Necanicum River Watershed Assessment

E & S Environmental Chemistry, Inc.

and

Necanicum River Watershed Council

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NECANICUM RIVER WATERSHED ASSESSMENT

Final Report

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BLM	Bureau of Land Management
C-CAP	Coastal Change Analysis Program
CHT	channel habitat type
CLAMS	Coastal Landscape Analysis and Modeling Study
CREST	Columbia River Estuary Study Taskforce
DBH	diameter at breast height.
DEM	digital elevation model
DLG	digital line graph
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCB	fecal coliform bacteria
GEN	general permit
GIS	geographic information system
GPS	global positioning system
LWD	large woody debris
NMFS	National Marine Fisheries Service
NOAA	National Aeronotic and Space Administration
NPDES	National Pollutant Discharge Elimination System
NWI	National Wetlands Inventory
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OPSW	Oregon Plan for Salmon and Watersheds
OWEB	Oregon Watershed Enhancement Board
OWQI	Oregon Water Quality Index
OWRD	Oregon Water Resources Department
POD	point of diversion
RM	river mile
SSCGIS	State Service Center for GIS
TBNEP	Tillamook Bay National Estuary Project

TIN	total inorganic nitrogen concentration
TMDL	total maximum daily load
TSS	total suspended solids
U.S. EPA	U.S. Environmental Protection Agency
USDA	U.S. Department of Agriculture
USDAFS	USDA Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WPCF	Water Pollution Control Facility
WPN	Watershed Professionals Network

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EXECUTIVE SUMMARY

1. Introduction

In this watershed assessment, we have summarized current conditions and data gaps within the Necanicum River watershed to help to identify how current and past resource management is impacting aquatic resources. This background information can then be used to create a decision-making framework for identifying restoration activities that will improve water quality and aquatic habitats. Following is a summary of key findings and data gaps from the primary components of this watershed assessment, including fisheries, aquatic and riparian habitat, hydrology, water use, sediment sources, and water quality.

2 Important Fisheries

The Oregon Watershed Enhancement Board (OWEB) assessment method used in preparing this watershed assessment focuses strongly on watershed processes that affect salmonids and their associated habitats. Understanding the current condition of salmonid populations in the watershed is vital to identifying the effects of the spatial and temporal distribution of key habitat areas. Additionally, salmonids are often used as indicator species under the assumption that they are the most sensitive species in a stream network (WPN 1999, Bottom et al. 1998, Tuchmann et al. 1996). Habitat conditions that are good for salmonids generally reflect good habitat conditions for other species of aquatic biota.

Anadromous salmonid species known to occur in the Necanicum River include chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), steelhead trout (*O. mykiss*), and sea-run cutthroat trout (*O. clarkii*). The chinook salmon were introduced, whereas the other species are native to this drainage. Although details of their life history and habitat requirements differ substantially, all spawn in fresh water, migrate through the estuary, and rear for varying lengths of time in the ocean before returning to their natal streams to complete their life cycle. Resident cutthroat trout and Pacific lamprey (*Entosphenous tridentatus*) are also present in the Necanicum River.

The National Marine Fisheries Service (NMFS) has listed coho salmon as threatened as required by the Endangered Species Act. Coastal cutthroat and steelhead are candidates for listing. Listing for chum and chinook was not warranted as determined by NMFS. Listing occurs for an entire Evolutionarily Significant Unit (ESU) which is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.

Coho salmon populations along the entire Oregon coast are now considered depressed. Coho use nearly all of the Necanicum River watershed as habitat, including all of the subwatersheds, but the population is very low. Numbers of adult coho (mostly age 3) escaping to the spawning grounds have been indexed using the peak count method, which is based on repeated counts on the spawning grounds. Peak count surveys were conducted by the Oregon Department of Fish and Wildlife (ODFW) in the Necanicum River from 1981 through 2001. Counts have been low and variable since 1983, and all-time lows were reached in 1997. ODFW estimated coast-side coho spawner abundance in 1999. The Necanicum River, plus Ecola Creek and other mid-size ocean tributaries, only accounted for about eight percent of the coho spawners in the north coast region during that year.

A combination of factors, including rearing and spawning habitat degradation, reduction in summer streamflow, passage restriction impacts at dams, decrease in ocean productivity, excessive fishing, and impacts caused by hatchery programs, have been implicated in most of the declines and extinctions of coho salmon populations in Oregon. In coastal rivers and lower Columbia Basin tributaries, low summer flows and the loss of complex in-stream structure, winter side channels, sloughs, and shade have been identified as predominant problems. Timber harvest in the coastal temperate rain forest belt has contributed to winter habitat loss, particularly in the uplands. Logging has caused the loss of large conifers from riparian areas that would have provided long-lasting in-stream structures when they fell into streams. Siltation from logging roads, road-failures, and loss of ground cover, along with reduction of water filtering and shade due to the removal of riparian vegetation, have reduced egg and juvenile survival. Agriculture, industrialization, and urbanization have degraded coho rearing habitat in the lower river and estuary through such actions as diverting water, channelizing streams, diking off-channel and estuary areas, and releasing effluents that elevate temperatures and reduce water quality (ODFW 1995).

Agricultural and logging practices along low gradient river reaches in lower basins have greatly decreased the complexity and productivity of juvenile salmonid rearing areas. Wetlands, marshes and braided channels have been straightened, channelized, diked, drained and deforested to create croplands, pastures, and urban areas. Summer flows and water quality have also decreased and summer water temperatures have increased in these areas.

Less is known about the present status of sea-run cutthroat trout than about any of the other anadromous salmonid species in the Necanicum River watershed. Sea-run cutthroat trout, the smallest of the anadromous salmonids present in the watershed, have not been fished commercially. This species is believed to be at very low levels in all Oregon North Coast waters. The status of the Necanicum River population is not known. It is known, however, that sea-run cutthroat trout are found in the mainstem Necanicum River and resident populations occur in some of the tributary streams above waterfall barriers.

Oregon is near the southern edge of chum salmon distribution, which may, in part, account for the large interannual variability in run sizes that have been observed in some populations over the years. Chum salmon populations have been very depressed south of the Columbia River. The Necanicum River has a sustaining population of chum salmon, but it is very small and unstable. Due to the very low counts on the spawning grounds since about 1992, concern has been growing that the chum populations throughout the North Coast of Oregon are experiencing serious problems. Chum salmon use only the lowest portions of the Necanicum River watershed, and require typical low gradient, gravel-rich, barrier-free freshwater habitats and productive estuaries. They have not been supplemented by hatchery fish.

Most coastal steelhead in Oregon are winter-run fish and summer steelhead are present only in a few large watersheds. The subspecies (*Oncorhynchus mykiss irideus*) includes a resident phenotype (rainbow trout) and an anadromous phenotype (coastal steelhead). Winter steelhead are native to the Necanicum River and are widely distributed throughout the watershed. Winter steelhead generally enter streams from November through May and spawn soon after entering freshwater.

No reliable information on the historic abundance of steelhead in the Necanicum River is available. Rough estimates of total coast-wide steelhead run size made in 1972 and 1987 were similar (Sheppard 1972, Light 1987), suggesting that overall abundance remained relatively constant during that period. The steelhead population in the Necanicum River has been judged to have been impacted by habitat deterioration, but appears to be healthy at present. Most spawning occurs in the mainstem.

Coastal steelhead abundance follows a similar cycle in all populations from Puget Sound in Washington to California, indicating that factors common to all populations influence trends. The most probable factor responsible for this cycle is ocean condition. Ocean productivity is recognized to undergo long-term cycles that include periods that are relatively favorable or unfavorable to the survival of salmonids. This cycle appears to be a natural process that is not strongly affected by management actions. The ocean productivity cycle appears to have been unfavorable for steelhead recently, and all steelhead population abundance trends have been correspondingly low (ODFW 1995).

Steelhead and rainbow trout populations have also been affected by freshwater habitat degradation. Most coastal salmonid freshwater habitats were historically coniferous, temperate, rain forest ecosystems. Stream systems were structurally complex, with large in-stream wood, flood plains, beaver ponds, braided channels, and coastal marshes and bogs. Human activities have altered these ecosystems, particularly by reducing their complexity and removing components that were essential to steelhead and rainbow trout production. Logging and road construction in the Coast Range and Cascade Mountains have had the most widespread impact on coastal steelhead, and have affected most populations.

There has been a high-intensity winter steelhead fishery in the Necanicum River, targeted on hatchery fish. Nevertheless, the Necanicum River has continued to produce viable numbers of wild or unmarked fish.

3. Aquatic and Riparian Habitats

Distribution and abundance of salmonids within the watershed varies with habitat conditions such as substrate and pool frequency as well as biological factors such as food distribution. In addition, salmonids have complex life histories and some use different portions of the watershed during different parts of their life cycle. There are also differences among salmonid species in their timing and extent of habitat utilization. The interactions of these factors in space and time make it difficult to identify the specific watershed components that most strongly affect salmonid populations. Consequently, entire watersheds must be managed to maintain fish habitats, and not just individual components.

Healthy populations of anadromous salmonids are generally associated with the following freshwater habitat characteristics:

- cool, clean, well-oxygenated water;
- unobstructed access to spawning grounds;
- clean, stable spawning gravel;
- winter refuge habitat for juveniles;
- complex stream channel structure with an appropriate mixture of riffles, pools, and glides;
- deep pools;

- stream channels with an abundant supply of large woody debris;
- abundant food supply;
- adequate summer stream flows; and
- diverse, well-established riparian community.

ODFW has conducted stream habitat surveys in approximately 19 percent of the Necanicum River watershed stream network. Habitat conditions are variable in time, however, and change in response to hydrologic factors. In particular, large flood events, such as occurred in 1996, can alter large woody debris (LWD) and sediment conditions in the watershed to a significant extent.

Stream morphology describes the physical state of the stream, including features such as channel width and depth, pool frequency, and pool area (Garono and Brophy 1999). Pools are important features for salmonids, providing refugia and feeding areas. Substrate type is also an important channel feature since salmonids use gravel beds for spawning. These gravel beds can be buried by heavy sedimentation, resulting in loss of spawning areas as well as reduced invertebrate habitat. For streams that were surveyed, stream morphology and substrates were compared against ODFW benchmarks to evaluate current habitat conditions. In the streams surveyed, the pool frequency for the majority of the pools fell in the moderate category, and the remainder were rated as desirable for pool frequency. The majority of the stream reaches were also in the moderate category based on the percent of area of the stream reach in pools. However, 12 percent of the surveyed streams were rated as undesirable for percent pools. In general, the depth of pools was moderate. Residual pool depth was desirable for 16 percent of all stream reaches surveyed. None of the surveyed streams had undesirable residual pool depths.

Gravel conditions in riffles demonstrated generally desirable conditions, although Bergsvik Creek and South Fork Necanicum River showed moderate conditions in all reaches surveyed.

Large woody debris is an important feature that adds to the complexity of the stream channel. LWD in the stream provides cover, produces and maintains pool habitat, creates surface turbulence, and retains small woody debris. Functionally, LWD dissipates stream energy, retains gravel and sediments, increases stream sinuosity and length, slows the nutrient cycling process, and provides diverse habitat for aquatic organisms (Bischoff et al. 2000, BLM 1996). LWD is more abundant in intermediate sized channels in third- and fourth-order streams than in larger streams. In fifth-order and larger streams, the channel width is generally wider than the length of a typical piece of LWD, and therefore, LWD is not likely to remain stable in the channel.

LWD conditions in the surveyed streams were undesirable. In particular, the density of key pieces of LWD was consistently rated as undesirable. Riparian conditions uniformly demonstrated undesirable conditions, with all streams lacking sufficient densities of conifers in the riparian zones.

The potential for LWD recruitment in the Necanicum River watershed was poor. None of the riparian areas in the watershed demonstrated a high potential to contribute LWD to the stream channel. In all of the subwatersheds except Neacoxie, at least 75 percent of LWD recruitment potential was classified as low. The lack of large conifers (>24" dbh) in this watershed is likely a result of vegetation removal and historic fires along the riparian corridor.

Riparian vegetation is an important element of a healthy stream system. It provides bank stability, controls erosion, moderates water temperature, provides food for aquatic organisms and large woody debris to increase aquatic habitat diversity, filters surface runoff to reduce the amount of sediments and pollutants that enter the stream, provides wildlife habitat, dissipates flow of energy, and stores water during floods (Bischoff et al. 2000). Natural and human degradation of riparian zones diminish their ability to provide these critical ecosystem functions.

Shade conditions in the streams in the Necanicum watershed surveyed by ODFW were generally rated as desirable. Only the Neacoxie subwatershed showed a significant proportion of less-than-desirable shade conditions. Results from our air-photo analysis of stream shading yielded similar results to the stream reach surveys of ODFW. Stream shading conditions were generally high across the watershed. Shade conditions were high for at least 50 percent of the stream length in five of the seven subwatersheds. Areas not rated as high generally occurred along the mainstem of the river and in the two lower subwatersheds (Neacoxie and Seaside).

Stream channels are often blocked by natural barriers, such as waterfalls, or by human-caused barriers, especially poorly designed culverts at road crossings. This has resulted in significant loss of fish access to suitable habitat. Anadromous fish migrate upstream and downstream in search of food, habitat, shelter, spawning beds, and better water quality. Fish populations can be significantly limited if they lose access to key habitat areas.

Only 23 culverts out of a total 259 road-stream crossings have been surveyed for potential fish passage barriers by ODFW, and 69 percent of those surveyed were judged to be impassable. The Necanicum River watershed has an average stream crossing density of 3.2 stream crossings per square mile. Stream crossing densities were highest in the South Fork and Seaside subwatersheds (4.4 and 4.2 crossings per square mile, respectively). The Upper Necanicum subwatershed contained half of the surveyed culverts in the watershed that were judged to be impassable. It should be noted, however, that only a very small percentage of the culverts in the watershed have been surveyed by ODFW.

Disconnecting the floodplain from the river can lead to reduced physical complexity and channel downcutting due to increased water velocities, resulting in deteriorated habitat conditions. Additionally, disconnection from the floodplain can lead to changes in the biotic structure of the aquatic ecosystem by limiting nutrient and organic material exchanges between the stream and floodplain. Urban development and associated attempts to control flooding have reduced the natural complexity of the river channel and separated the river from its floodplains in some places. The loss of natural floodplain function has impacted other resources with economic value, such as the fish and shellfish industries, which attracted commercial and residential development to the floodplain (Coulton et al. 1996). To some degree, hydrological modifications have probably increased streambank erosion by increasing water depth and flow velocity in the lower river (Leopold et al. 1992). In addition, the removal of large woody debris has made streambanks more vulnerable to this type of erosion process.

Wetlands contribute critical functions to watershed health, including water quality improvement, filtration, flood attenuation, groundwater recharge and discharge, and fish and wildlife habitat. Wetlands constitute an important landscape feature in the Necanicum River watershed. The predominant wetland types are palustrine wetlands and estuarine marshes. Palustrine wetlands are common along many of the stream corridors, especially in the Neacoxie and Seaside subwatersheds.

Wetlands play an important role in the life cycles of salmonids (Lebovitz 1992, Shreffler et al. 1992, MacDonald et al. 1988, Healey 1982, Simenstad et al. 1982). Estuarine wetlands provide holding and feeding areas for salmon smolts migrating out to the ocean. These estuarine wetlands also provide acclimation areas for smolts while they are adapting to marine environments. Riparian wetlands can reduce sediment loads by slowing down flood water, allowing sediments to fall out of the water column and accumulate (Mitsch and Gosselink 1993). Wetlands also provide cover and a food source in the form of a diverse aquatic invertebrate community. Backwater riparian wetlands also provide cover during high flow events, preventing juvenile salmon from being washed downstream.

Good (2000) determined that tidally-influenced wetland habitat in the Necanicum River watershed has been reduced by only about 10 percent since the mid-1880s. In contrast, 13 of the 17 largest estuaries in Oregon were estimated to have lost more than half of their original tidal wetland area. In general, the complexity of the Necanicum estuarine habitat has been reduced, however. Complex structure provided by LWD and associated pools has been removed and the connections between river channels and some portions of their floodplains have been altered. These losses are probably permanent.

Thus, the overall condition of aquatic and riparian habitats in the watershed has been changed. Habitat quality for salmonid fish and other biota has been reduced. On-going and future efforts to restore habitat quality include, in particular, replacement of culverts that have blocked fish access to important habitat, improvement of LWD and LWD recruitment potential, and livestock exclusion.

4. Hydrology

Human activities in the watershed can alter the natural hydrologic cycle, potentially causing changes in water quality and the condition of aquatic habitats. Changes in the landscape can increase or decrease the volume, size, and timing of runoff events and affect low flows by changing groundwater recharge.

Topography in the Necanicum River watershed is characterized by steep headwaters that lead quickly into low-gradient floodplains. Elevations in the watershed range from sea-level to 2,846 feet it its highest point. Precipitation ranges from about 74 inches annually in the lowlands to abut 150 inches in the highest elevations of the watershed (based on PRISM model calculations; Daly et al. 1994).

Flooding is a natural process that contributes to both the quality and impairment of local environmental conditions. Consequently, flood management attempts to reduce flood hazards and damage while protecting the beneficial effects of flooding on the natural resources of the system. River flooding tends to occur most commonly in December and January, during periods of heavy rainfall or snowmelt, or a combination of both. River flooding combined with tidal flooding can extend the flood season from November to February. The lowland valleys are the most prone to flooding during these periods.

Peak flows occur as large volumes of water move from the landscape into surface waters. The primary process that generates peak flows in streams of the Coast Range and its associated ecoregions is rain events. The Coast Range generally develops very little snow pack. Snow pack that does develop in the coastal mountains is usually only on the highest peaks and is of short duration. Rain-on-snow events are infrequent in the Coast Range although these events have contributed to some of the major floods, including the floods of 1964 and 1996. These large floods are rare events, and we have no data to suggest that current land use practices have exacerbated the flooding effects from rain-on-snow events.

The Necanicum River watershed has an extensive floodplain area that occupies about seven percent of the watershed. There are substantial estuarine and palustrine wetlands adjacent to the mouth of the river and in the Neacoxie and Seaside subwatersheds are often inundated during flooding periods. One of the primary natural functions of the floodplain is to reduce the severity of peak flows, thereby reducing downstream impacts and flood hazards. Portions of the floodplain area in the Necanicum River watershed have been altered, reducing floodplain storage of flood waters. The impacts of these changes are expected to be minimal, however, because the floodplain wetlands are largely intact and downstream development is not spatially extensive.

Increased peak flows can have deleterious effects on aquatic habitats by increasing streambank erosion and scouring (ODFW 1997a). Furthermore, increased peak flows can cause downcutting of channels, resulting in a disconnection of the stream from the floodplain. Once a stream is disconnected from its floodplain, the downcutting can be further exacerbated by increased flow velocities as a result of channelization.

Although the largest floods are most important from a flood hazard standpoint and are frequently associated with rain-on-snow events, the effects of increases in smaller magnitude peak flows cannot be discounted from a stream channel or ecological standpoint (Naiman and Bilby 1998). High flows constitute a natural part of the stream flow regime and are largely responsible for transporting sediments and forming channels. Consequently, increases in the magnitude of moderate peak flows can lead to channel incision thorough bank building or erosion. Because forest harvest practices are common in the watershed, there may be effects of forestry on watershed hydrology other than those commonly associated with rain-on-snow events. These might include reduced evapotranspiration, increased infiltration and subsurface flow, and increased overland flow (Naiman and Bilby 1998). Such changes may result in modified peak and low flow regimes and subsequent effects on in-stream aquatic habitat quality.

Road construction associated with timber harvest and rural development has been shown to increase wintertime peak flows of small to moderate floods in Oregon Coast Range watersheds

(Harr 1983, Hicks 1990). This assessment uses a roaded area threshold of eight percent to screen for potential impacts of roads on peak flows (discharge increase >20 percent; WPN 1999). Watersheds with a greater than eight percent roaded area are considered to have a high potential for adverse hydrologic impact, four to eight percent have a moderate potential, and less than four percent have a low potential.

According to GIS calculations from the ODF fire roads coverage, the density of forest roads in all of the subwatersheds in the Necanicum River watershed were considered to have a low potential impact on hydrology. Screening for land management activities that may be affecting natural hydrologic conditions suggests that forest roads have little effect on current hydrologic regimes, but other hydrologic impacts may have occurred in response to upland management and/or development in the valley bottom. Rural residential areas generally showed moderate to high potential for peak flow enhancement, but occupy relatively little area. Their overall impact on watershed hydrology is expected to be minimal. Loss of historical floodplain acreage and land cover (such as wetlands, forested valley bottoms) have likely had minimal impacts on hydrologic conditions in the Necanicum River watershed.

5. Water Use

Water that is withdrawn from the stream has the potential to affect in-stream habitats by dewatering that stream. Dewatering a stream refers to the permanent removal of water from the stream channel, thus lowering the natural in-stream flows. In-stream water rights were established by the Oregon Water Resources Department for the protection of fisheries, aquatic life, and pollution abatement; however, many remain junior to most other water rights.

The largest amount of water appropriated in the Necanicum River watershed is for municipal and domestic use by the City of Seaside (17.65 cfs). Most of this water is appropriated from the South Fork Necanicum River.

Based on current water availability model outputs, there appears to be significant concern for dewatering in the Necanicum River watershed. Three of the subwatersheds consistently demonstrated water loss greater than 20 percent of the predicted in-stream flows. In the South Fork Necanicum River, dewatering potential exceeded 100 percent of flows one out of every two years. Consequently, it is likely that water withdrawals from the Necanicum River and its tributaries are having a large impact on current in-stream flows. Any time water is appropriated for out-of-stream use, there is a potential for some effects on the in-stream habitats to occur during periods of low flow. It is our recommendation that in-stream water rights continue to be protected and in-stream flows monitored during low flow conditions.

The amount of water that has been appropriated for fish and wildlife represents about one-tenth of the total water rights for the watershed. Assuming that the in-stream water right for fish and wildlife is a good indicator of the amount of water required to provide adequate habitat conditions for salmonids, there appears to be a potential for low flow conditions to have deleterious effects on local salmonid populations. Any out-of-stream water use during low flow situations would be expected to exacerbate habitat problems. In-stream flow requirements for salmonids need to be further evaluated to determine actual impacts of surface water withdrawals on salmonid populations. Protection of in-stream flow for salmonid habitat is needed in the Necanicum River watershed.

6. Sediment Sources

Erosion is a natural watershed process in the Oregon Coast Range. The bedrock geology of much of the Oregon Coast is composed of weak, highly erosive rock types. However, most experts agree that land use practices have increased the rate of erosion in many coastal watersheds (WPN 1999, Naiman and Bilby 1998). High levels of sediment in rivers and streams are associated with loss of agricultural lands and filling of the estuaries. Sediment is also negatively impacting many aquatic organisms. Sediment input to the stream system is highly episodic, with the majority of sediment deposition into the stream system occurring during large storm events. Understanding the role of erosion and its interaction with other watershed processes is critical to maintaining a healthy ecosystem.

Upland processes that deliver sediment to the stream system include landslides and surface erosion. In lowland streams and rivers, erosion occurs primarily as streambank erosion, which often causes significant losses of riparian agricultural land. Wildfires in the uplands alter soil conditions, setting the stage for increased rates of erosion. In this watershed, slope instability, road instability, rural road runoff, and streambank erosion are significant sources of sediment. Shallow landslides and deep-seated slumps are common in the Oregon Coast Range. Streamside landslides and slumps are major contributors of sediment to streams, and shallow landslides frequently initiate debris flows. Forest and rural residential roads are a common feature of this watershed, and some of the forest roads are present on steep slopes. Washouts from roads contribute sediment to streams, and sometimes initiate debris flows in the upper watershed. The density of roads, especially unpaved gravel and dirt roads, indicates some potential for sediment contribution to the stream network.

Agricultural and pasture land runoff, as well as the history of fire in the region, are also contributing factors. However, because agricultural and pastoral lands occupy less than one percent of this watershed and are mostly located at the lower elevations of the watershed, their contribution to sediment is low. Urban runoff is also not expected to be a major contributor of sediment in this watershed. Developed lands (urban and rural residential) occupy about six percent of the Necanicum River watershed.

Under natural conditions, geology, topography, and climate interact to initiate landslides. With human intervention, natural conditions may be modified in ways that increase the likelihood of landslides occurring. Road-building often creates cuts and fills. In a slide-prone landscape, road-cuts may undercut slopes and concentrate runoff along roads, and road-fills on steep slopes may give way, initiating a landslide (NRC 1996). Vegetation removal, such as by logging or wildfire, may also increase the likelihood of landslides and consequent debris flows. In the short term, a debris flow can scour a channel or remove beneficial prey (benthic macroinvertebrates) and channel structures. Over the long term, these events deliver woody debris, organic matter, and gravel that could result in the reestablishment of productive aquatic habitat and provide an important reset mechanism to the stream ecosystem.

Landslide inventory data for the Necanicum River watershed were not available for analysis and inclusion in this assessment. Based on topography, studies conducted in other coastal areas, and an evaluation of potential debris flow hazard zones, landslide frequency in the Necanicum River watershed is probably moderate. Specific locations of landslide activity are unknown, although landslides and debris flows probably contribute the majority of the sediment in the watershed.

Human uses of the lowlands have affected the rate and character of lowland sedimentation through changes in flooding frequency and size, and by the alteration of floodplains and wetlands. In addition, channel modification, removal of LWD, and streamside grazing have increased streambank erosion. These changes have in turn affected the quantity and quality of riparian and aquatic habitat in the lowlands.

Sediment in the rivers and streams of the Necanicum River watershed is an issue of concern. The combination of the wet climate, steep slopes in the uplands, and erosive soils results in naturally high levels of sediment in coastal rivers and streams. The historic wildfires in the watershed, as well as resource management practices over the past century, are associated with an additional increase in sediment levels. High levels of sediment in the streams may have contributed to increased rates of sedimentation in the estuary. Additionally, high sediment levels are associated with the declining health of salmonid populations. While naturally occurring sources of sediment in the watershed may be uncontrollable (and perhaps to some degree beneficial), the additional sediment contributed by human activity can in some cases cause habitat degradation.

Roads are the primary source of sediment related to human activity in the Necanicum watershed. Contribution of sediment from roads is attributed to two processes: landslides originating from roads, and road runoff. Landslides coming from roads generally produce the largest proportion of road-associated sediment. The high density of stream-crossing culverts on sidecast dirt and gravel roads indicates that road-associated landslides are of concern in the Necanicum River watershed. However, few roads within the watershed are both in close proximity to a stream and on a slope greater than 50 percent. Road-related sediment contribution to streams is therefore not expected to be a substantial problem. Cooperation with private landowners to identify and improve sediment sources on private roads will help to mitigate the impact of sediment in the watershed.

Lastly, streambank erosion is a significant concern in the lower portions of the Necanicum River watershed. While the overall contribution of sediment from streambank erosion is probably less than other sources, erosion from the streambank is associated with a lack of riparian shade and consequent effects on water temperature. Restoration of riparian vegetation and prevention of livestock grazing near streambanks will lessen sediment contribution from streambank erosion.

7. Water Quality

The water quality assessment proceeds in steps. The first step is to identify uses of the water that are sensitive to adverse changes in water quality and identify potential sources of pollution in the watershed. The second step establishes the evaluation criteria. The third step examines the existing water quality data in light of the evaluation criteria. Conclusions can then be made about the presence of obvious water quality problems in the watershed, and whether or not additional studies are necessary. The ODEQ has developed the Oregon Water Quality Index (OWQI) as a water quality benchmark that is keyed to indicator sites monitored regularly by ODEQ. The

OWQI integrates measurements of eight selected water quality parameters (temperature, dissolved oxygen, biochemical oxygen demand, pH, ammonia+nitrate nitrogen, total phosphates, total solids, fecal coliform bacteria) into a single index value that ranges from 10 (the worst) to 100 (the best). Land use, geology, hydrology, and water quality vary widely throughout the North Coast region. Comparing minimum seasonal Oregon Water Quality Index (OWQI) values, water quality in the Necanicum River ranges from good to excellent according to OWQI, and generally as good as, or better than, water quality in other nearby rivers. Water quality data are collected by the ODEQ for the Necanicum River at Seaside as part of their ambient water quality network. In addition, STORET contains water quality monitoring data for 16 sites in the watershed that have been sampled more than once since 1966.

Major tributaries were sampled for temperature during the summers of 2000 and 2001 by the watershed council. Temperature data have been statistically processed to yield the 7-day average of the daily maximum temperatures (commonly referred to the *7-day statistic*). These 7-day statistics are used to specify if the sampled stream temperatures violate State water quality standards. Based on these data, none of the tributaries appear to be temperature-limited for salmonid rearing and growth, but may be moderately impaired for salmonid spawning and incubation. In summer months, the various tributaries reach maximum 7-day average stream temperatures in the range of about 14^{o} to 17^{o} C.

Of the 119 available dissolved oxygen measurements, 15 (12.6 percent) were below 8.0 mg/L, and 77 (64.7 percent) were below 11.0 mg/L. These data suggest that at least portions of the Necanicum River may be impaired with respect to dissolved oxygen to support salmonid spawning and incubation.

Available monitoring data indicated that total phosphorus concentration in the Necanicum River was above the screening criterion of 0.05 mg/L in 43 percent of the measured samples. These data suggest that the Necanicum River may be moderately impaired with respect to phosphorus. However, based on recent studies of the Wilson River, it is possible that much of the phosphorus in streamwater in the Necanicum River watershed may be associated with suspended solids derived from upland erosion and may not necessarily contribute to algal growth in the aquatic ecosystem.

Available monitoring data suggest that nitrate concentrations have increased in the Necanicum River since the 1960s. The cause of such an increase in nitrate cannot be determined from the available data. It is possible that nitrogen fixation in large alder stands in the watershed may be contributing to higher nitrogen concentration in the river. The available data suggest, however, that the Necanicum River water quality may be moderately impaired with respect to nitrogen.

The Necanicum River is on the 1998 ODEQ 303(d) list of water quality impaired water bodies for bacteria from the mouth of the headwaters. Additional sampling during storm events is needed to more fully evaluate bacterial contamination.

Only 1 of 142 measurements exceeded the turbidity evaluation criterion of 50 NTU. This suggests that the Necanicum River is not impaired with respect to turbidity. However, turbidity is generally associated with high discharge conditions, and the discharge levels at the time of sample collection are not known for the available monitoring data. Additional sampling during storm events is needed to more fully evaluate turbidity.

At the screening level of this assessment, water quality in the major streams of the Necanicum River watershed would be considered impaired because of the frequency of exceedence of the evaluation criteria for temperature, nitrogen, total phosphorus, and bacteria. Dissolved oxygen may also be a problem with respect to salmonid spawning and incubation. There is no reason to suspect that the river suffers from impairment with respect to pH, turbidity, or trace metals. There are not sufficient data to make a preliminary judgement with respect to organic contaminants. It should be noted, however, that available water quality data are not adequate for water quality characterization in this watershed, especially with respect to spatial variability and the response of parameters that tend to be episodic in nature, such as bacteria, turbidity, and total phosphorus.