmer and Landowner in Gooseneck Creek subwatershed. *Channel Modifications Team Leader.*

2.7 Hydrology and Water Use

Methodology

The natural hydrologic cycle is the driving force behind a watershed system. The amount of precipitation and the rates of infiltration and evapotranspiration primarily dictate both the quantity and the time of year that water is available in the watershed. Human land use activities can alter the hydrologic cycle and influence the water budget. The primary land use activities that impact hydrology are urbanization, rangeland, forestry, and agriculture.

Mill hydrological data was analyzed following the OWAM protocol. The manual uses a series of steps to determine the peak flow characteristics of the watershed. Evaluations are then completed for four separate groups of land uses and activities that potentially affect peak flows. They are forestry, agriculture and rangeland, forest and rural roads and urban and/or rural residential development.

Time constraints and the limited availability of information dictated that some parts of the hydrology/water-use sections were not covered. Below is a list of areas (using the OWAM) that were and were not covered.

Covered:

- Peak flow analyses.
- Low flow analyses.
- Forestry and Rural Road Worksheet BLM GIS layers to estimate road density. Estimates of crown closure were not available.

Not Covered:

- From OWAM agriculture and rangeland worksheet (H-5). Not enough time to accurately complete, crop information difficult to obtain. Requires extensive fieldwork to assure accuracy.
- From OWAM forest and rural road worksheet (H-6).
- Urban and residential area worksheets.

Floods

Streamflow records at the Mill Creek gaging station were the principal source of data to document past floods. The Mill gaging station recorded discharge values beginning October 1 1958, and continued until it was decommissioned on September 30, 1973. Following 1973, there are not records of continuous flow data in the Mill watershed, however instantaneous measurements taken by varies state, and federal agencies are available.

The largest of the floods in the Mill watershed was estimated to have occurred in 1996. Flows measured during that event on the south Yamhill were the highest levels ever recorded, however no recorded values for Mill Creek exist due to the gaging stations closure.

The 1974 Army Corp. of Engineers publication *Flood Plain Information for the South Yamhill River* reported 5 major floods prior to 1996 for which stream flows were recorded (Table 7). The largest of these floods was recorded in 1964 and caused “extensive flooding in the area” (UACE, 1974). The highest recorded flow rate on Mill Creek was 5040 cubic feet per second (cfs) on December 22, 1964. There have been numerous other large floods in Yamhill River Watershed, occurring in 1861, 1931, 1949, 1960, 1962, and 1965.

Table 7. Floods in the South Yamhill Watershed[20]

Date of Crest*
23-Dec-64
21-Jan-72
16-Jan-74
22-Dec-55
16-Nov-73

Stream Flow

Flow data was collected on Mill Creek at the gaging station (gage # 14193300) located near RM 12, elevation roughly 600 feet above sea level[21] (WRD, 1999). The gage measures flow for an estimated 17,564 acres, which includes the entire Upper Mill sub-watershed and nearly half of the Middle Mill Sub-watershed (Figure 5 – See historical section). While this gaging location does not record the total water yield for the Mill watershed, it is thought to represent a majority of the flow. Figure 12 presents the daily stream flow data recorded at the Mill Creek gaging station from 1958-73.

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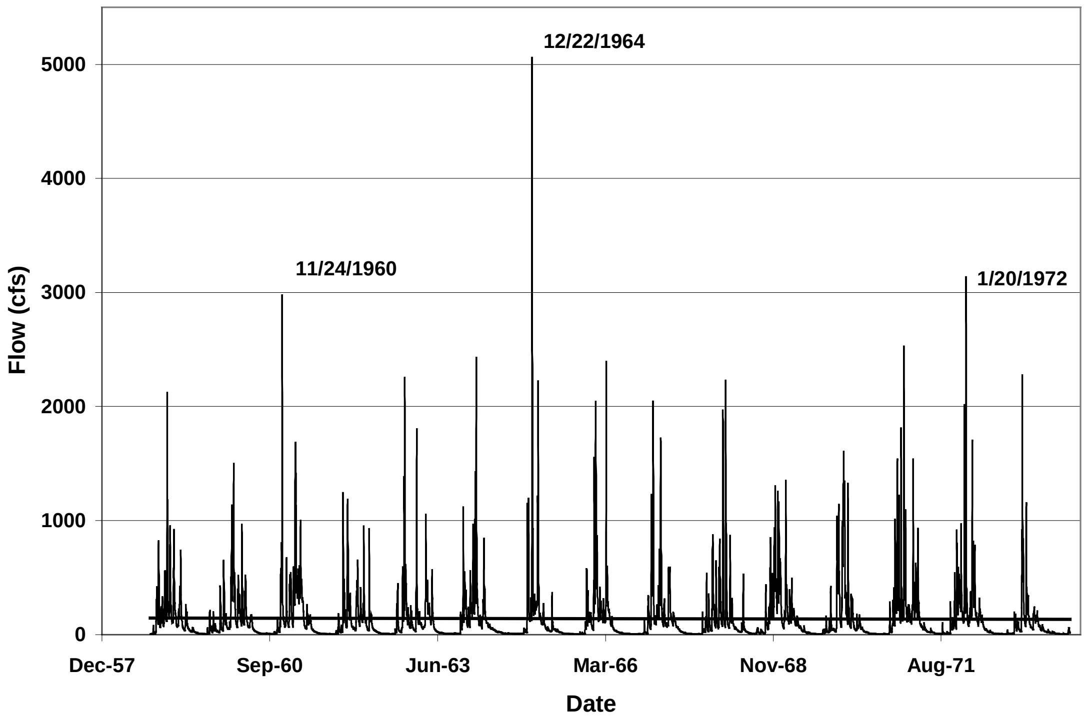
[20] Flood data collected on South Yamhill River near Whiteson, Oregon (Period of Records 1940-1974).
[21] Mill flow data from Water Resources Website: (http://www.wrd.state.or.us) Mill Creek = WRD# 8420.

Figure 12. Mill Creek Daily Flows (WY 1958-73)



Additional flow data was more recently collected by the Water Resource Department on Gooseneck Creek and recorded in Table 8**.** Note that rights for water use from Gooseneck Creek (excluding instream rights) total of 3.34 cfs during these spring-summer months

.

Table 8. Gooseneck Creek Flows

Instantaneous Flow Samples on Gooseneck Creek at HWY 22 Crossing (WRD,1999).

Year	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
1994	June*	3.55	June*	0.36	x	x	x	x
1995	8-Sep-95	0.15	x	x	x	x	x	x
1998	10-Jun-98	8	7-Jul-98	2.56	x	x	x	x
1999	29-Apr-99	9.22	14-May-99	8.83	7-Jun-99	5.19	20-Jul-99	1.02

** Exact Date Not Available.*

Peak and Low Flows

Stream flows can be influenced by human land use activities such as irrigation withdraws and or stream channel modifications that can affect the time and amount of water that is present in the stream. Human influenced peak flows can cause flooding, increase bank erosion, and or deepen the channel downcutting consequently lowering the streamside water table. Human dampened low flows lead to increased stream temperatures and decreased water quality conditions, both of which can adversely influence aquatic habitat. Analysis of the historic streamflow records give us a tool to determine the probability that low or high flow events of given magnitudes will be exceeded.

Peak flows are defined here as the maximum, single, daily, flow (cfs) per water year while low flows are defined as the minimum, 7-day average, flow (cfs) per water year. Peak flows were then analyzed for their 'recurrence interval' or 'probability of occurring'[22] using a Log Pearson Type III analysis. Estimates of peak and low flows are useful for a variety of reasons including the design of both culverts and streamside restoration projects.

The peak flow return periods for the 1996 (estimated) and 1964 (WY 1965) floods are estimated to have less than a 1% chance of occurring in a given year or to be 100+ year storm events. A field "effective discharge" or bankfull width was determined in the field using high flow marks in the stream (BLM, 1997). From this analysis, bankfull flow at the Mill Creek gage showed a discharge of 1,900 cfs with a recurrence interval (RI) of 0.91. An analysis using the gage flow records showed a bankfull flow to be 2,500 cfs. The researchers hypothesized that field determined bankfull discharge was underestimated at this site. Peak flows ranged from 654 cfs to 5040 cfs while the average annual peak flow for the Mill gaging station was determined to be 2105 cfs. The average daily discharge was 148 cfs. Table 9 shows the peak flows recorded between 1958-1973 at the Mill Creek gaging station.

Low flows were analyzed by first determining the lowest average 7-day flow period for each calendar year. Then a Pearson Type III distribution was used to determine the 10-year probability of recurrence of the flow. This type of analysis is termed a 7Q10 flow and, among other uses, is used by regulatory agencies for managing water quality receiving waters. 7-Day low flows ranged from 3 cfs to 6 cfs with the average annual 7-day low as 4.2 cfs. Table 9 shows the 7-day low flows recorded between 1958-1973 at the Mill Creek gaging station.

[22] For example, a 100 year flood has a 1% chance of occurring in any given year, a 25-year flood has a 4% probability of occurring in any given year (OWEB, 1999).

Table 9. Yearly Peak and Low Flows (WY 1958-73)

Mill Creek
Stream Discharge Summary

Year	Peak Flow	7-Day Low Flow
1958	825	5
1959	654	5
1960	2980	5
1961	1690	4
1962	2200	4
1963	1800	5
1964	5040	4
1965	2210	3
1966	2380	3
1967	1720	4
1968	2230	6
1969	1350	4
1970	1800	3
1971	2530	5
1972	3120	4
1973	1150	3

Land Use and Hydrology

Land use activities that have a potential to influence the hydrology of the Mill watershed were analyzed using the OWAM. Information was available with regards to forestry practices and rural road conditions for the land use screening. Some information was available for rangeland, agriculture, and rural residential development. Further data and field verification is required to complete the land use impacts on peak flows in the Mill watershed.

Risk from forestry practices in the Mill watershed on peak flow is unknown. Some of the information that the OWAM required was available for the determination of forestry impacts. This information included historical crown cover as BLM historical seral stage maps and current seral stages (BLM, 1998).

The coast range is generally considered to be an area where rain-on-snow events are infrequent in occurrence but have contributed to some of the major flooding including the 1964 and 1996 flood events. More land use analysis is required to understand the impacts caused by forest management practices.

An assessment of agricultural and rangeland impacts on flow was not possible due to limited time and data constraints. The potential for agricultural impacts is probably highest in the Lower Mill sub-watershed as more than 90% of the land use is designated agricultural. Rural residential land use impacts were analyzed by estimated the road densities using maps provided by the BLM. The Mill watershed had an overall road density of roughly 3.1 miles per square mile.

A low risk was assigned to the all of Mill's sub-watersheds with road densities, both for forested and agricultural lands, recorded below 2%. For forested and rural roads, densities between 4-8% are assigned a moderate risk while road densities greater than 8% are assigned a high risk. This assessment did not evaluate location nor construction design of roads. Poorly placed roads that are near the stream channel have a much higher potential to influence peak flows. More field assessment is needed to better understand the potential risks in the Mill watershed.

Water Rights and Use

Under Oregon State law, all water is publicly owned. With a few exceptions, a water right is required before using water. This includes domestic use of water from a creek, river, or any other surface water source. Landowners that have water flowing by, through or under their property do not have the right to use that water without a permit from the state (WRD, 1997). Water rights are issued through an application process administered by Oregon's Water Resources Department.

There are currently 135 surface water rights permits in the Mill watershed according to records at WRD in Salem. The bulk of Mill's water rights are permitted for irrigation (93%), agriculture (2%) and domestic uses (3%). Of these three major uses, irrigation is by far the most significant use by both the quantity and timing of the withdraws.

Irrigation rights are authorized to withdraw a total of 15.25 cfs during the irrigation season, which runs from April through September. These irrigation rights provide water for 1328 acres of farmland in the Mill watershed with a majority of those acres located in the Lower Mill and Gooseneck sub-watersheds. The lowest annual stream flows also tend to occur during this irrigation period. While irrigation waters are withdrawn from the active channel, some of the water does return to the system via sub-surface flows. Table 10 summarizes the year round quantity (cfs) and percentage of the total for each type of permit for the Mill watershed (WRD, 1999).

Instream rights for fish habitat (1993) and pollution abatement (1983) are determined by the ODFW and DEQ on a stream by stream basis. Depending on the habitat and specifically the type of native fish species (in this case winter Steelhead) present in the watershed, ODFW determines a minimum stream flow needed to sustain a healthy aquatic ecosystem. DEQ determines minimum flows needed to abate water quality pollution.

Table 10. Water Right Types by Quantity and Distribution

Water Right Type	% of total	cfs
Irrigation	93%	15.25
Domestic	3%	0.51
Agriculture	2%	0.33
Miscellaneous	1%	0.17
Fish/Wildlife Habitat	<1%	0.07
Industrial	<1%	0.01
Municpal	0%	0
Recreational	0%	0
Total	100%	16.34 cfs

Table 11 shows the instream water rights for Mill watershed relative to the time of year. Water rights are based on a seniority system wherein if natural flows are limited, the senior or oldest rights have priority over the junior or most recently issued rights. Instream water rights were granted for Mill watershed on 11/3/83, while a majority of the human-use rights were granted before that date.

Table 11. Instream Water Rights

Months	cfs
October - May	80
June (1-15)	15
June (16-30)	10
July (1-15)	7
July (16-31)	5
August (1-15)	5
August (16-31)	5
September (1-15)	5
September (16-30)	5

There is one major reservoir in the Mill watershed located on the upper section of Gooseneck Creek. Owned by the Buell-Red Prairie Water District, the reservoir supplies domestic and agricultural water for nearly three hundred area homes and farms. Most of the water to recharge the reservoir is collected during the high winter flows and then retained through the rest of the year. The district also has a well that provides supplemental water during the low flow season. This well aquifer is actively recharged with surface water during the high flow season.

Water Rights and Stream Flow

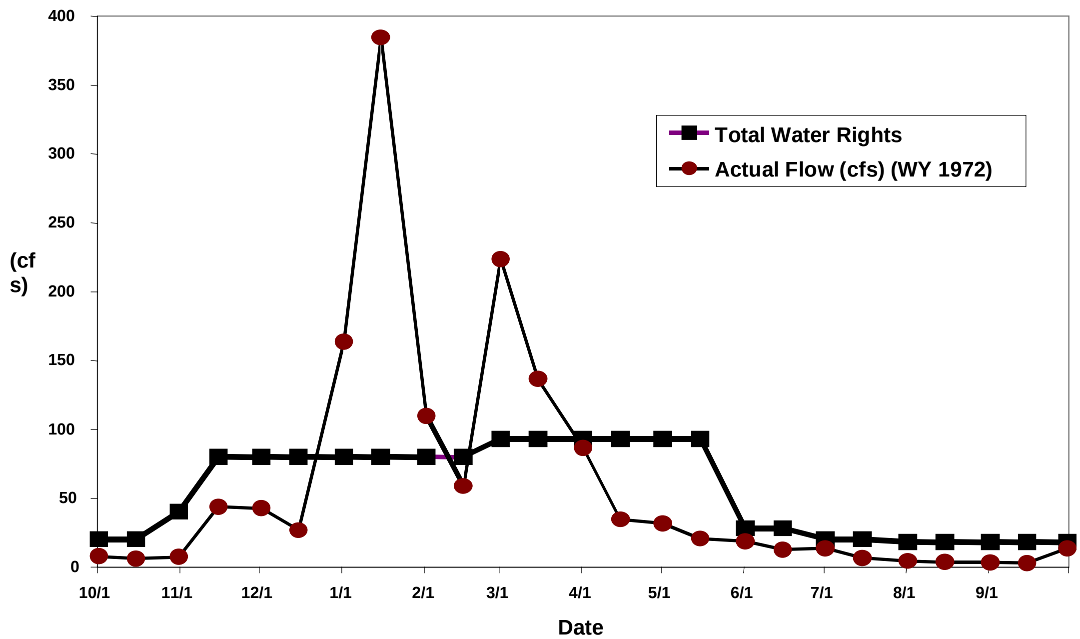
As is often the case in the western United States, where water availability can be limited during the summer months, the sum of all the legal water rights can exceed the actual water available in the system. When we combine all the anthropogenic rights for the Mill watershed with the instream rights for aquatic habitat and fish populations, we arrive at a total water allocation for the watershed. Note that both instream and irrigation rights change on a bi-monthly basis. Figure 13 plots actual flow data (Water Year 1972[23]) from the gaging station against this total water allocation for Mill Creek.

The assumption is made here that the gaging station location, which is upstream from all the water right claims, represents the background or ‘natural’ stream flow in Mill Creek. In addition, the assumption that Gooseneck Creek’s flow contribution is minimal during the summer low flow periods. This is most likely a safe assumption as majority of the actual stream flow for Mill Creek is thought to come from Upper and Middle Mill sub-watersheds past the gaging station.

While winter flows (mid-December until end of March) exceed the total surface water rights, the opposite is true for the other 8-½ months of a year. This is of particular concern during the summer months when low flows can compound problems such as stream temperatures and water quality parameters like fecal coliform levels.

[23] Estimated as approximately a average year for our years of water rights records.

Figure 13. Actual Flow versus Water Rights for Mill Creek



References and Resources:

Water Resources Department. October 1997. Water Rights in Oregon – An introduction to Oregon's Water Law and Water Rights system. State of Oregon, Salem, OR.

Hawe, Patrick. BLM 1997. A Summary of Field Investigations on Mill Creek, South Yamhill River Basin, Oregon. Mary's Peak Resource Area, Salem District, Salem, OR.

Willamette Basin Task Force. 1969. *Willamette Basin Comprehensive Study – Water and Related Land Resources.* Pacific Northwest River Watersheds Commission, NRCS McMinnville, OR.

Ferber, Bill. Jan-Nov, 1999. Water Master for Salem District. *Personal communications.*

Water Resource Department Webpage: www.wrd.state.or.us.
Oregon Climate Center Webpage: www.ocs.orst.edu.

2.8 Mill Water Quality

Introduction

The purpose of the water quality assessment for the Mill watershed is to review any water quality data available for Mill watershed and report any limitations or areas of concern. The physical and chemical condition of a watershed's water has an important influence on the aquatic habitat and the human uses of that water. The water quality assessment section of the OWAM addresses water quality issues that were not included in other parts of the manual: temperature, dissolved oxygen, pH, nutrients, bacteria, chemical contaminants, and turbidity.

Methodology

The OWAM uses a five-step approach for collecting and analyzing water quality data. The first step is the identification of the beneficial uses for the watershed as designated by the DEQ. The next step is to identify the water quality criteria pertinent to the watershed and then assemble all available water quality data for those criteria. This includes reporting any 303(d) listed water bodies in the watershed and the relevant listing information. The final step is to analyze the data collected and flag any areas of water quality concern that are identified. The data used for this assessment can be obtained by contacted the Yamhill Basin Council in McMinnville, Oregon or the Department of Environmental Quality in Salem.

Covered:

- Analysis of water quality data from EPA/DEQ.
- Analysis of stream temperature data from YBC and BLM data.
- Analysis of water quality publications from USGS reports.
- DEQ, County, EPA, and local resident interviews regarding water quality.

Not Covered:

- Field sampling of water quality parameters.
- Ground water or well water information (difficult to obtain).
- Synthetic and organic chemical information (not available).
- Stream and river sediment sampling (data not available).
- BLM Macrovertebrate Sampling Results (time constraints).
- Buell-Red Prairie Water District Reservoir Data (time constraints)

Mill's Beneficial Uses

Oregon's Department of Environmental Quality (DEQ) is the state agency responsible for protecting Oregon's public water for a wide range of beneficial uses. DEQ has established the following list of beneficial water uses for Mill watershed. "Numerical and narrative water quality criteria found in the Willamette basin water quality standards are benchmarks used to determine if water quality "supports" a use such as irrigation, drinking water supplies, or cold water aquatic life (e.g. salmon)."[24]

The Mill watershed is considered a part of the Willamette basin for which the beneficial uses were compiled (Table 12). It should be noted that some designations such as hydropower are not necessarily applicable to the actual local uses. The most sensitive of the beneficial uses for the Mill watershed are public water supply, irrigation, and salmonid fish rearing.

Table 12: Beneficial Uses:

Public Domestic Supply	Livestock Watering	Anadromous Fish Passage	Salmonid Fish Rearing
Private Domestic Supply	Salmonid Fish Spawning	Resident Fish & Aquatic life	Wildlife and Hunting
Industrial Water Supply	Fishing	Boating	Water Contact Recreation

[24]DEQ, personal communication, May 1999.

Irrigation	Aesthetic Quality	Hydro Power	

Water Quality Limitations

DEQ has listed Mill Creek on the 303(d)[25] list for exceeding standards for both fecal coliform concentrations and water temperature. Mill and Gooseneck Creeks have also been listed as "water bodies of concern" (WBC) for exceeding sedimentation, habitat modifications, and flow modifications standards. Table 13 lists DEQ's 303(d) list of water quality limited streams for Mill watershed. Table 14 lists the 'Water Bodies of Concern' in the Mill Watershed and the supporting data for those listing.

Table 13. Water Quality Limited Streams from 303(d) List

Stream Location	Parameter Basis for Listing	Criteria Supporting Data	Season Status	Basis For Listing	Supporting Data
Mill Creek, mouth to headwaters	*Bacteria*	*Water Contact Recreation*	*Summer*	*DEQ NPS Report 1988: observation "severe"*	*DEQ Data 44% of samples exceeded standard.*
Mill Creek, mouth to headwaters	*Temperature*	*Rearing > 64 ^{0}F*	*Summer*	*DEQ NPS Report 1994: observation "moderate"*	*86% of summer values exceeded standard.*

[25] The 303(d) list is a list of water quality limited streams in the state of Oregon.

Figure 14. Water Quality

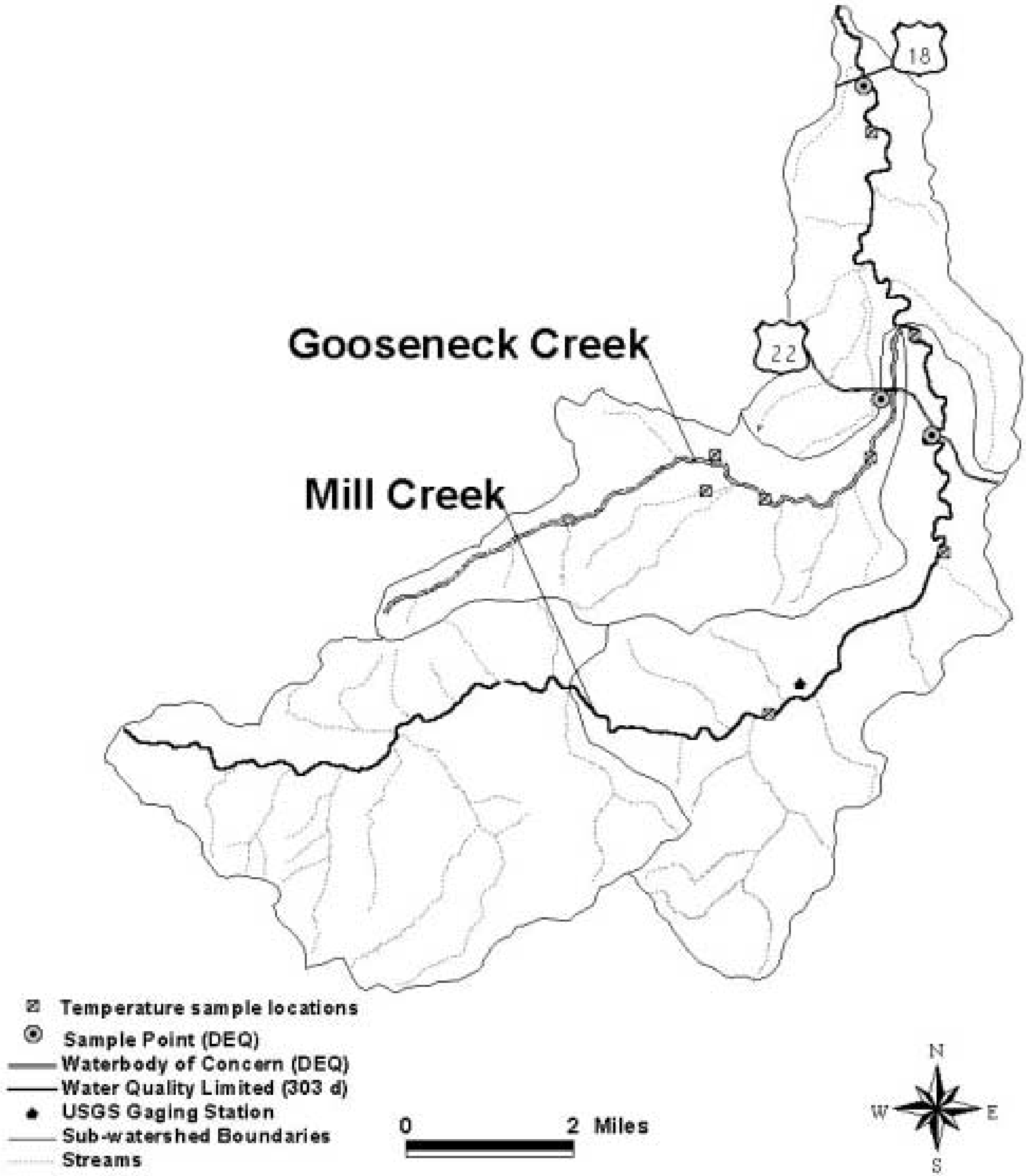


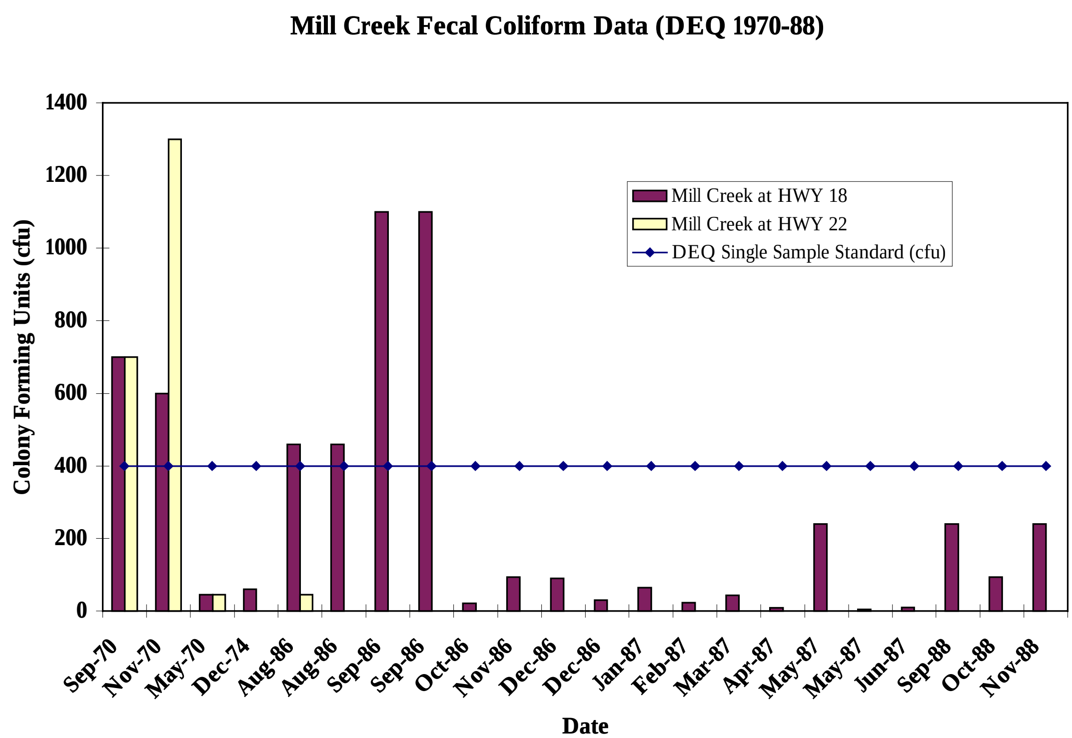
Table 14. Water Bodies of Concern

Location	Water Qualtity Parameter	Basis for Concern
Mill Creek, mouth to headwaters	*Sediments*	*DEQ NPS Report 1988: observation "severe - moderate"*
Mill Creek, mouth to headwaters	*Flow Modification*	*DEQ NPS Report 1988: observation "moderate"*
Mill Creek Mouth to headwaters	*Habitat Modification*	*DEQ NPS Report 1988: observation "moderate"*
Gooseneck Creek, mouth to headwaters	*Flow Modification*	*DEQ NPS Report 1988: observation "moderate"*
Gooseneck Creek, mouth to headwaters	*Sediments*	*DEQ NPS Report 1988: observation "moderate"*

Fecal Coliforms

Fecal coliforms are microorganisms that indicate when feces is present in the water and warn us of the associated pathogenic health hazards. Table 13 reports DEQ's data supporting the 303(d) listing for Mill Creek. DEQ collected water quality data on Mill Creek beginning in the 1970s until the late 1980s, however data was not available on any of the watershed's other numerous streams.

Figure 15. Fecal Coliform Data from DEQ (1970-88)



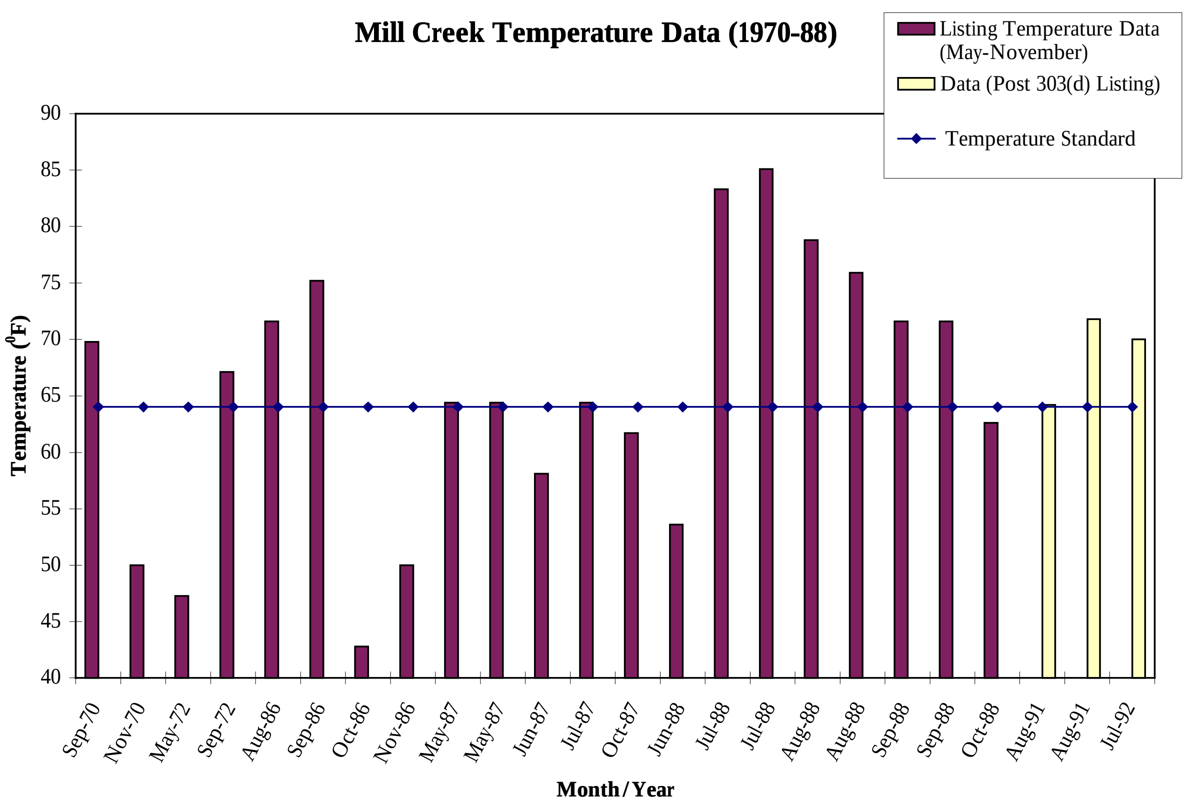
The DEQ protocol for listing a water body states that only the water-body sampled and found in exceedence will be recorded on the 303d list. Mill Creek was therefore listed for fecal coliform (water contact: recreation, summer) from the mouth to the headwaters (See Figure 14). The data collected between 1970-88 for this listing is shown in Figure 15. Water samples were collected where Mill Creek intersects with State highways 18 and 22. The DEQ limit for a single fecal coliform sample is 400-cfu/100 ml (blue line). Note that redundant data collected during the same sampling day was graphed as only the higher of the two points.

Since the time of this listing, the DEQ has changed the fecal indicator from the bacterial group of fecal coliforms to a subset of that group known as *Escherichia coli* (*E. coli*). The change is meant to increase the accuracy of the standard. Fecal coliform standards will be established for Mill watershed using this new technique during the total maximum daily load (TMDL) process scheduled for the Yamhill watershed in 2003. This process will assess the 'natural' or background concentrations of fecal pollution and then establish a threshold by which the watershed will be monitored.

Temperature

The DEQ maximum temperature standard for streams is 64^0 F. Growth and reproduction of native species are adversely affected when water temperatures range outside the optimum. Mill has a threatened species of cold-water fish spawning in the watershed (winter Steelhead). During the winter spawning period for Steelhead the stream temperatures are not to exceed 55 ^{0}F. During the rest of the year, the 64^0 F temperature limit applies.

Figure 16. DEQ Temperature Data for Mill Creek



Mill Creek is listed as temperature limited stream on the 303(d) list (Table 13). Figure 16 shows the data collected by DEQ[26] to establish this listing. This data was collected near the bridge crossing of Mill Creek and state highway 18. Note that only the higher of two redundant data points (same date and time) was included in the graph.

Data was collected in seven separate locations through out the Mill watershed during the summers of 1998-9 (Figure 16). Table 15 reports the seven-day average maximum and minimum, as well as the daily change in temperature (ΔT), and the warmest seven-day average value.[27] In 1998, none of the locations were below the temperature standard of 64 ^{0}F.

In comparison, the 1999 temperatures tended generally to be lower than the previous year but still only the two locations, Gooseneck #3 and Rowell Creek, were below the 64^{0}F standard. This was most likely due to the cooler summer season experienced in 1999 and not to a significant improvement in the riparian shade conditions from year to year.

Additional temperature data was recorded by the BLM and Willamette Industries on Mill Creek (1998-99) with maximum temperatures shown in Table 16. The temperatures in this headwaters area of Mill Creek are considerably cooler than of those recorded further downstream. However, only 2 out of the 7 sites monitored were below the temperature standard.

Table 15. Yamhill Basin Council's Summer Temperature Data (1998-99)

Site Location	Year	7-Day averages				Warmest day of 7-day max		
		Date	Maximum	Minimum	Δ T	Date	Maximum	Minimum
Mill Creek Site #1	1999	08/01/99	79.5	63.3	16.2	08/03/99	81.1	64.4
Mill Creek #1	1998	07/25/98	85.8	66.5	19.3	07/27/98	90.1	70.9
Mill Creek Site #2	1999	08/01/99	74.8	64.1	10.7	08/03/99	76.1	64.6
Mill Creek #2	1998	07/25/98	78.4	67.2	11.2	07/27/98	81.5	70.0
Mill Creek Site #3	1999	08/25/99	69.0	62.7	6.2	08/26/99	69.8	62.8
Mill Creek #3	1998	07/26/98	73.2	66.9	6.3	07/28/98	76.5	69.1
Gooseneck Creek Site #1	1999	07/28/99	74.0	61.0	13.0	07/27/99	75.2	60.3
Gooseneck Creek #1	1998	07/26/98	77.0	66.4	10.6	07/27/98	79.9	68.5
Gooseneck Site #2	1999	07/12/99	67.0	57.5	9.5	07/12/99	68.9	58.6
Gooseneck Creek #2	1998	07/26/98	73.7	63.4	10.2	07/28/98	76.5	65.8
Gooseneck Site #3	1999	07/26/99	61.3	57.6	3.8	07/27/99	62.2	57.2
Gooseneck Creek #3	1998	07/25/98	65.4	61.9	3.5	07/27/98	67.1	63.5
Rowell Creek (Trib of Mill)	1999	08/25/99	61.9	58.5	3.4	08/28/99	62.4	59.9
Rowell Creek (Trib of Mill)	1998	07/25/98	65.3	61.1	4.1	07/27/98	66.9	63.0

Additional historical temperature and flow data is available from ODFW's 1950s habitat surveys and reports. The data was not reported here due to lack of clarity in the records on where the data was collected. Specific temperature standards will be established for Mill watershed during the total maximum daily load (TMDL) process scheduled for the Yamhill watershed in 2003. This process will assess the natural temperature levels and then establish a threshold by which the watershed will be monitored.

[26] Data collected as single samples, other water quality parameters were also tested.
[27] Data table provided by Melissa Leoni, YBC coordinator.

Table 16. BLM & Willamette Industries Temperature Monitoring Data (1998)

Site Name (Location)	Maximum from Seven Day Average	Agency
Mill Creek (RM 15.4)	66.6	BLM
Mill Creek (RM 16.8)	67.8	BLM
Mill Creek (RM18)	65.8	BLM
Mill Creek RM(19.1)	63.0	BLM
Mill Creek (RM 19)	64.1	Willamette
Mill Creek (RM 18.1)	68.1	Willamette
Mill Camp (RM 19.9)	63.8	Willamette

Nutrients

Elevated levels of nutrients such as phosphorous and nitrogen can cause increased algae growth and consequently low concentrations of dissolved oxygen both of which can be detrimental to watershed habitats. These types of nutrients can enter the watershed from a variety of sources both human and natural in origin. Typically, elevated levels are assumed to be not of natural sources but from causes such as farm and home fertilizers.

Mill Creek has been approved for point source discharge of phosphorous from its mouth to the headwaters. A Total Maximum Daily Load (TMDL) was established for the creek (and the Yamhill watershed) by DEQ on 12/8/92. Phosphorous data collected in Mill Creek showed 0% (0 of 19) of the samples taken exceeded the TMDL standard of 70 ug/l with a maximum of 200 ug/l between 1986-1998. The most recent data for total phosphorous ranged from 10 ug/l to 180 ug/l. Data was gathered at the bridge crossing of state highway 18 and Mill Creek.

Dissolved Oxygen

Sufficient concentrations of dissolved oxygen (DO) are essential to support aquatic life, and especially salmonid species. The water quality standards for Oregon contain a number of different criteria for dissolved oxygen concentrations. For the purposes of a watershed screening, the evaluation criterion is set at a minimum of 6.5 mg/l. Monthly data recorded by DEQ between 1987-88 showed DO values ranging from 8.1 mg/l to 13.7 mg/l. These values are considered adequate according to state law.

pH

The hydrogen ion concentration of water is measured in pH. Acidic pH values are considered those below pH 7.0 and alkaline (basic) for those greater than a pH of 7.0; a pH of 7.0 is considered neutral. Water pH is an important indicator of availability of nutrients as well as the presence of toxic chemicals in a watershed. Oregon Water Quality standards specify that the approved pH range for west of the Cascades' watersheds as being between 6.5 to 8.5 pH.

Monthly data collected by the DEQ between 1987-88 show values ranging from pH 7.0 to 8.4. It should be mentioned that the samples collected during the summer of 1988 showed values that approached the upper limit of the standard. Streams with high pH values could be caused by a number of natural and human created causes. More information is needed to assess this condition.

Turbidity/ Suspended Solids

Turbidity is a measurement of the clarity of water. Turbidity is measured by recording the amount of light that passes through a particular water sample. Generally high values for turbidity (**>** 50 NTU[28]**)** indicate excessive amounts of suspended sediments or particles in the system. These solids can affect fish in a variety of ways such as damaging their gills and/or reducing the ability to sight prey. Data recorded through out the year by DEQ between 1987-88 showed turbidity levels ranging from 1.0 to 29.0 FTUs.[29] Note that DEQ's 303(d) listed Mill Creek as a 'water body of concern' for sediments and suggested that more information be collected for this watershed.

Other Contaminants

The Willamette Valley has seen a widespread increase in use of synthetic chemicals such as pesticides, herbicides and other organic chemicals (Wentz, et. al., 1998). These chemicals can be transported from the soil surface to streams through a combination of subsurface drainage, surface runoff, and soil erosion. Infiltration of rain and irrigation water facilitate transport of chemicals to ground water (Wentz et. al., 1998). Synthetic chemicals such as these have the potential to cause damage to Mill's water quality and aquatic animal species' health and reproduction.

The levels of land applications and instream/groundwater concentrations of synthetic chemicals in the Mill watershed are not known at this time. Some streams measured in the Willamette basin during a USGS water quality study (Wentz, et. al., 1998) reported elevated levels of some pesticides in the stream sediments. Additionally pesticides such as Atrazine were reported highest "during spring following pesticide application, but relatively high concentrations also occurred during fall runoff" (Wentz et. al., 1998). More information regarding specific synthetic chemical use and instream concentrations is needed for the Mill watershed.

Elevated levels of heavy metals such as mercury and lead have also been found in stream sediments receiving stormwater runoff from urbanized areas or areas with mining activities (Wentz et. al., 1998). With other parts of the Willamette Valley showing these elevated levels of heavy metal, more information should be collected regarding specific levels of sediment metals in the Mill watershed.

Point Source Discharge

DEQ regulates discharges to surface water through permits. Permits designed to protect water quality included water permits, storm water discharge permits, erosion control permits and oil spill contingency plans. Information collected from DEQ's online Water Quality Facility Information System showed no permitted point source discharge in the Mill watershed. For additional information regarding point source permits, contact the DEQ office in Salem.

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[28] Nephelometirc turbidity unit

[29] Hach FTU units are considered directly equivalent to NTU units.

Data Considerations and Limitations

It should be noted that the water quality data used for this assessment (excluding the temperature data) is the result of 'grab' sampling[30]. Grab samples can be a useful tool in understanding water quality conditions but caution should be exercised when drawing conclusions from this data. Temperature, pH, dissolved oxygen, and many of the other parameters change on a seasonal, daily and evenly hourly basis. Care should be taken to consider the time and date the data was collected in order not to misrepresent or marginalize a particular water's quality parameter. DEQ and the EPA both have adopted specific protocols for the water sampling and should be considered in any future analysis and/or monitoring plans. This assessment reports ranges of water quality parameters in an attempt to demonstrate the prevailing conditions found in the watershed assuming that single samples tell us something about the those conditions.

References and Resources

Wentz et. al. 1998. *Water Quality in the Willamette basin, Oregon 1991-95* United States Geological Survey (USGS). USGS Circular # 1161.

Oregon Department of Environmental Quality. Feb. 1998. *Oregon's 1998 Section 303(d) Decision Matrix*. DEQ, Salem Oregon.

Environmental Protection Agency (EPA). 1998. *Yamhill Basin Data from Storet System Database.* Washington DC. Contact: (202) 382-7220.

Oregon Department of Environmental Quality website: http://www.deq.state.or.us/

Ades, Dennis. Summer 1999. DEQ Laboratory. *Personal Communications.* Salem OR.

Dicksa, Bob. DEQ Point Source Permitting Manager. Winter-Spring 1999. *Personal Communications.* Salem OR.

Weick, Rodney DEQ Ground Water. Spring 1999. *Personal Communications.* Salem OR.

Leoni, Melissa. March 1999. *Yamhill Basin Council 1998 Temperature Monitoring Report.* Yamhill Basin Council, McMinnville OR.

Oregon Department of Fish and Wildlife. (ODFW) 1952. *Mainstem of Yamhill and Tributaries Inventory.* District office, Adair Village, OR.

Macrovertebrate Sampling Data and Summary, Contact Patrick Hawe, Hydrologist, BLM, Salem.

2.9 Sediment Sources

Introduction

Erosion of sediments can be a part of the natural processes in a watershed. Fish and the aquatic habitat have evolved to compensate for natural levels of sediments entering the system. The amount of erosion can vary greatly depending on both the season and the weather. The occurrence of events such as landslides, debris flows, wildfires, and bank erosion caused by a stream meandering are all processes that are part of the natural system. All of these processes contribute to a background or natural level of sediments in the aquatic system.

[30] 'Grab sampling' means a single water sample collected in a closed container from a surface water location.

The challenge is to determine what sediment load an aquatic system such as the Mill watershed is adapted to handle, and what human-induced sediment loads are exceeding this level. Because both natural and human induced events are so highly variable, it makes it difficult to discern between the two when determining prevalent conditions.

Methodology

The 1999 OWAM uses several steps to assess the quantity and sources of sediments in a watershed. First, it focuses on collecting an inventory of the visible signs of erosion. This includes locating and mapping landslides, road washouts, or areas of extensive gullying. The next step is to identify and map areas of situations for which erosion and movement of sediment into streams is likely to occur in the near future. This includes housing developments, new storm drain outlets, clearcuts, specific agricultural crop rotations, new road construction, old road failures and undersized culverts. The third step is to summarize the collected information in way that allows us to identify the human-caused problems and prioritize them according to realistic remedies.

We should be careful to mention that the movement of sediments into streams can be a natural or human influenced process. Pulses of large fine sediments, cobbles, and large boulders are naturally moved through the system through time as they introduced by natural processes such as debris flows or landslides. The type of sediments that this assessment focuses on are the fine sediments from human sources which can be detrimental to fish spawning and rearing.

Covered:

- ODF Peak Flow Map.
- GIS landslide inventory and slope stability (BLM, 1999).
- NRCS soil surveys.
- USGS Topographical maps.
- Conversations with county and state highway engineers to identify any known problem road sections. Information very limited for Mill watershed.

Not Covered:

- County, state, and private timber landslide inventories.
- Private and government locations of upland management practices that have potential to contribute sediments (i.e., clear-cuts).
- County records of roadwork that identifies problem road sections.
- Mill-specific agricultural crop information to understand where potential sediment sources, and forest road hazard inventories from public or private sources.
- Field verification of individual road culverts.
- Locations of recent burns. No recent wild fires or broadcast burns were noted in the watershed.

Sediment Sources

The OWAM process includes making an evaluation of the types of sources that are mostly likely to contribute sediments to the watershed. Road instability, slope instability, rural road runoff and erosion from cropland were estimated to be the primary sources of sediment for the Mill watershed. In Lower

Mill sub-watershed, road instability, and erosion from crop and pastureland have the highest potential to contribute sediments and in particular fine sediments to the stream (Figure 17).

The soil types in the Lower Mill sub-watershed tend to be made up mostly of erodible silty-loams. Crop types for the Lower Mill sub-watershed were estimated at roughly 65-70% dryland fields, 10-15% in nursery or tree farms and another 10-15% in timber which left roughly 1-5% as rural residential. Of these dryland fields an estimated 60% were perennial crops like grass seed or wheat in 3-5 year rotations. The other 40% of the dryland fields were annuals in 1-2 year rotations (Hale, 1999).

One of the most important factors in determining cropland contributions of fine sediments is to know where, when and how often cover crops are used to protect the top soil from heavy winter rains and wind. Unfortunately, cover crop information was not available for the Lower Mill sub-watershed. While additional information is needed to determine the quantity and exact locations of these inputs, it is assumed from the soil and crop types that the Lower Mill sub-watershed does contribute fine sediments to the Mill watershed.

Landslides and Debris Flows

Areas in the Mill watershed have been identified by the BLM and ODF that pose a high risk for landslides and debris flows (Figure 17). Risk was determined by a variety of geologic and topographic parameters including soil type, slope gradient, and rainfall. These areas tend to be located in the elevations of Upper, Middle, and Gooseneck sub-watersheds. The Mill watershed is reported have one of the highest slide risk areas in the region with rates predicted at one slide per 494 acres (BLM, 1998). This rate increases to one slide per 23 acres of land having greater than 60 percent slope gradients (BLM, 1998).

The BLM has evaluated slope stability in the watershed using the slope gradients and soil types. The classes are moderate, (60-75% slopes), high (67-90% slope), and severe (> 90% slopes) (See Figure 17). Indeed, in these upper many of the slopes in the upper elevations of the watershed exceed 90% classifying them as ‘severe’ risks for landslides.

Following the 1996 major flooding the BLM used recent and historical aerial photographs to estimate the quantity and cause of landslides in the Mill watershed region (BLM, 1998). This larger region included Mill, Rickreall, Rowell, and Luckiamute watersheds. Both Mill and Rickreall watersheds had a majority of the regional slides (57%) while only making up 13% of the total land area surveyed.

Table 14 compares the flight year the photographs were taken with the predicted causes of each of the landslides identified. The table also breaks down the land ownership of where the slides occurred. This study predicted the ratio of road-related landslides vs. those landslides from forested areas is about 7.7 to 1. Ratios of landslides from clearcut vs. forested areas were estimated at 7.2 to 1.

Approximately 80% of the slides found in the study area originated on private lands. About 56% of the slides occurred before 1956 and were most likely due to extensive logging that occurred prior to that time and due to the inadequate road engineering practices in use at that time. Another 37% of the total slides surveyed occurred following the 1996 storm event. Landslides surveyed in 1996 are shown in Figure 17.

Table 17. Number and Type of Landslides in Mill Watershed Region

	Landslide Causes						
	Road Related		Clear cut Related		Forested		
Aerial Flight Year	Private	Public	Private	Public	Private	Public	Total
1956	50	12	24	12	3	2	103
1966	26	1	17	1	2	1	48
1974	5	6	6	6	0	0	23
1982	4	3	0	0	0	0	7
1996	33	0	52	12	8	2	107
Totals	118	22	99	31	13	5	288

Streams in the Mill watershed are listed by DEQ's as being 'water body of concern' for sediments. Understanding where and why landslides are occurring in the watershed can help us to identify problem practices and areas for corrective actions.

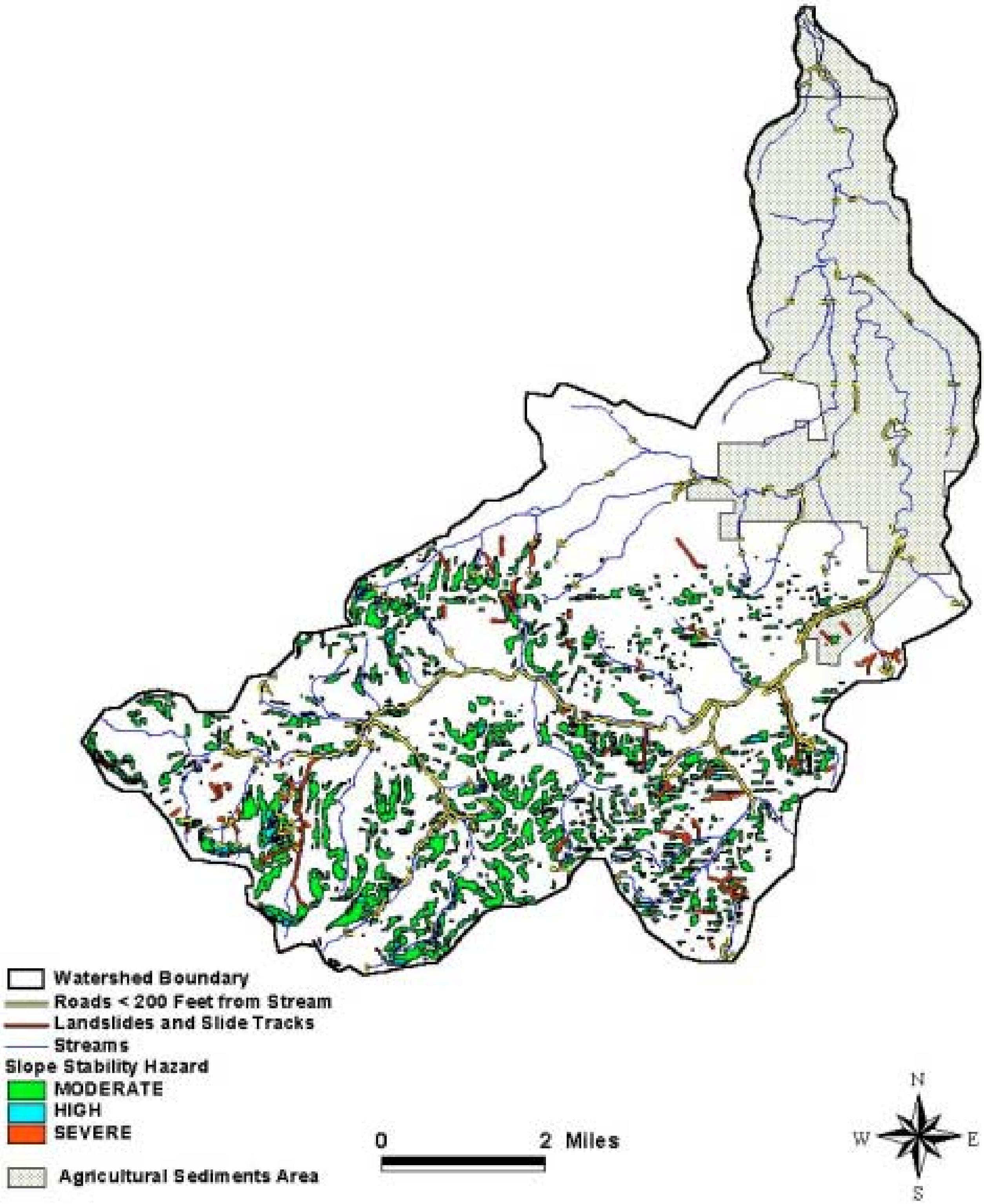
Rural Road Runoff:

To make an assessment of the amount and location of sediments contributed by road runoff, many variables need to be considered. The quality of surface rock, road maintenance, and construction, ditch conditions, cut-slope conditions are some of the data gaps that were identified during assessment process. We examined topographic maps (as described in the OWAM) and recorded the road segments in each sub-watershed within 200 feet of a stream (Figure 17).

The amount of sediment contributed by road runoff is highly variable and difficult to measure. During field verification visits through out the watershed, road conditions and maintenance were generally good with very little rutting or failures in the road surfaces. Mill Creek road, beginning near the Mill Creek Park until the Cedar Creek area, was almost continuously within 200 feet for stream.

As the road and main channel of Mill Creek enter the upper portion of the watershed, the valley bottom becomes highly constricted forcing them to be side by side with less than a few feet between them. While the road is in relatively good condition, its proximity and upslope location to Mill Creek indicates that it has a high probability of contributing fine sediments to the system.

Figure 17. Sediment Sources



Sediment Sources References and Resources

USDA Soil Conservation Service. 1982. *Soil Survey of Polk County, Oregon.* NRCS Library, Dallas OR.

U.S. Geological Survey topographic maps (Laurel Mountain, Socialist Valley, Sheridan, Grand Ronde, OR, 1:24,000, 7.5-minute quadrangle, 1970 photorevised 1975 and 1969, photorevised 1986). NRCS Library, McMinnville, OR.

Department of Geology and Mining Industry. 1999. *Personal Communications.* Albany OR.

Oregon Department of Forestry (ODF). 1999. *Peak Flow Map.* Salem OR.

Hawe, Patrick, BLM. 1999 *Personal communication.* Salem, OR.

Mill, Keith, ODF. 1999. *Personal communication.* Salem, OR.

Tracey, Rob, NRCS, 1999. *Personal communication.* McMinnville, OR.

Hale, Ken, NRCS, 1999. *Personal communication.* Dallas, OR.

2.10 Restoration Efforts

Current Restoration work in the Mill Watershed

In order to plan restoration and monitoring efforts for the Mill watershed, it is important to understand where current and recently completed work is located. Figure 18 depicts some of the locations for road, riparian and instream restoration and protection work in the Mill watershed.

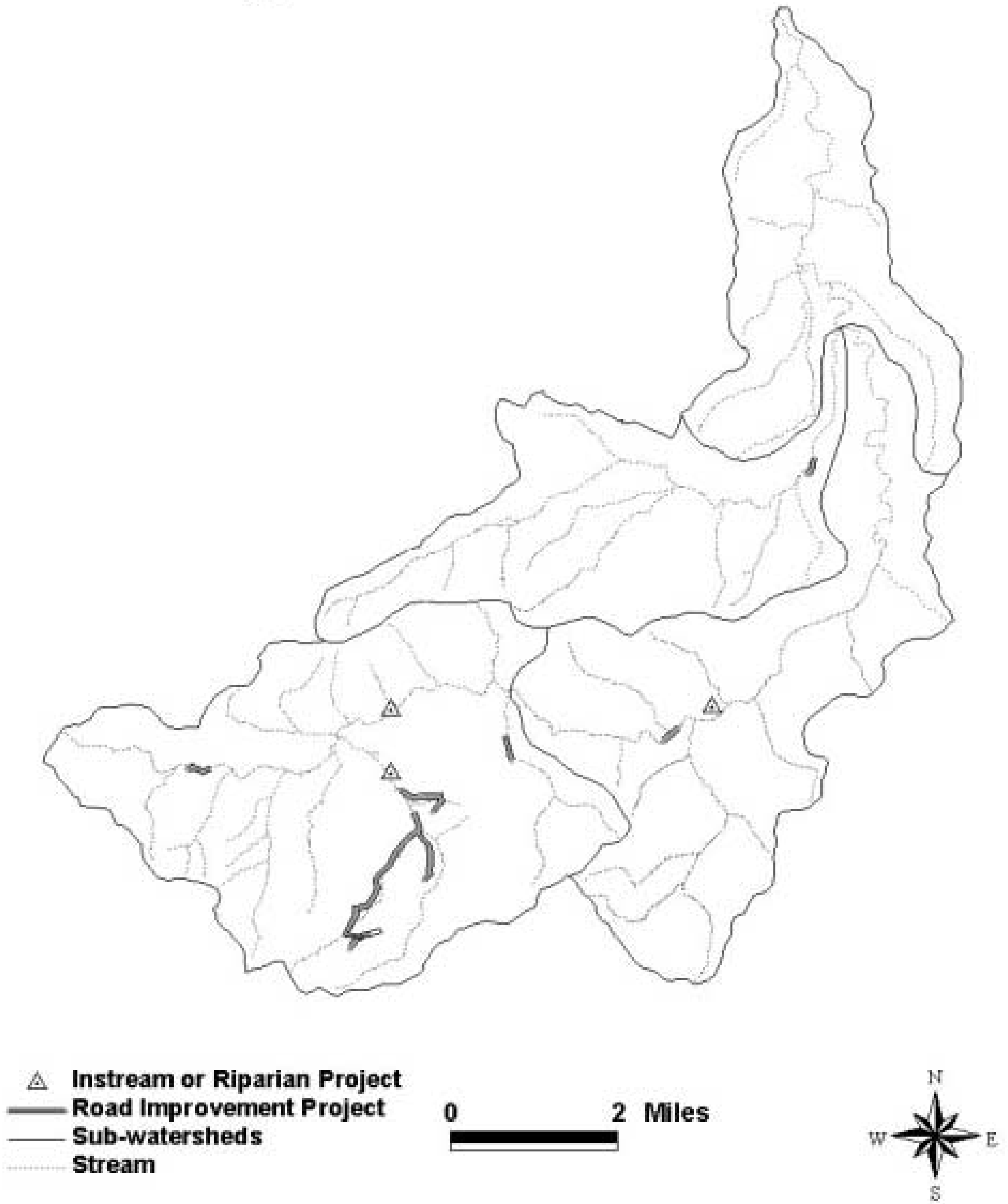
All of the road improvement work shown in Figure 18 was reported being done by Willamette Industries. The instream work shown was done by private landowners that requested that their names not be used in publications. The restoration information used to create this map was provided by the Oregon Watershed Enhancement Board (OWEB).

OWEB is collecting site locations for both road and instream/riparian restoration projects through out the state of Oregon. Private industries and landowners have been invited to share their restoration projects and plans with OWEB, which is compiling a database, and corresponding map of private and public projects [31].

The Gooseneck Creek watershed group has been active in watershed enhancement activities such as roadside trash clean up and monitoring the fish passage barrier at the HWY 22 and Gooseneck Creek crossing. Current plans are to meet with ODOT, ODFW, and NRCS officials to discuss possible solutions for the barrier.

[31] For more information contact Susanne Maleki GWEB, Corvallis (541)-757-4623.

Figure 18. Restoration



3. 0 Watershed Condition Summary

Methodology

The channel habitat types (CHTs) defined during the course of the assessment were used as segment identifiers for the overall summary of conditions. 59 segments were numbered and their locations recorded (Figure 6)**.** CHT segments were then utilized in a decision matrix (Table 18) to ascertain specific locations in the watershed that fall into one of the three following groupings:

Protect (P) Areas with relatively high-quality aquatic-riparian habitat fish populations, or water quality conditions.

Restore (R) Areas with low-quality aquatic habitat, limitations on fish presence or production, or water quality concerns; the impacts and sources are identified.

Information (I) Areas where the aquatic-riparian condition, fish populations, or water quality cannot be accurately determined and/or the links to impacts are not clear.

The assessment component results were used to rate each stream segment as one of the three categories. Some components were divided into two sections to accommodate additional information. During the course of using this matrix it was observed that specific definitions of the *protect, restore and information* ratings for each assessment component were required.

Generally components were scored on the presence of watershed concerns in the near vicinity of the CHT segment. (e.g. Water Rights was scored 'Restore' for all of those areas where their exist water right holders because of the present over allocation of water and was scored "Protection' for all of the areas where there are no water rights permits issued.) The total number of ratings for each CHT segment were tallied and an overall segment evaluation made. The segments were mapped in Figure 19.

CHT segments that were nearly even in all three categories were designated as Restoration segments. Areas that require protection were not identified during the course of this assessment. While individual component in the matrix designated CHT segments for *protection*, the summation of these designations was never enough to rate the segment *Protect.* It is hypothesized that some of the segments currently defined as requiring *information* are in fact areas of protection.

Figure 19. Condition Summary