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May 21, 2007

To Whom It May Concern,

Accompanying this letter you will find the North Yamhill River Subwatershed 2005-2006 Final Water Quality Monitoring Report. The data in this report was collected during the summers of 2005 and 2006, as part of the North Yamhill Water Quality Monitoring Project, a two-year effort to collect baseline data in the North Yamhill River Watershed. The results will help the YBC and our partners determine where to focus efforts to improve water quality as well as enhance fish and wildlife habitat.

Chemical, biological, and physical stream parameters were sampled and measured for this project. Parameters monitored included temperature, dissolved oxygen, turbidity, pH, conductivity, *E. coli* and benthic macroinvertebrates (aquatic insects, a good indicator of water quality). The full report, which includes background information, scientific methods, state standards, and a discussion of the results, will be available on the YBC website at www.co.yamhill.or.us/ybc.

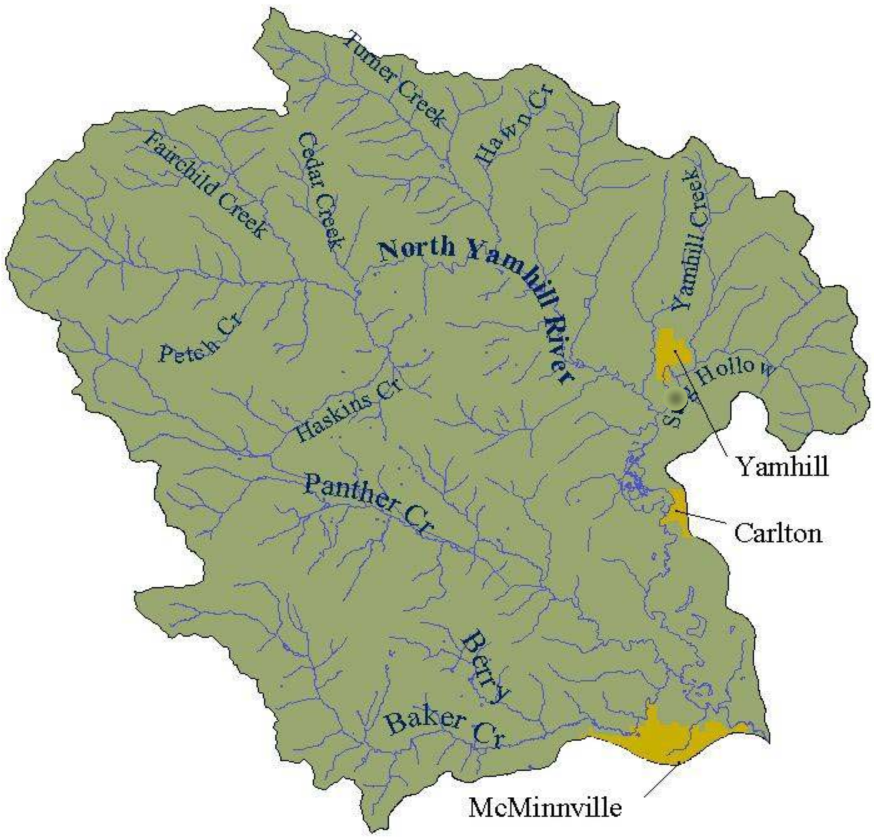
This project was made possible through a grant from the Oregon Watershed Enhancement Board and additional support from the Oregon Department of Agriculture, Oregon Department of Environmental Quality, McMinnville Water Reclamation Facility, and the Yamhill Soil and Water Conservation District. The participation of landowners, volunteers and other organizations was vital to the success of this project. The Yamhill Basin Council is dedicated to improving local watersheds by working collaboratively with private and public landowners and organizations.

Thank you for your interest in the Yamhill Basin Council. We hope you find this report interesting and educational. Please feel free to share this with your family, friends and colleagues!

Sincerely,

Steve Covey
Chair
Yamhill Basin Council

NORTH YAMHILL RIVER SUBWATERSHED



WATER QUALITY MONITORING FINAL REPORT

March 2007

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Abbreviations and Acronyms

AgWQMAP	Agricultural Water Quality Management Area Plan
BLM	Bureau of Land Management
BOD	Biological Oxygen Demand
DEQ	Department of Environmental Quality
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
GIS	Geographic Information System
GPS	Global Positioning System
L	Liter
LAC	Local Advisory Committee
mg	Milligram
mL	Milliliter
MPN	Most Probable Number
NRCS	Natural Resource Conservation Service
NTU	Nephlometric Turbidity Units
ODA	Oregon Department of Agriculture
ODFW	Oregon Department of Fish and Wildlife
OWEB	Oregon Watershed Enhancement Board
QA	Quality Assurance
QC	Quality Control
RM	River mile
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WRF	Water Reclamation Facility (City of McMinnville)
WQMP	Water Quality Monitoring Project
YBC	Yamhill Basin Council

Chapter 1 – Background and Introduction

Background

Yamhill Watershed
The Yamhill Basin Council (YBC) was founded in 1995 and consists of 27 member positions representing stakeholders and watershed residents working together to improve the Yamhill River watershed. The Yamhill Basin is located within Yamhill and Polk counties and consists of the Yamhill River watershed (769 square miles) and the Chehalem Creek watershed (56 square miles). Elevation in the Yamhill Basin ranges from 60 to 3,600 feet. The Yamhill River is a tributary of the Willamette River. The Yamhill River and Chehalem Creek are tributaries of the Willamette River. The Yamhill River enters the Willamette near Dayton, Oregon and Chehalem Creek enters the Willamette near Newberg, Oregon.

North Yamhill River Subwatershed
The North Yamhill River subwatershed, the focus area of this study, consists of 445 miles of waterways and covers 113,441 acres (177 square miles), almost entirely in Yamhill County, Oregon. (See Map 1, page 7, for a visual reference of the North Yamhill Basin within the state of Oregon with an additional insert of the North Yamhill subwatershed within the boundaries of Yamhill County). The North Yamhill River starts in the eastern slope of Trask Mountain in the Coast Range, flowing south and east to its convergence with the Yamhill River, just southeast of McMinnville. The Yamhill River then drains into the Willamette River near Dayton. Major tributaries to the North Yamhill River include Panther Creek, Baker Creek, Haskins Creek, Fairchild Creek, Yamhill Creek, and Turner Creek.

People
The 2005 estimated population of Yamhill County is 92,196 (US Census Bureau, 2006). Human population densities in the North Yamhill River subwatershed are concentrated in and around the cities of McMinnville, Carlton and Yamhill.

Land & Water Use
Most of the land in the Yamhill River watershed is privately owned (approximately 87%), with the majority of land uses in agriculture (60%) and industrial forestry (37%) (Leoni, 2001). Although the predominant land uses in the North Yamhill River subwatershed are agriculture and forestry, urban and rural residential use areas are growing.

Water Quantity
Water in the North Yamhill River subwatershed is used for municipal drinking water, irrigation and private wells. Water rights are currently over-allocated on several streams. Major impoundments for municipal drinking water are located on Haskins Creek, Turner Creek, and Panther Creek. Stream flow in the North Yamhill River subwatershed varies throughout the year, largely depending on the amount of rainfall. The high and low flows

have different impacts on the landscape and resources. Diversions and withdrawals for irrigation during the summer months also contribute to the fluctuations in flow. During the winter high stream flows, a prominent resource concern is soil erosion.

Ecology

The diversity and acreage of natural wildlife habitats in the North Yamhill River subwatershed have been reduced as land has been converted from natural forest and grasslands to managed forests, pasture, cropland, homesteads, and urban areas. Studies estimate that around 40% of the original wetlands in the Willamette Valley have been lost (YBC, 2003). As a result, some of the ecological functions of wetlands and riparian areas have been impaired. These areas filter contaminants, trap sediment, and provide wildlife habitat. Wetland and riparian vegetation also minimizes hydrologic fluctuations by retaining water during high flows, thus higher quantities of water to recharge groundwater storage or provide shallow subsurface flow to streams. Groundwater provides most of the instream flow during summer periods of low precipitation.

Fish and Aquatic Life

Table 1.1 lists examples of fish and other aquatic life which can be found in the North Yamhill River subwatershed. Several of the Yamhill Basin's fish and aquatic vertebrate populations are currently in decline. The Upper Willamette steelhead is listed under the Endangered Species Act. Pacific lamprey is currently listed as vulnerable on the Oregon Sensitive Species List and is of special concern to tribal communities due to its cultural importance. The Columbia seep salamander and the Western pond turtle are currently listed as critical on the state Sensitive Species List, while the status of the tailed frog and red-legged frog is vulnerable.

Table 1.1 Examples of Aquatic Vertebrates Found in the North Yamhill Basin

Yamhill Basin Aquatic Vertebrates
Red-side shiner
Northern pike minnow
Largescale and bridgeslip sucker
Pacific lamprey
Brook lamprey
Sculpin species
Winter steelhead
Cutthroat trout
Pacific giant salamander
Tailed frog
Red-legged frog
Columbia seep salamander

Photo 1.1 Cutthroat Trout

Photo 1.2 Red-Legged Frog

Water Pollution

There are several potential sources of water pollution in the North Yamhill River subwatershed. Non-point sources of pollution in the Yamhill Basin include erosion from agriculture, rural residential, forestlands and streambanks, roadsides, and development in urban areas; contaminated runoff from livestock and other agricultural operations; and contaminated runoff from established urban areas, septic systems, and natural sources. Pollutants from non-point sources are carried to the surface water or groundwater through the action of rainfall, irrigation runoff, and seepage. Leaching of nutrients and pesticides can also impact water quality. During periods of low flow, especially during the summer months, nutrients and pesticides may impact water quality more severely due to the decreased dilution of the contaminants. Also, the increased water temperatures during the summer season can negatively impact aquatic life.

Water quality is a significant natural resource issue. It affects fish and wildlife while also being an important natural resource to watershed residents who use surface water for public and private domestic water supply, irrigation, livestock watering, water recreation, and fishing in various water bodies throughout the area. The North Yamhill River and several of its tributaries are listed on the 303(d) list as Water Quality Limited by the Oregon Department of Environmental Quality (DEQ) (Table 1.2). Previously, very little monitoring has taken place in the lower elevations of drainages within Yamhill County. The majority of monitoring taking place in the basin occurs on tribal land (Confederated Tribes of the Grand Ronde), federal lands (Bureau of Land Management (BLM)), or private forest industry lands in the higher elevations of the basin.

Table 1.2 DEQ Water Quality Limited Streams in the North Yamhill Watershed.[1]

Waterbody	Parameter	Season	List year	Listing Status
Baker Creek	Temperature	Summer	2002	303(d)
North Yamhill River	Dissolved Oxygen	Oct-May	2002	303(d)
North Yamhill River	Fecal Coliform	Year round	1998	303(d)
North Yamhill River	Temperature	Summer	1998	303(d)
Panther Creek	Temperature	Summer	1998	303(d)
Panther Creek	Temperature	Summer	2002	303(d)
Turner Creek	Temperature	Summer	1998	303(d)

In 1998, the Yamhill Basin Council (YBC) began temperature monitoring in streams throughout the Yamhill Basin. These initial efforts focused on widespread monitoring in the lower portions of the basin, at agricultural, rural residential, and city sites. While these data was an important first step, more measurement and testing on temperature as well as other

[1] Only streams monitored by the YBC WQMP during 2005/2006 are included in this list. To view the full listing of water quality limited streams (including river miles), visit the Oregon DEQ Water Quality Assessment website at http://www.deq.state.or.us/wq/assessment/assessment.htm. For detailed instruction on how to access and search for other water quality listed streams, site information, and data collected, see appendix G.

water quality parameters help with understanding and working to improve the health of the watershed. In addition, collecting more targeted water quality data will help DEQ develop more accurate Total Maximum Daily Loads (TMDLs) for 303(d) listed waters by the target completion year of 2007. Creating TMDLs involves gathering information on a basin scale to calculate the level of pollution reduction needed for streams to meet state water quality standards.

The Agriculture Water Quality Management Plan (Senate Bill 1010) impacts landowners living outside urban growth boundaries that are not covered by the Forest Practices Act. The plan's overall mission is to identify voluntary strategies that landowners may use to reduce water pollution in the Yamhill River sub-basin. The Yamhill Subbasin Agricultural Water Quality Management Area Plan (AgWQMAP) was developed locally through the efforts of a Local Advisory Committee, consisting of affected landowners residing within the basin, the Yamhill Soil and Water Conservation District, and the Oregon Department of Agriculture (ODA). The plan relies on the voluntary efforts of landowners as they work toward Best Management Practices, which are common-sense activities that farmers may utilize to reduce pollution and help farms to become more efficient, such as off channel watering for livestock, manure storage, and planting riparian buffers. The areas targeted in the plan include: erosion prevention and sediment control; irrigation management; livestock waste; nutrient management; pesticide management; streamside (riparian) management, and roads and farmsteads (Yamhill River Subbasin LAC, 1999). Continued voluntary water quality monitoring is expected to assist in identifying areas that may particularly benefit from prevention management, preservation, restoration, and continued monitoring efforts. It is expected that it would also promote public awareness and acceptance of the Yamhill AgWQMAP. Increased knowledge on water quality in the basin would also help direct the Soil and Water Conservation District's efforts in assisting landowners.

Introduction

In 2003 and 2004, the YBC conducted a Water Quality Monitoring Project (WQMP) at 25 sites throughout the Yamhill Basin. After completing this project, the YBC identified the need to gain better understanding of our watershed and water quality through a more detailed subwatershed monitoring effort. The North Yamhill River subwatershed was selected for this detailed study because of diverse and rapidly changing land uses, the presence of multiple urban areas, and the ability to concentrate the water quality monitoring to multiple sites within several subwatershed stream systems.

The Oregon Watershed Enhancement Board (OWEB) awarded a monitoring grant in the amount of $35,758 to conduct the 2005/2006 Water Quality Monitoring Project to study several water quality parameters in the North Yamhill River subwatershed, specifically focused on the North Yamhill River, and tributaries of the N. Yamhill River including, Turner Creek, Yamhill Creek, Baker Creek, and Panther Creek. This project was also supported by matching services and donations from the YBC, Yamhill Soil and Water Conservation District (SWCD), ODA, McMinnville Water Reclamation Facility (WRF), Oregon DEQ, Natural Resource Conservation Service (NRCS), volunteers, and generous landowners.

GOALS of the North Yamhill Subwatershed 2005/2006 WQMP:

- Assess water quality in areas of the North Yamhill River basin that currently receives little or no monitoring.
- Evaluate water quality issues of the streams in the North Yamhill basin identified on 303(d) list. (See Table 1.2)
- Refine our understanding of water quality in each subwatershed: 1) N. Yamhill River, (including the tributaries, Turner Creek & Yamhill Creek), 2) Panther Creek, and 3) Baker Creek.
- Aid in prioritizing areas/sub-basins in need of water quality improvement.
- Aid the YBC in selection of potential preservation and/or restoration sites and projects.
- Identify additional water quality studies that may be necessary.
- Provide opportunities to educate and involve landowners, residents, and college and high-school age youth in water quality monitoring and analysis.
- Share water quality information with residents, stakeholders and decision-makers.

KEY COMPONENTS of the North Yamhill Subwatershed Water Quality Monitoring Project:

1. Baseline water quality monitoring of temperature, dissolved oxygen, turbidity, conductivity and *E. coli* to support Agricultural Water Quality Management Planning (SB 1010) in the North Yamhill Basin, on the North Yamhill River, Turner Creek & Yamhill Creeks (tributaries of the North Yamhill River), Panther Creek, and Baker Creek.
2. Collection of benthic macroinvertebrates to determine where water quality may or not be impaired and compare results with physical/chemical data collected.
3. Collection of habitat data, including: gradient, substrate, wetted width, bankful height and bankful width, canopy cover, and thalweg depth.
4. Collection of stream discharge (flow) data at one site within each targeted sub-basin of the North Yamhill River subwatershed; on the North Yamhill River, Panther Creek, and Baker Creek.

Seventeen (17) sites were selected within the North Yamhill subwatershed: 6 on the North Yamhill River (including 2 tributaries of the North Yamhill River: Turner Creek and Yamhill Creek), 3 on Panther Creek, and 8 on Baker Creek. Sampling site locations were chosen to provide representation of stream reaches, downstream of the mouths of tributaries, where access was granted, and where the streams were wadeable and safe for data collection. Table 1.3 contains site numbers, names of sites, and identifying information, and Map 1 on the following page, contains a visual representation of where the sites are located within the North Yamhill subwatershed.

Table 1.3 2005/2006 N. Yamhill River Subwatershed Monitoring Sites

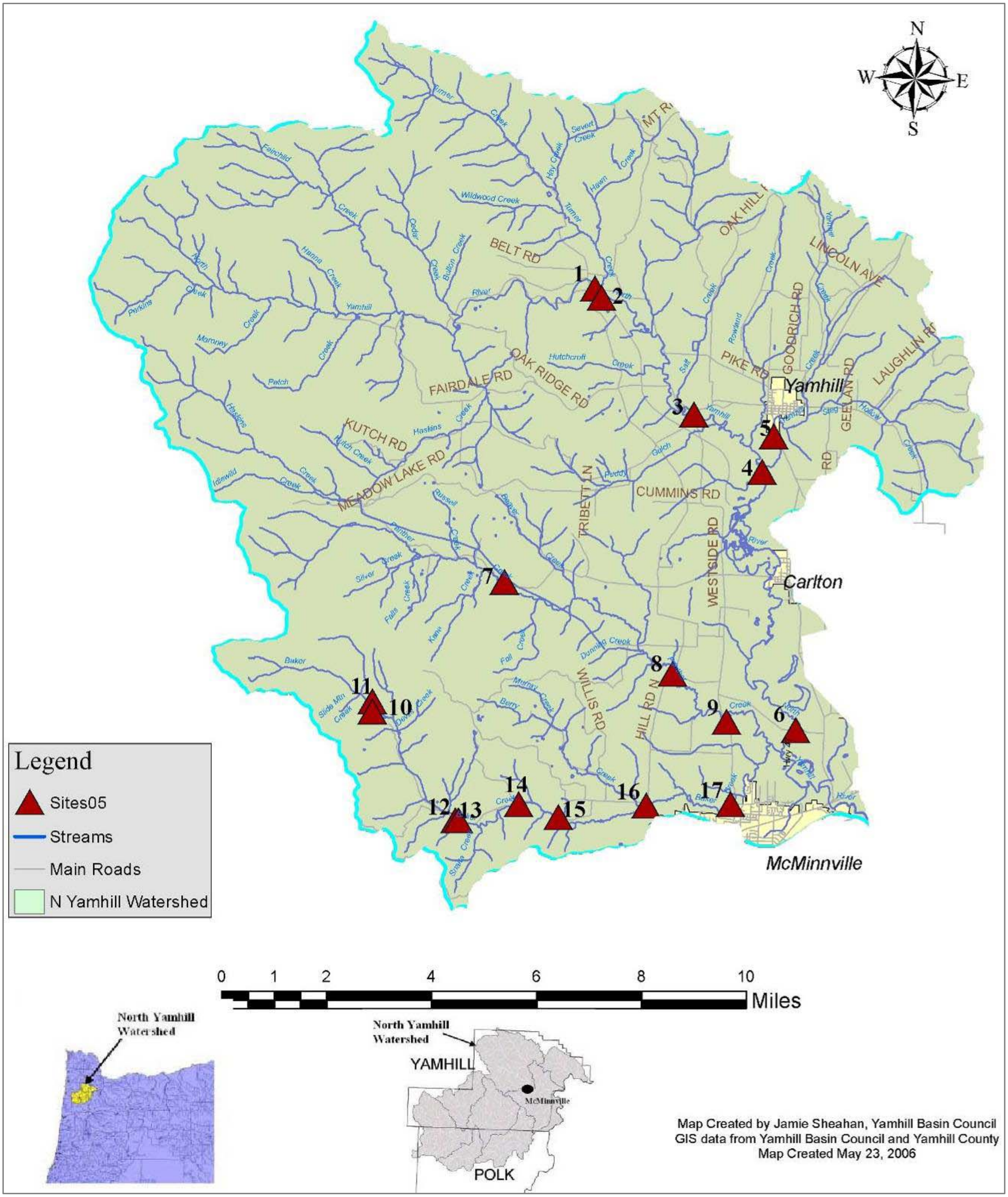
Site No.	Stream/River	Site Name/Location
1	Turner Creek	Tributary of N. Yamhill River
2	N. Yamhill River	Downstream of Turner Creek
3	N. Yamhill River	Downstream of Site No. 2
4	N. Yamhill River	Downstream of Site No. 3
5	Yamhill Creek	Tributary of N. Yamhill River – Converges just upstream of Site No. 4
6	N. Yamhill River	Downstream of Site No. 4
7	Panther Creek	Upper Panther Creek
8	Panther Creek	Middle Panther Creek
9	Panther Creek	Lower Panther Creek
10	Baker Creek	Upstream of Rainbow Lake
11	Baker Creek	Downstream of Rainbow Lake
12	Baker Creek	Upstream of Juliette Dam
13	Baker Creek	Downstream of Juliette Dam
14	Baker Creek	Huber Park
15	Baker Creek	Ed Grenfell Park
16	Baker Creek	Downstream of Site No. 15
17	Baker Creek	Tice Woods Park

Photo 1.3 North Yamhill

Photo 1.4 Panther Creek

Photo 1.5 Baker Creek

Map 1 2005/2006 Monitoring Site Locations



Water Quality Parameters Monitored

Water Temperature

Water temperature is one of the most important and critical parameters when assessing water quality. Temperature affects the metabolism of aquatic organisms and thus their growth and ability to survive. High temperatures may be lethal to fish and other organisms. The Oregon DEQ **standard for temperature is a 7-day average maximum of 64.4 ºF (18 ºC) or less.** This standard was set for the survival of salmonids during the rearing period of the life cycle (typically June through September), while other aquatic species may have more or less tolerance to this standard.

Dissolved Oxygen (DO)

Dissolved oxygen (DO) is the amount of oxygen freely available in water and necessary for aquatic life and the oxidation of organic materials. Low levels of dissolved oxygen can be fatal to fish and other aquatic organisms. Oregon DEQ has set a **minimum standard of 8 milligrams of oxygen per liter (mg O_2/L)** for cold water rearing and a minimum standard of 11 mg O_2/L for salmon spawning until fry emergence. Streams are placed on the DEQ 303(d) list if less than 10% of samples fall below the state standard during rearing season (June-October). Water at colder temperatures has a larger capacity to hold DO, while warmer water has less capacity to hold DO. Plant photosynthesis and aeration (e.g., as produced by stream riffles) increase DO, while animal respiration and aerobic decomposition of organic materials (i.e. Biological Oxygen Demand (BOD), decreases DO.

Turbidity

Turbidity is the property, or ability, of a sample to absorb or scatter light. Turbidity is measured in nephlometric turbidity units (NTUs) and is used to estimate the amount of sediment being transported in a body of water, or total suspended solids (TSS) present (e.g., from fine sediment and breakdown of aquatic organisms). While there is currently no specific DEQ standard number for turbidity, a low flow background of **less than 3 NTUs for minimal impact to aquatic life is considered a guideline for the Yamhill Basin** (Ishii, 2005). The DEQ language for turbidity standards states that activities may not increase turbidity more than 10% above background turbidity levels. High levels of turbidity are harmful to salmonid and other aquatic organisms from the impact of clogging gills, suffocation of fish eggs, and sediment deposition in substrate spaces, thus disturbing habitat for aquatic insects as well. High turbidity levels also interfere with the ability for sunlight to be reflected from the water surface, thus lending to more absorption of light and heat, and increased temperatures.

Conductivity

While the DEQ has not set a standard maximum, the suggested guideline for conductivity in the Willamette Valley is **180 microsiemens per centimeter (mhos/cm) or less.** (Ishii, 2005).

Conductivity, or specific conductance, measures the ability of a water sample to conduct electricity or pass an electrical current. Temperature and concentration of ions influences the conductivity of a sample. Conductivity is influenced by natural geology and stream flow. High conductivity may also indicate human-related activities such as wastewater, fertilizer runoff and urban runoff.

Escherichia coli (E. coli)

The state standard for *E. coli* calls for a **geomean of five samples taken over 30 days to be less than 126 MPN/100mL**[2]. *E. coli* is a species of bacteria that may be used as an indicator of fecal contamination; it is found in animal and human wastes and is easily quantified in the lab. The presence of *E. coli* in stream samples indicates that other pathogens may be present. Consistent elevated values may be the result of anthropogenic (human) impact, wildlife, domesticated animals, livestock or leaking septic systems.

Flow/Stream Discharge

Stream discharge fluctuates throughout the seasons. The volume in cubic feet per second (cfs) and velocity recorded at one site monthly within each subwatershed (North Yamhill River, Panther Creek, and Baker Creek) of the North Yamhill basin provides a snapshot over the May-October sampling season of the amount of streamflow that is being delivered from each subwatershed. This is the first project in which the YBC has conducted streamflow measurements.

Benthic Macroinvertebrates

Benthic macroinvertebrates (aquatic insects such as stoneflies, mayflies, snails, clams, and aquatic worms) serve as good overall indicators of water quality. Aquatic insect species have varying sensitivity responses to physical and chemical influences, therefore the presence or absence of specific species can indicate water quality issues that may be occurring. After a sample of benthic macroinvertebrates are identified, ten metrics, or subsets of data, are scored and summed to arrive at a Benthic Index of Biological Integrity (B-IBI) value which is used to determine the presence or absence of impairment as compared to reference sites (relatively pristine sites)[3]. Benthic macroinvertebrates provide another way of assessing water quality beyond chemical and physical parameters.

Physical Habitat

Physical habitat data collected, including gradient (slope) of stream, riparian canopy cover, substrate composition, large woody debris presence, and depth and width measurements of the stream may provide information on the overall ecological health conditions of the stream. Data results can be used in conjunction benthic macroinvertebrate B-IBI results for a more comprehensive analysis of the conditions of physical habitat in relation to the integrity of the aquatic insect community.

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[2] The equation is for the geomean of E. coli: $10^\wedge(\log_{10}V + \log_{10w}W + \log_{10}X + \log_{10}Y + \log_{10}Z)$.

[3] See Appendix A for further explanation of macroinvertebrate sample processing, identification, and metrics.

Chapter 2 – Methods

The Monitoring Technician and accompanying volunteers sampled according to standard protocols set in the Quality Assurance Project Plan (QAPP). The QAPP was developed by the YBC for the North Yamhill Water Quality Monitoring project, following protocols in the OWEB *Water Quality Monitoring Guidebook,* and with assistance and approval from DEQ. The DEQ Volunteer Monitoring Coordinator provided hands-on training in May 2005 and ongoing technical support throughout the project. Volunteer trainees practiced measuring temperature, turbidity, dissolved oxygen, conductivity and practiced collecting water samples for E. coli analysis and benthic macroinvertebrate sampling. Throughout the 2005 and 2006 sampling period, the YBC Monitoring Technician continued to train volunteers as needed.

The 2005/2006 Water Quality Monitoring Project consisted of measuring several chemical, biological and physical parameters, as summarized in Table 2.1.

Table 2.1 Parameters, Sampling Frequency and Method (Instruments) used for Monitoring

# of Sites	Parameter	Sampling Frequency	Method (Instrument)
17	Water Temperature	Monthly: May-October 2005 & 2006 Continuous: May-September 2005 & May-October 2006	YSI 30 Conductivity Meter VEMCO™ data loggers
17	Dissolved oxygen	Monthly: May-October 2005 & 2006	Winkler titration with Hach OX-DT
17	Turbidity	Monthly: May-October 2005 & 2006	Hach 2100P Turbidimeter
17	Conductivity	Monthly: May-October 2005 & 2006	YSI 30 Conductivity Meter
17	*E. coli*	Yearly: 5 continuous weeks in August and September 2005 & 2006	Quanti-Tray 2000 MPN Enumeration Test Procedure with Colilert reagents
3	Flow (Stream discharge)	Monthly: June-October 2005 & May-October 2006	Flow-Mate digital flow meter and top-setting wading rod
9 (2005) 7 (2006)	Benthic macroinvertebrates	Yearly: Late Fall (September/October) 2005 & 2006	8 ft^2 composite sample of 8 kicks with a 500 micron net; identified by contractor
7	Substrate	Yearly: Late Fall (September/October) 2005 & 2006	Modified Wollman pebble count
7	Wetted width Bankful width	Yearly: Late Fall (September/October) 2005 & 2006	Tape measure and/or measuring rods
7	Gradient	Yearly: Late Fall (September/October) 2005 & 2006	Clinometer and/or Abney Level
7	Canopy cover	Yearly: Late Fall (September/October) 2005 & 2006	Densiometer

Water Temperature – Continuous

Continuous temperature was measured and recorded with VEMCO™ temperature loggers. The YBC deployed loggers at the end of May 2005 and retrieved loggers at the end of September 2005, and again deployed loggers at the end of May 2006 and retrieved the loggers at the end of October 2006. The ability to leave the temperature loggers in the water longer in 2006 was due to low flow during the 2006 season and less rainfall, thus lower water levels. The temperature loggers recorded stream temperatures every 30 minutes.

Loggers were tied with fishing line to branches above the water surface or roots beneath the water surface so that they were suspended in the deepest part of the flow as possible without touching the stream bottom. Due to relatively low flows in 2006, temperature loggers were inspected each month to assure they remained below the water surface. If a logger appeared to be in threat of being exposed to above surface conditions before the next monthly visit to each site, then the temperature logger was either retied or moved to a near-by location, being careful to not remove the logger from below the water surface so as not to interfere with water temperature recordings.

Analysis of the data was completed using Oregon DEQ's Hydrostat Simple program.

For **accuracy**, pre- and post-field deployment accuracy-check baths were conducted each monitoring season. Initialization of the loggers was performed using the VEMCO™ Minilog program. The temperature loggers were also factory-calibrated prior to being received by the YBC.

For **precision**, the loggers were audited in the field monthly and at the time of deployment and retrieval using a NIST (National Institute of Standards and Technology) factory-calibrated traceable thermometer[4].

Water and Air Temperatures – Point (Single Measurements)

Point (single monthly field measurements) water temperatures were measured using the YSI Model 30 Conductivity-Temperature Meter. Air temperatures were measured with the YSI Model 30 Conductivity-Temperature Meter in 2005. In 2006, a separate thermometer, (NIST thermometer), was used to measure air temperature, as it was determined that the YSI Conductivity-Temperature meter took too long to equilibrate after being exposed to the relatively colder water of the streams after measuring water temperature.

For Accuracy, the YSI conductivity-temperature meter and the NIST thermometer were calibrated by the DEQ prior to each sampling season.

For **precision**, a duplicate measurement of both water and air temperature was taken at one random site each field day.

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[4] Audited with a NIST certified thermometer (5°C-25°C).

Dissolved Oxygen

Dissolved oxygen was measured using the Winkler titration method and Hach standard pre-measured crystal reagents and liquid titrant. A 300mL labeled glass BOD (biological oxygen demand) bottle was slowly filled to overflowing in the stream with an effort to evacuate air bubbles. One powder pillow of manganous sulfate, followed by one powder pillow of alkaline azide was added. The bottle was sealed and shaken vigorously for about 20 seconds. After the precipitate had settled below the neck of the bottle, the bottle was shaken vigorously for another 20 seconds. After settling a second time, one powder pillow of sulfamic acid was added; the bottle was sealed and shaken vigorously again. The fixed sample was stored in a cooler with ice. Within 8 hrs after the sample was taken, 200mL of the sample was transferred to an Erlenmeyer flask, and titrated with a Hach digital titrator using 0.2 N sodium thiosulfate until the sample was light yellow. 1mL of starch indicator was then added, turning the solution blue, making it easier to see when the solution reached its endpoint (when the solution turns clear) during continued titration. The amount of dissolved oxygen in the sample was immediately recorded in mg O_2/L[5] from the reading on the digital titrator.

No **accuracy** check is available for DO for this project.

For **precision**, a duplicate sample was taken once per day at a randomly chosen site.

Photo 2.1 Hach Dissolved Oxygen Kit

Turbidity

Turbidity was measured with a Hach 2100 Turbidimeter. The bottle in which the stream sample was collected was agitated gently before filling a glass sample cell to be tested in the

[5] The number on the digital titrator was converted to mg O_2/L by dividing by 100.

turbidimeter, carefully wiped clean of any moisture or fingerprints, and placed in the Turbidimeter for the reading.

For **accuracy**, the Turbidimeter was checked against Formazin secondary standards before each field day.

For **precision**, a duplicate sample was taken once per day at a randomly chosen site.

Conductivity

Conductivity was measured with an YSI Model 30 conductivity-temperature meter. The meter probe was suspended and immersed in the stream and the specific conductance was recorded upon stabilization of the digital reading indicator.

For **accuracy**, the YSI 30 Conductivity-Temperature meter was checked against a pre-mixed conductivity standard supplied by DEQ before each field day. The conductivity meter was also factory calibrated and then tested at the beginning each monitoring season with 1000 mhos/cm standard solution by DEQ.

For **precision**, a duplicate sample was taken once per day at a randomly chosen site.

Photo2.2 YSI Model 30 Conductivity/Temperature Meter

Escherichia coli (*E. coli*)

To test for *E. coli*, stream samples were collected in labeled autoclaved bottles opened upstream and underwater and transported in a cooler with ice to the McMinnville Water Reclamation Facility (WRF) within 5.5 hours of collection. A chain of custody sheet was completed every day and submitted to the laboratory technicians at the WRF. Samples were collected at all sites in 2-3 day clusters for 5 weeks during the months of August and September (i.e., 5 weekly samples of all 17 sites). At the WRF, the Quanti-Tray 2000 MPN Enumeration Test Procedure and Colilert reagents were used. 100 mL of stream water were distributed into the wells of a tray using a Quanti-Tray Sealer and incubated at 35 degrees Celsius for approximately 24 hours. The trays were read under normal light to count the number of wells where the reagents turned yellow, corresponding to the Most Probable Number (MPN) of total coliforms (includes bacteria naturally occurring in the environment) per 100 mL. The trays were then read under UV light to count the number of fluorescing wells, corresponding to the MPN of *E. coli* [6].

For **precision**, one duplicate *E. coli* sample per day (or 10% of sampling sites – whichever was greater) was collected at randomly chosen site.

[6] The maximum measurable amount is 2419 MPN/100mL

Flow/Stream Discharge

Flow, or stream discharge, was measured in cubic feet per second (cfs) using a Marsh-McBirney Flow-Mate™ digital flow meter and a top-setting wading rod. Discharge was calculated using the standard velocity-area method. For a detailed description of flow measurement methods, see Appendix E.

Photo 2.3 Stream Flow Measurement

Benthic Macroinvertebrates

Benthic macroinvertebrates were collected using Oregon DEQ protocols. A D-frame kick net with 500 micron netting was used to capture macroinvertebrates in 8, 1ft squares in 1-8 (depending upon the number of riffles within the stretch being measured) riffles at each of 9 sites in 2005 and 7 sites in 2006. Moving downstream to upstream, so as not to disturb subsequent samples, rocks were scrubbed and substrate was disturbed for a depth of several centimeters within the 1ft squares upstream from the net with the hands and feet. Samples were preserved in 91% isopropyl alcohol (immediately on site) in labeled plastic containers. Within 24 hours, the alcohol was drained and the samples were recharged with 70% isopropyl alcohol for preservation before delivery to the contracted taxonomist.

Photo 2.4 Macroinvertebrate Collection

For **precision**, duplicate samples were collected for quality control each year at two of the sites in 1ft squares in the same riffles as the original or primary sample. The duplicate was collected at either an opposing or upstream 1 ft square so as not to disturb the original sample or contaminate the duplicate sample.

Physical Habitat

Physical parameters were measured at 7 of the 9 sites, where benthic macroinvertebrates were sampled in 2005 and at all 7 sites in 2006. (The 2 sites not measured for habitat in 2005 were deemed too deep or dangerous to conduct adequate field sampling along at least 50% or more of the reach). Transect distances were calculated from the average of four representative wetted widths within the reach. A modified Wollman pebble count to sample substrate type was conducted, with 5 samples collected (left bank, ¼ width, center, ¾ width, right bank) at each of the 21 transects and midpoints for a total of 105 samples. Wetted width was measured along 21 transects and midpoints. Bankful height and bankful width was estimated and measured at each of the 11 transects. Gradient was measured between each transect if visibility allowed using a clinometer and measuring rods. Canopy cover data was collected at each of the 11 transects at the left bank, center upstream, center left, center downstream, center right and right bank with a clinometer. Thalweg depth (deepest flow point in the stream) was measured every 100th of the total reach distance or at 9 points between each transect as well as each transect (a total of 101 thalweg measurements). Large woody debris (LWD) was tallied along the reach and categorized based on large-end diameter.

Photo 2.5 Habitat Data Collection

Location/Sites

The sampling locations were not site specific, i.e., not chosen to evaluate any point source conditions. Latitude and longitude were collected with an eTrex Summit personal navigator and recorded to the nearest tenth of a second. In order to protect the privacy of the landowners, details of specific locations will not appear in this report.

Quality Assurance/Quality Control

For purposes of quality control and quality assurance, table 2.2, lists precision and accuracy check protocol for water quality parameters measured.

A side-by-side sampling, or “split sample”, of several sites was conducted with the DEQ Volunteer Monitoring Coordinator in the Fall of 2007. This additional quality control measure is taken in addition to duplicate samples taken each field day by the monitoring technician during the routine monthly data collection. The "split sample" is done in accordance with DEQ protocol to ensure the accuracy of the sampling techniques and methods of the water quality technician and trained volunteers.

Table 2.2 Protocol for Precision and Accuracy for Water Quality Parameters

Parameter	Precision (Equipment Capability)	Accuracy (Calibration)
Air temperature-Point	Duplicate measurement taken once per field day (or 10% of sites per day)	Meter was calibrated by DEQ prior to each field season
Water Temperature-Point	Duplicate measurement taken once per field day (or 10% of sites per day)	Meter was calibrated by DEQ prior to each field season
Water Temperature-continuous	Field audits taken once per month per temperature logger	Pre- and post-deployment accuracy checks; Temperature loggers were factory calibrated
Conductivity	Duplicate measurement taken once per field day (or 10% of sites per day)	Measured against a pre-mixed conductivity standard supplied by DEQ; pre-field Meter was calibrated by DEQ prior to each field season
Turbidity	Duplicate sample taken at one site per field day (or 10% of sites per day)	Checked with Formazin secondary standards; pre-field
Dissolved Oxygen	Duplicate sample taken at one site per field day (or 10% of sites per day)	No accuracy check available

Data is graded according to DEQ standards for precision and accuracy (see Table 2.3 for requirements for obtaining DEQ level "A" quality data). See Appendix D for DEQ data validation criteria for all data quality grading.

Complete tables of data collected, including accuracy and precisions checks, are available from the Yamhill Basin Council upon request.

Table 2.3 DEQ Data Validation Criteria for Level A Data

Parameter	Precision (Equipment Capability)	Accuracy (Calibration)	Measurement Range
Water Temperature	±1.5 ° C	± 0.5 ° C	-5 to 35 ° C
Conductivity	± 10%	± 7% of Std. Value	0 to 4999 m S/cm
Turbidity	± 5%	± 5% of Std. Value	0 to 1000 NTU
Dissolved Oxygen	± 0.3 mg/l	± 0.2 mg/l	1 to 20 mg/l

Chapter 3 – Results

Results of note for each parameter are summarized below by subwatershed (North Yamhill River and tributaries, Panther Creek, and Baker Creek). The results for each parameter include a re-statement of the standard or guideline for that parameter, in addition to a map displaying the geospatial relationships of water quality results for each parameter. The maps also show the minimum value (for standards or guidelines for which an ideal value is greater than the standard or guideline) and a maximum value (for parameters with standards or guidelines for which an ideal value is less than the standard or guideline) so as to visually represent areas of concern. Following the maps are explanations for the results and charts showing the seasonal trend in each correlating water quality parameter.

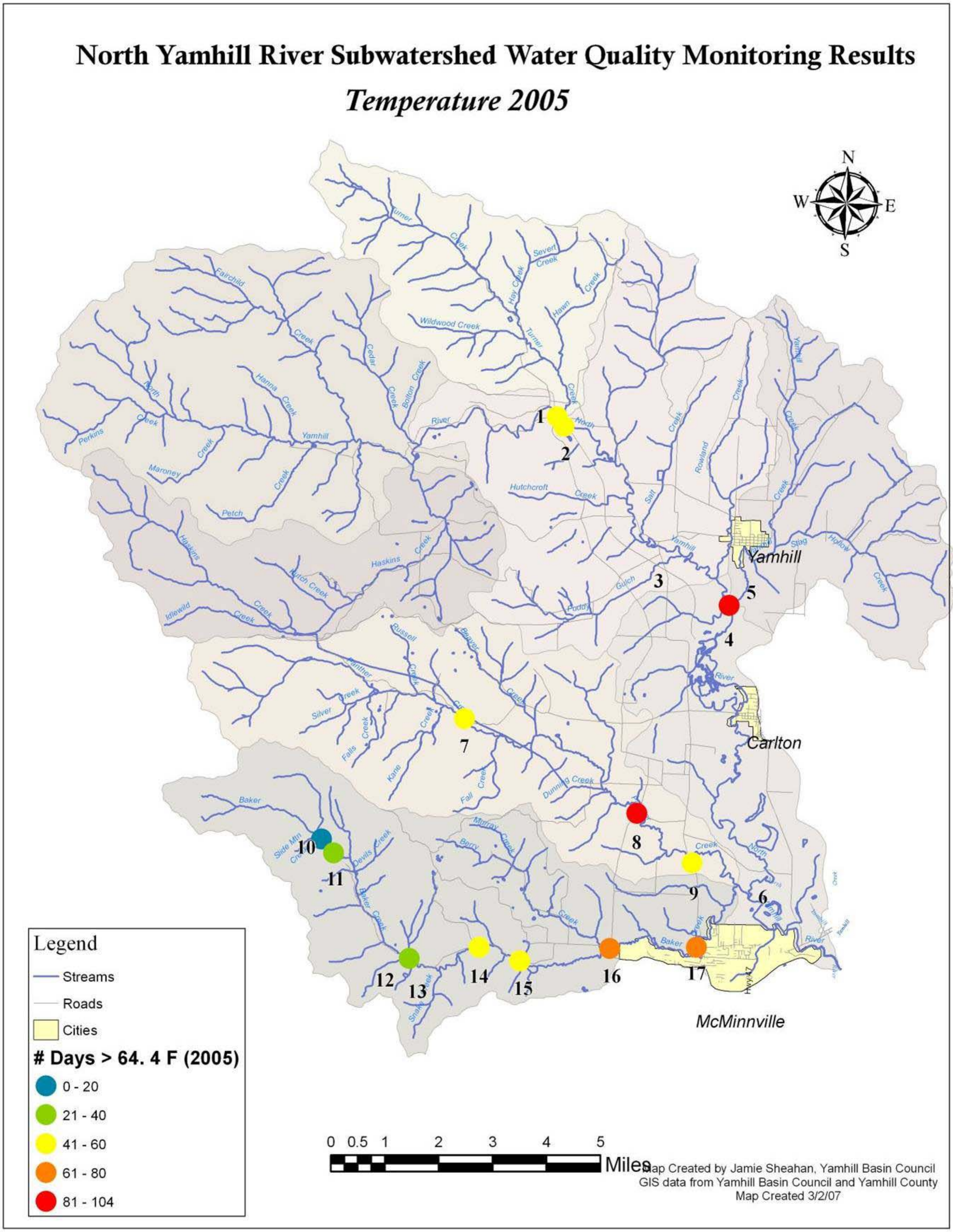
Water Temperature (Continuous)

Photo 3.1 Continuous Temperature Data Logger

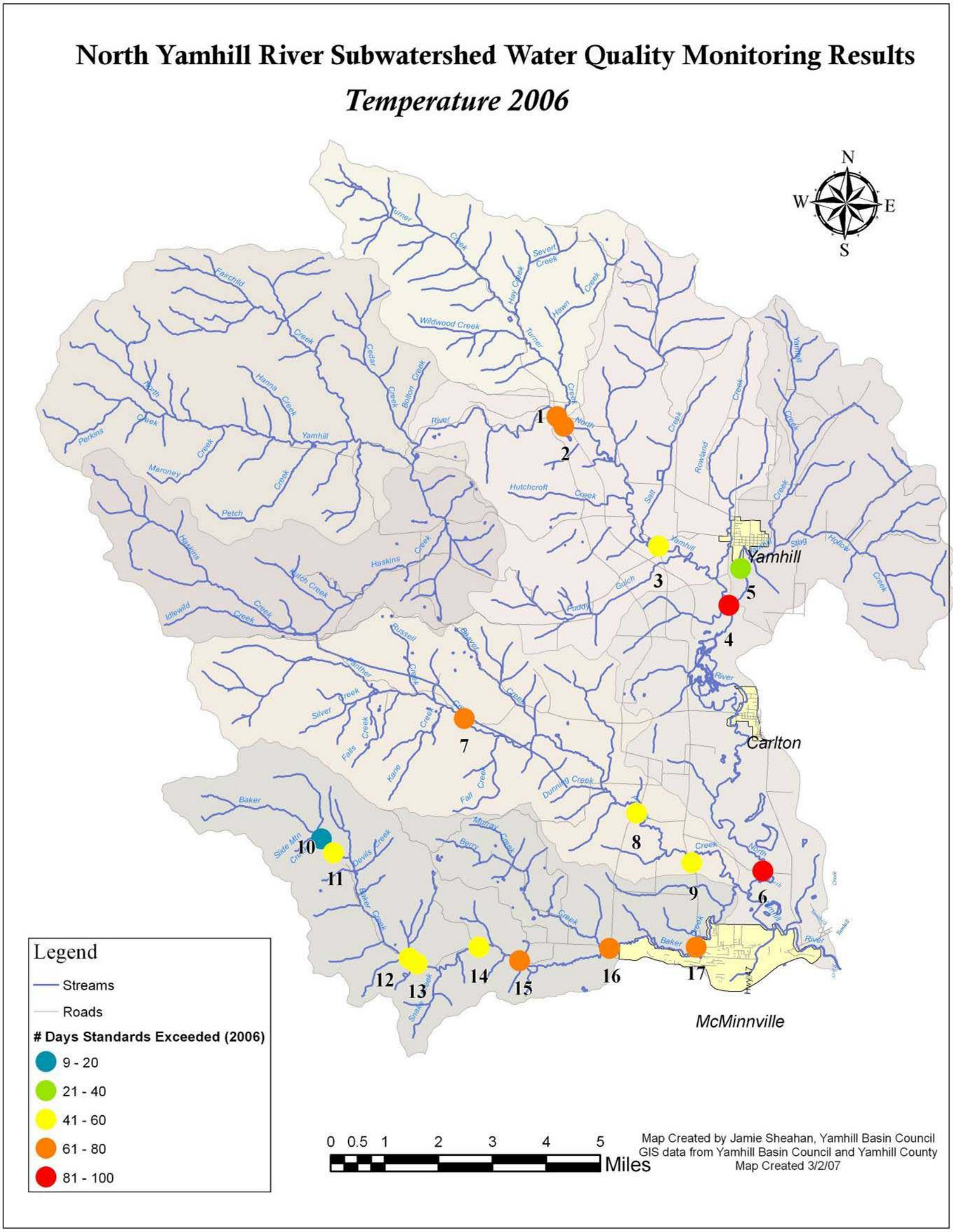
The DEQ standard is a 7-day maximum average of 18°C (64.4 °F) or less.

Maps 3.1 & 3.2 show the percentage of samples that exceeded and fell below the temperature standard for 2005 and 2006, respectively, as represented by the pie chart next to each site. The maximum value measured from for the sampling season is also indicated.

Map 3.1 2005 Temperature – Days Above Standard



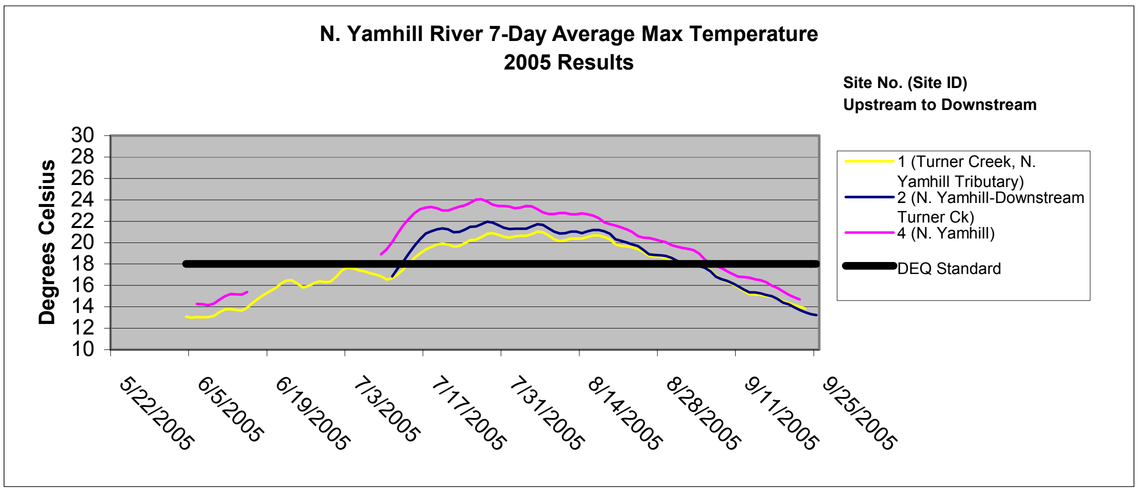
Map 3.2 2006 Temperature – Days Above Standard



North Yamhill River and Tributaries Temperature

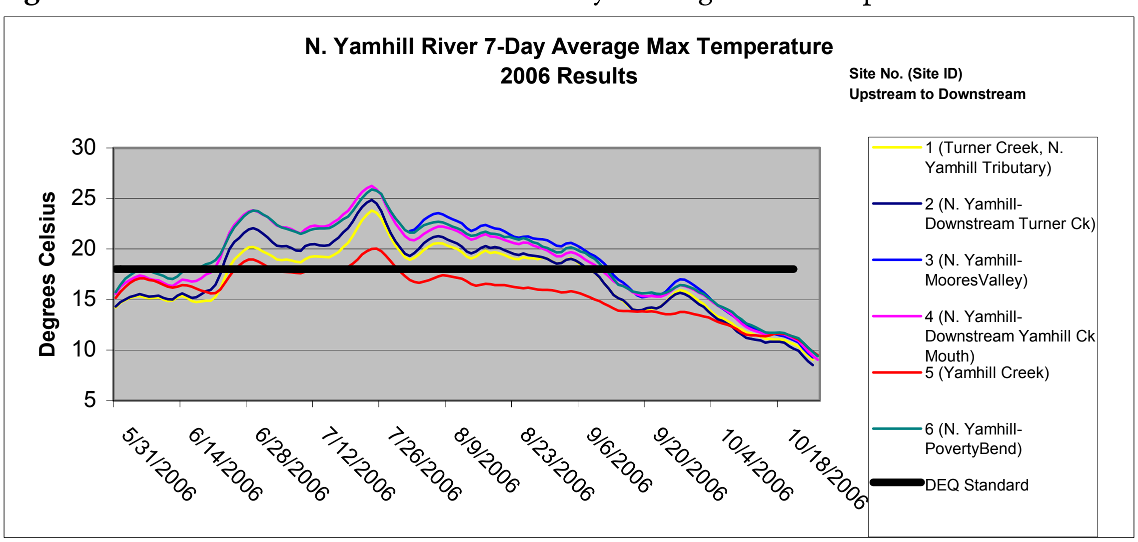
For 2005, as shown in Figure 3.1a, the sites monitored on the North Yamhill River exceeded the DEQ temperature standard from approximately Mid-July through the end of August, during the hotter summer months. At site No. 4 (N. Yamhill River downstream of Yamhill Creek), the temperature logger had been removed accidentally during the second week of June and was redeployed during the second week of July, accounting for the missing temperature data between mid June to mid July. The loggers at site Nos. 3 & 6 on the N. Yamhill River were lost. A logger was not deployed No. 5 (Yamhill Creek), due to safety concerns.

Figure 3.1a 2005 North Yamhill River 7-Day Average Max Temperature



In 2006, as shown in Figure 3.1b, temperature loggers were deployed at all six sites on the N. Yamhill, including the tributaries of Turner Creek and Yamhill creek, recording measurements May through October. The temperatures began to exceed the standard of 18°C earlier in the season than in 2005, approximately mid-June through mid-September. Yamhill Creek (Site No. 5) was the only site to have maintained temperatures below the standard from the end of July throughout the remainder of the season.

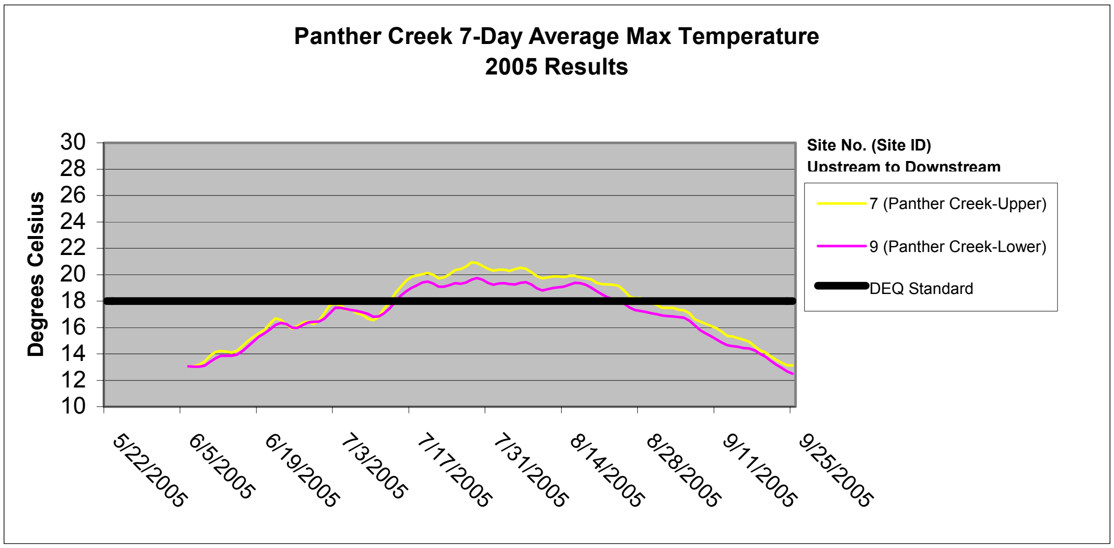
Figure 3.1b 2006 North Yamhill River 7-Day Average Max Temperature



Panther Creek Subwatershed Temperature

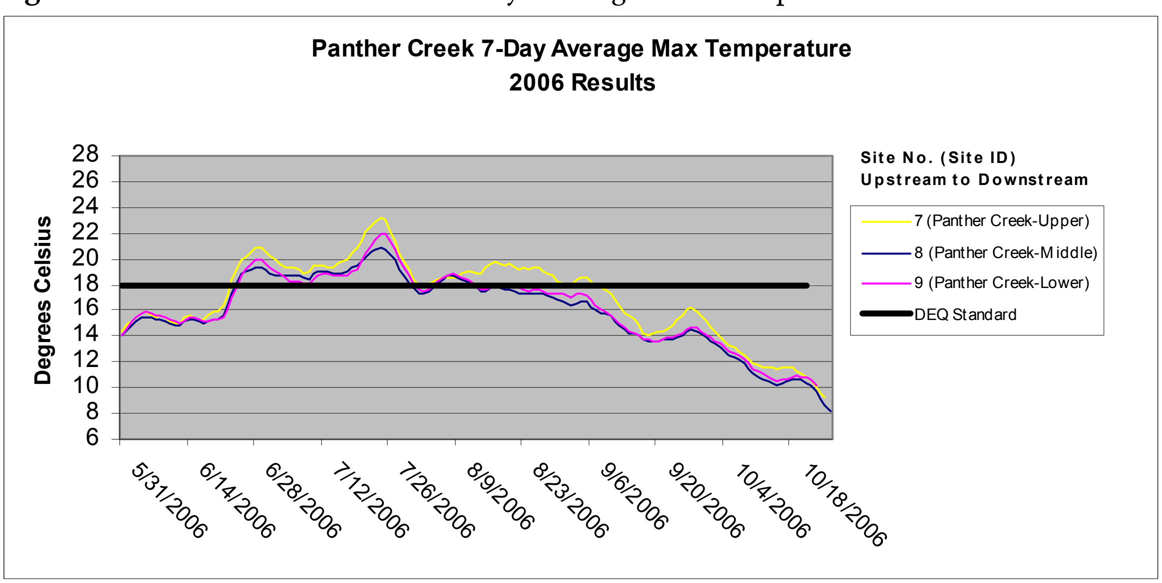
In 2005, all three Panther Creek sites (Figure 3.2a), exceeded the DEQ water temperature standard between early July to early August. The temperature logger at site No. 8 (Middle Panther) was found upon retrieval in late September, to have been exposed to the air above the water surface during the monitoring period of May-September and is not shown on Figure 3.2a.

Figure 3.2a 2005 Panther Creek 7-Day Average Max Temperature



In 2006, all 3 sites on Panther Creek (Figure 3.2b) began to exceed the temperature standard earlier than in 2005 from approximately late June to early August, except for site No. 7 (upper Panther), which continued to exceed the standard until early September.

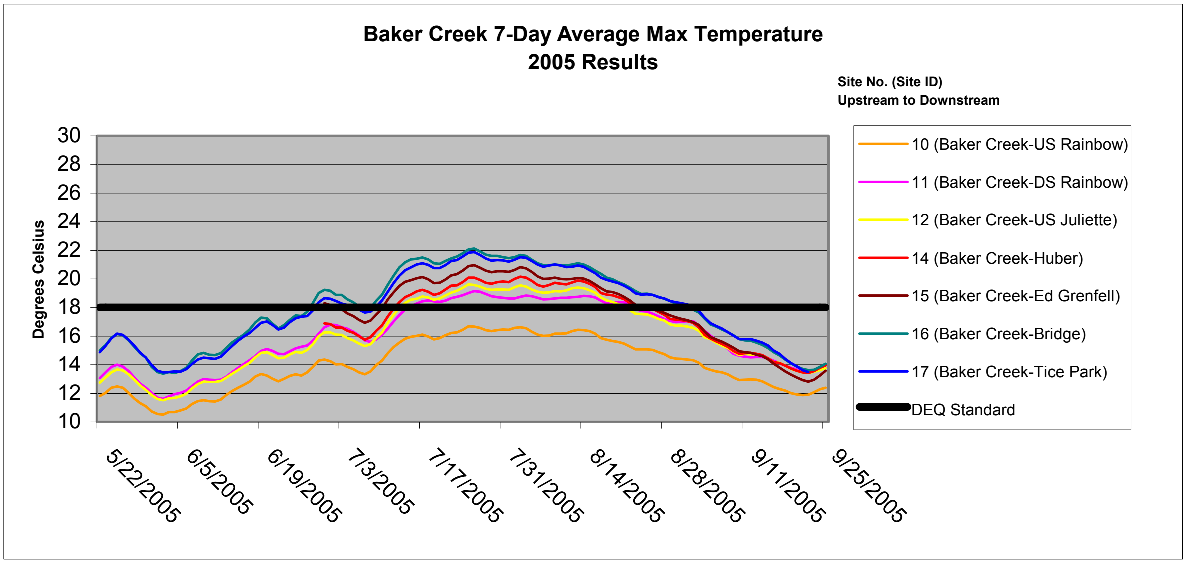
Figure 3.2b 2006 Panther Creek 7-Day Average Max Temperature



Baker Creek Subwatershed Temperature

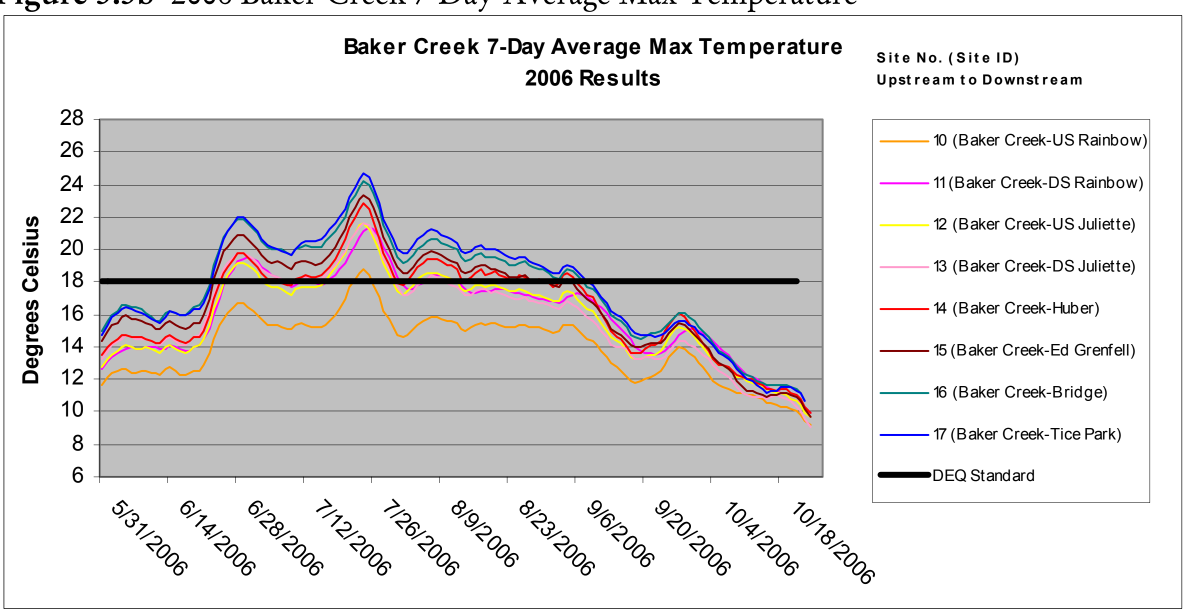
Figure 3.3a showing the temperature data recorded for Baker Creek indicates increased temperature recordings, downstream to upstream, respectively. Site No. 10 (Upper Rainbow lake) did not exceed the DEQ temperature standard throughout the entire monitoring season in 2005. This was the only site of all sites monitored by continuous temperature loggers on Baker Creek that did not exceed the standard. All of the other sites exceeded the standard, approximately mid-July to mid-August.

Figure 3.3a 2005 Baker Creek 7-Day Average Max Temperature



As shown in figure 3.3b, again in 2006, temperatures increases are shown from downstream to upstream, respectively. Site No. 10, which consistently measured below the standard, slightly exceeded the standard for a few days towards the end of July.

Figure 3.3b 2006 Baker Creek 7-Day Average Max Temperature

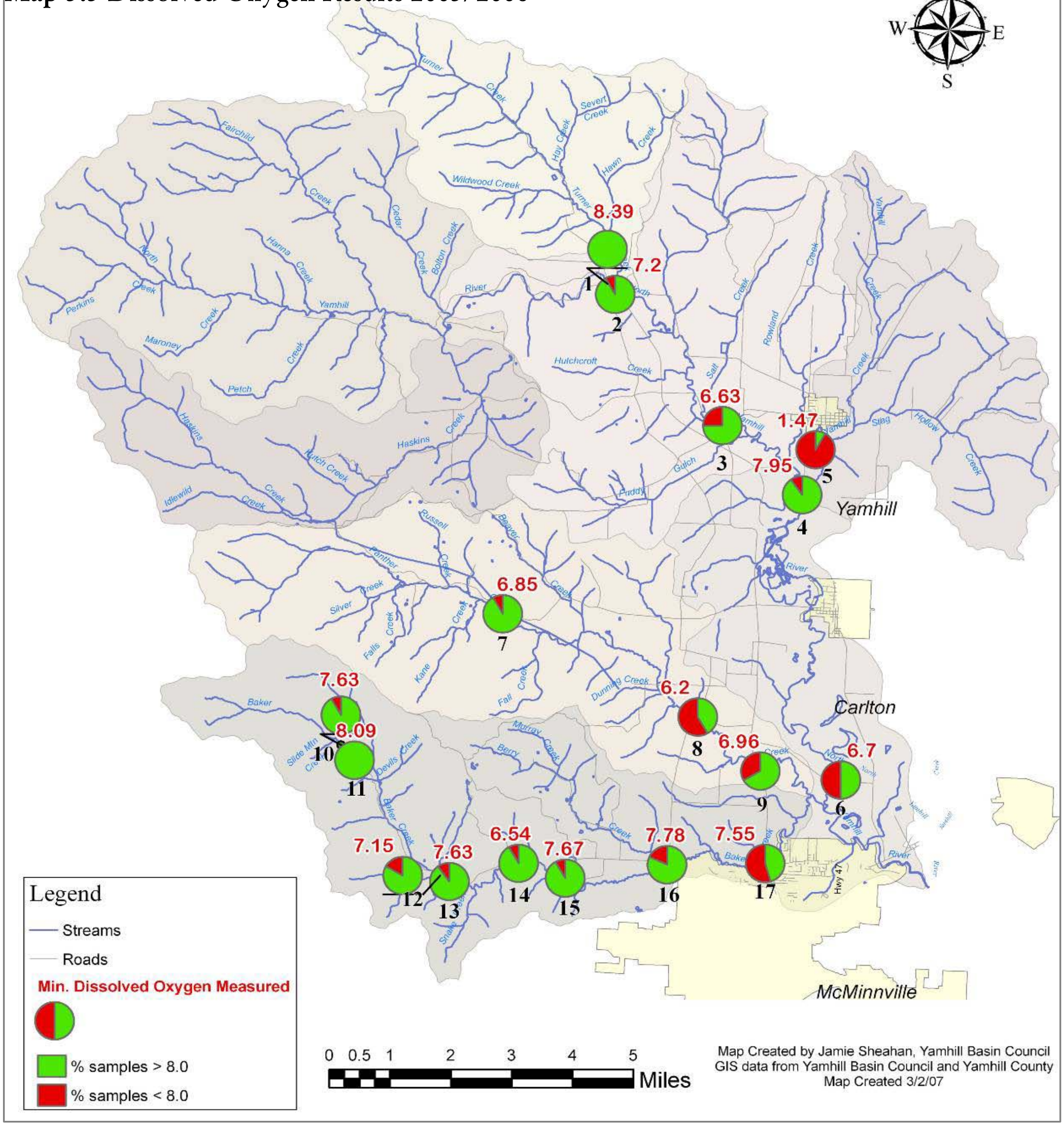


Dissolved Oxygen

The DEQ standard indicates a value of **greater than 8 mg O_2/L for cold water rearing**. Samples were collected and fixed throughout the morning and early afternoon, which should be taken into consideration when comparing values between sites. Photosynthesis results in daily DO fluctuations with lower values at night and early morning and higher or peak values in the late afternoon.

Map 3.3 shows the percentage of samples that exceeded and fell below the DO standard. The minimum DO value measured during is also indicated next to each site.

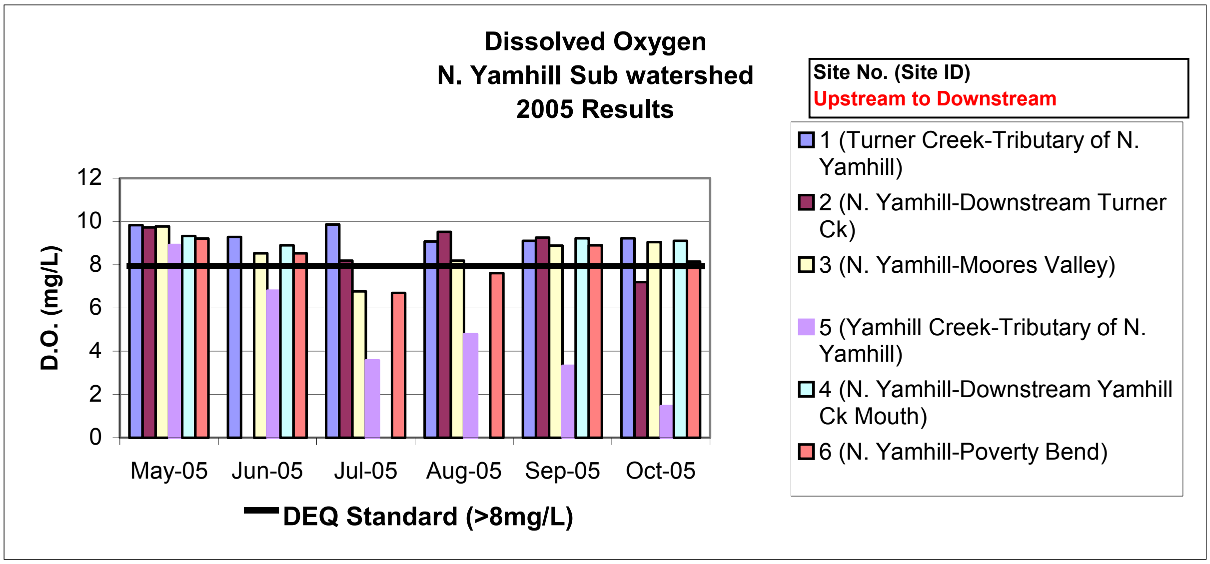
Map 3.3 Dissolved Oxygen Results 2005/2006



North Yamhill River and Tributaries Dissolved Oxygen

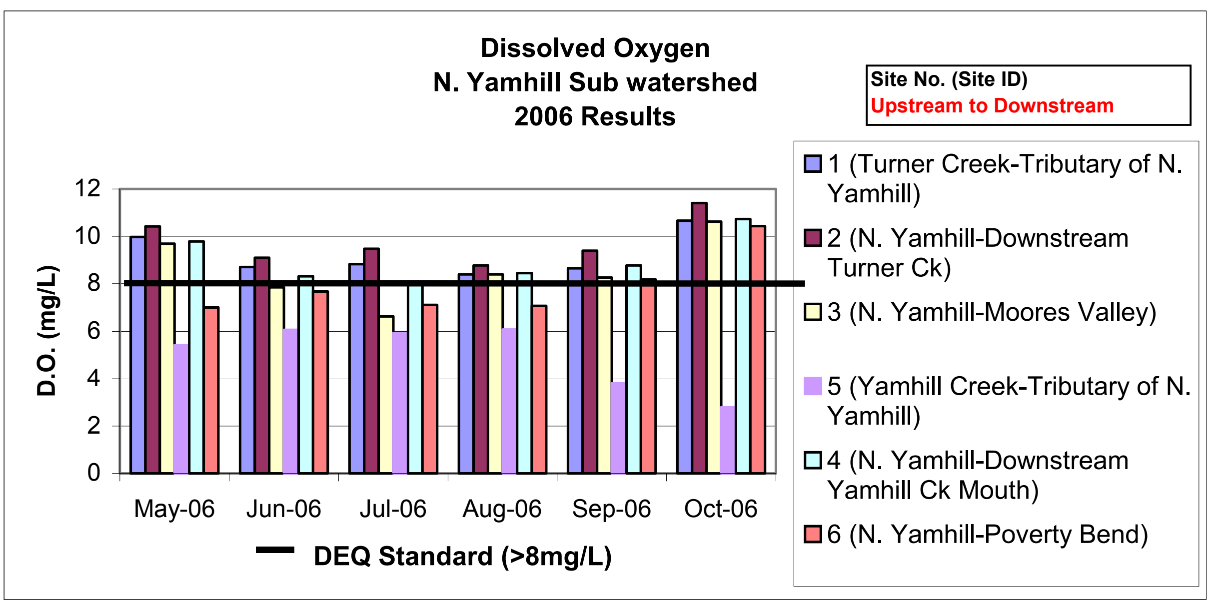
For 2005, as shown in Figure 3.4a, most sites monitored on the North Yamhill River met or exceeded the DEQ DO standard throughout the sampling season. Yamhill Creek (site No. 5) consistently fell below the standard throughout the sampling season. Site No. 6 fell below the standard twice in 2005, during July and August.

Figure 3.4a 2005 Dissolved Oxygen North Yamhill River Subwatershed



In 2006, most sites met or exceeded the standard through the sampling season as shown in Figure 3.4b. The Yamhill Creek site (No. 5), again consistently fell below DO standards in 2006. Site No. 6 on the N. Yamhill fell below standards in May-August of 2006.

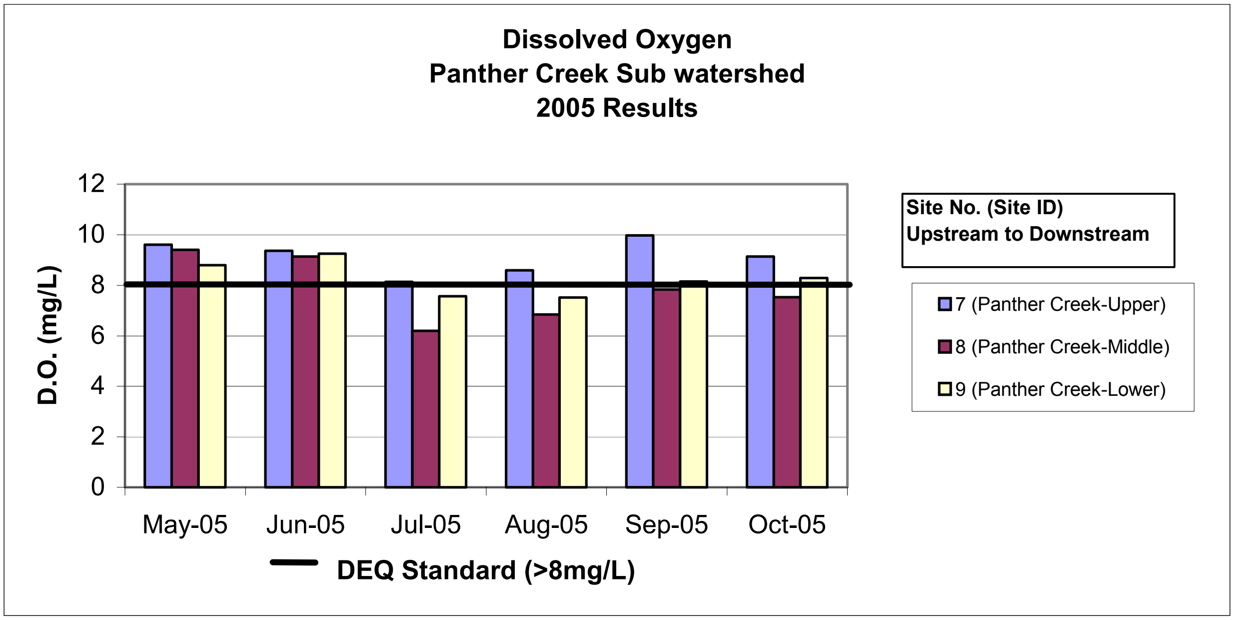
Figure 3.4b 2006 Dissolved Oxygen North Yamhill River Subwatershed



Panther Creek Subwatershed Dissolved Oxygen

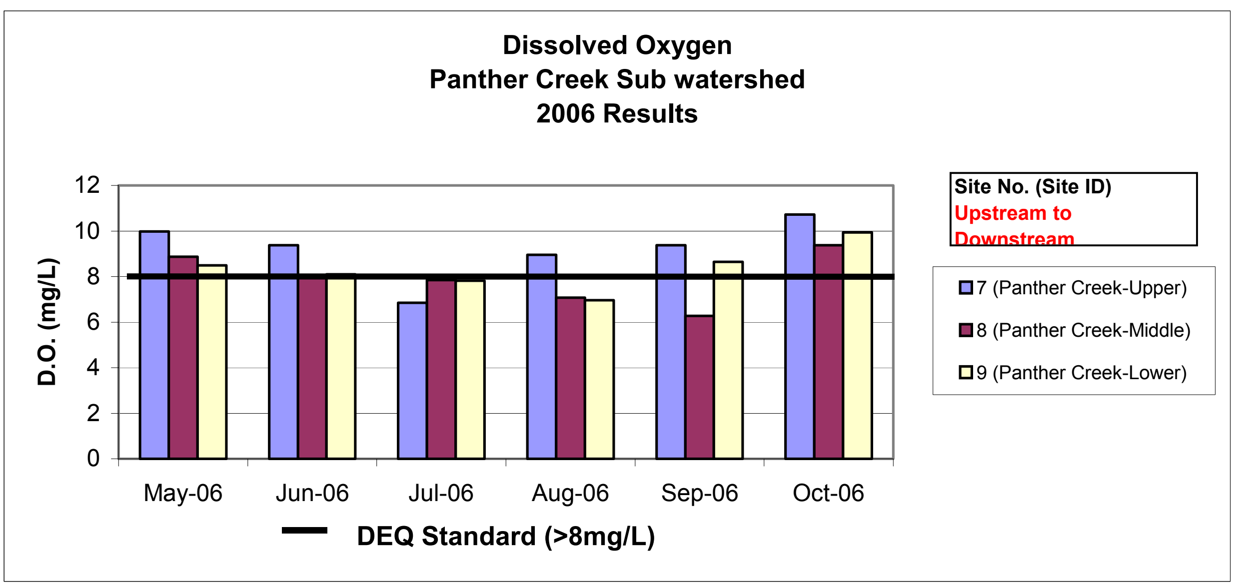
In the Panther Creek subwatershed in 2005, all three sites exceeded the standard in May and June; while July through August showed decreasing DO values. Upper Panther Creek (site No. 7) met the DO standard throughout the monitoring season as shown in Figure 3.5a.

Figure 3.5a 2005 Dissolved Oxygen Panther Creek



In 2006, as shown in figure 3.5b, all three sites exceeded the standard in May and October. Upper Panther Creek (site No. 7) only fell below the DO standard during the month of July.

Figure 3.5b 2006 Dissolved Oxygen Panther Creek



Baker Creek Subwatershed Dissolved Oxygen

All sites monitored on Baker Creek met or exceeded the DO standard in May and September of 2005. Figure 3.6a shows that no one specific site met or exceeded the standard throughout the entire 2005 sampling season.

Figure 3.6a 2005 Dissolved Oxygen Baker Creek

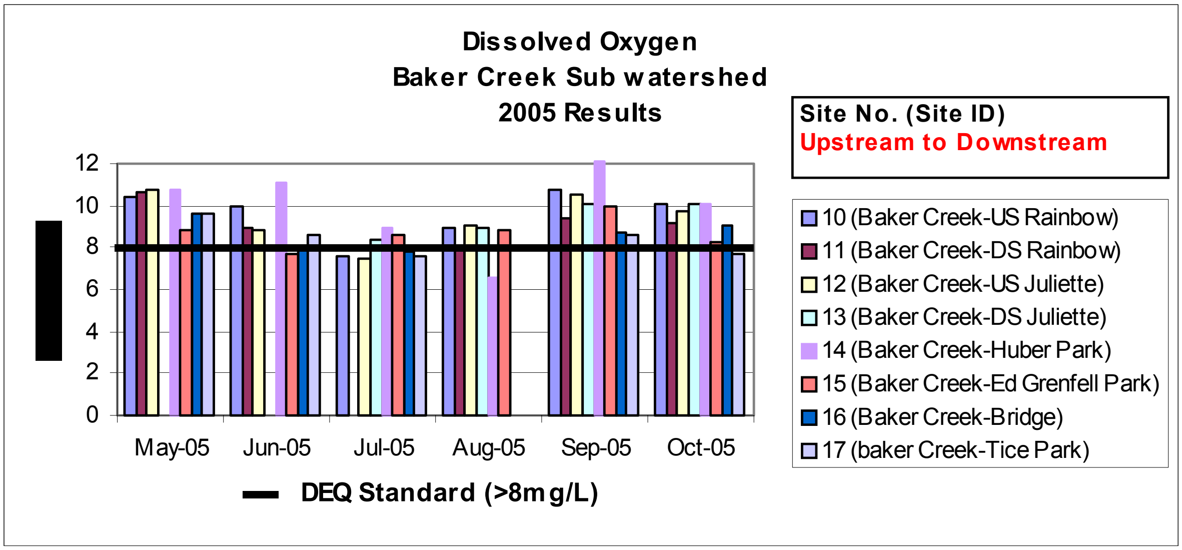
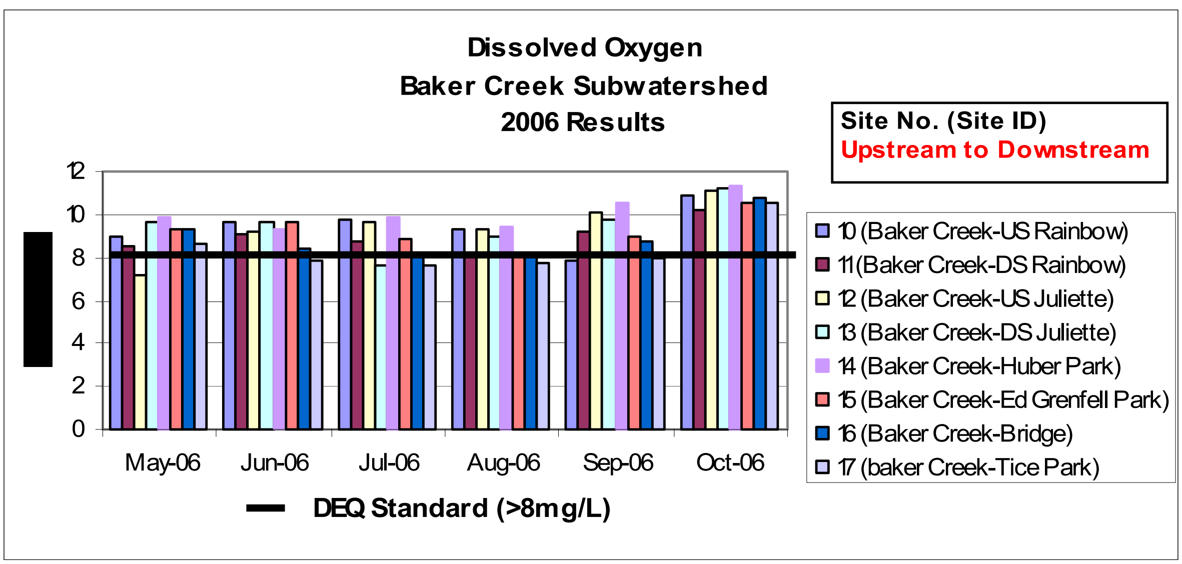


Figure 3.6b shows that the DO values in 2006 met or exceeded the standards for the entire sampling season with a few exceptions. Site No. 17 (at Tice Woods Park) fell below the DO standard, although only minimally, during the months of June-September.
Site Nos. 12 and 13, upstream and downstream Juliette dam, respectively, had DO values fall below the standard only one time.

Figure 3.6b 2006 Dissolved Oxygen Baker Creek

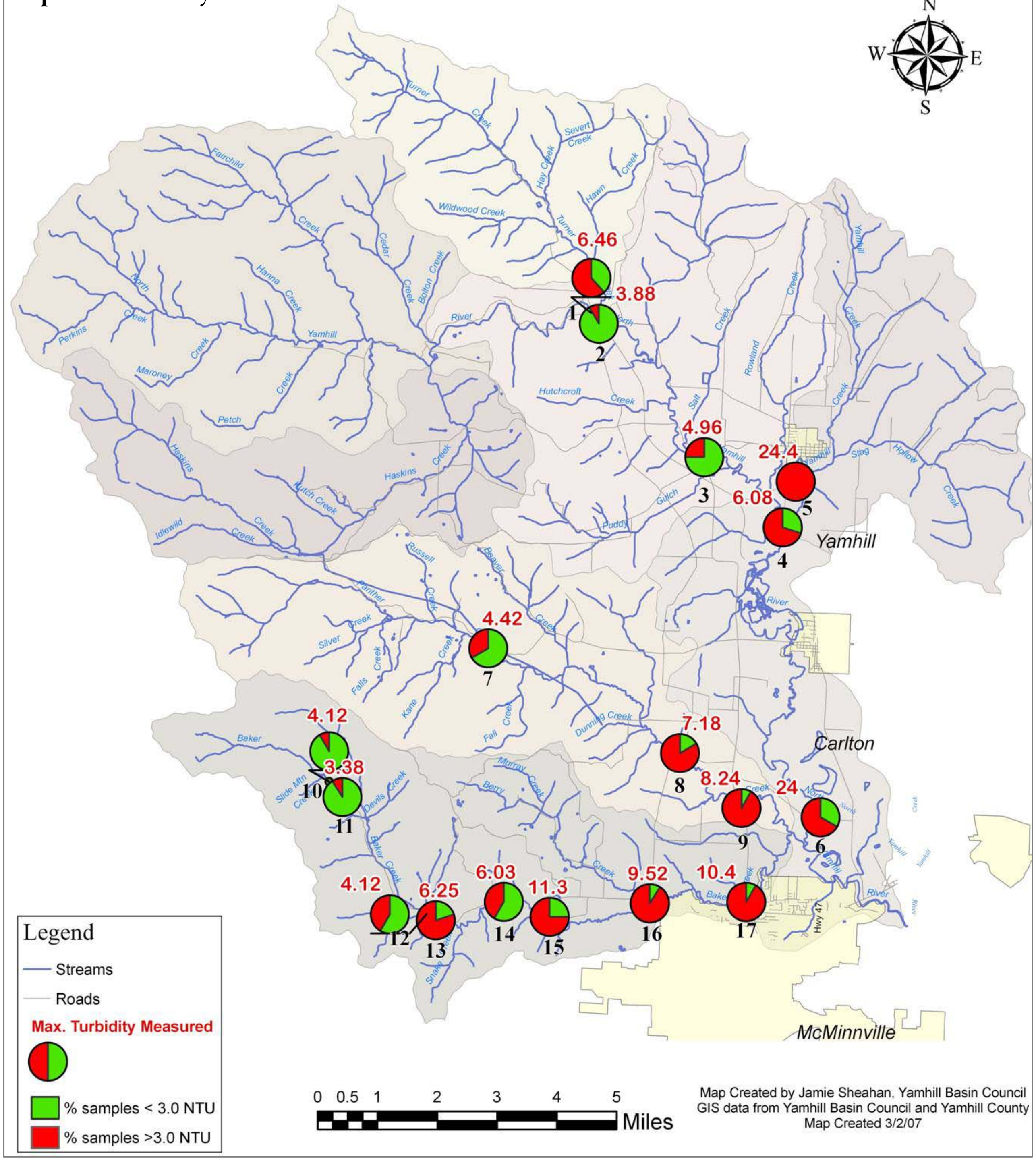


Turbidity

As a guideline for low flow, samples should be less than 3 Nephlometric Turbidity Units (NTUs). Currently, there is no ambient DEQ standard for turbidity.

Map 3.4 shows percentage of samples that exceeded the turbidity guideline for both years. The maximum turbidity value measured is also indicated next to each site.

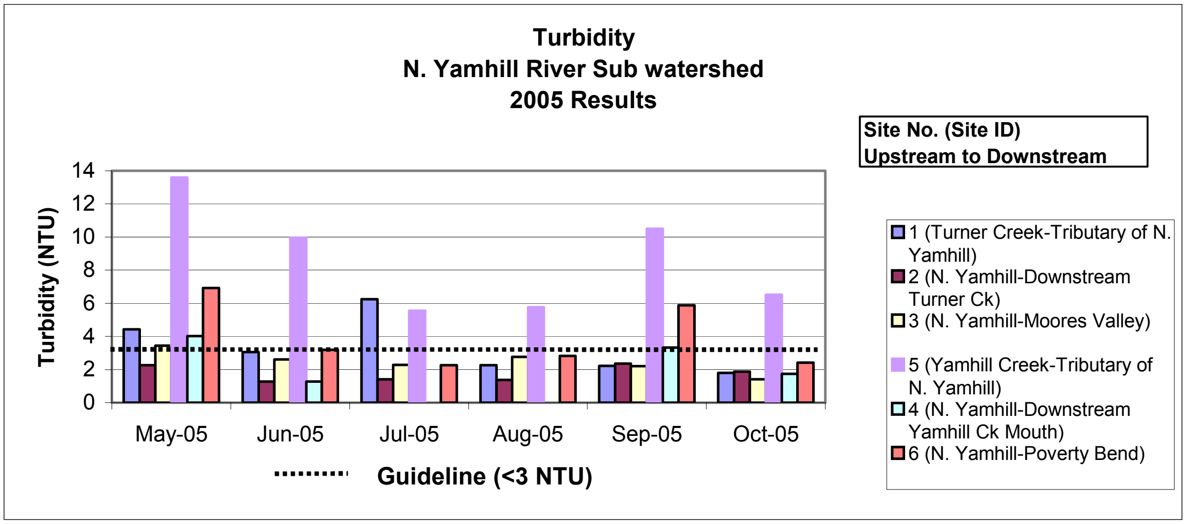
Map 3.4 Turbidity Results 2005/2006



North Yamhill River and Tributaries Turbidity

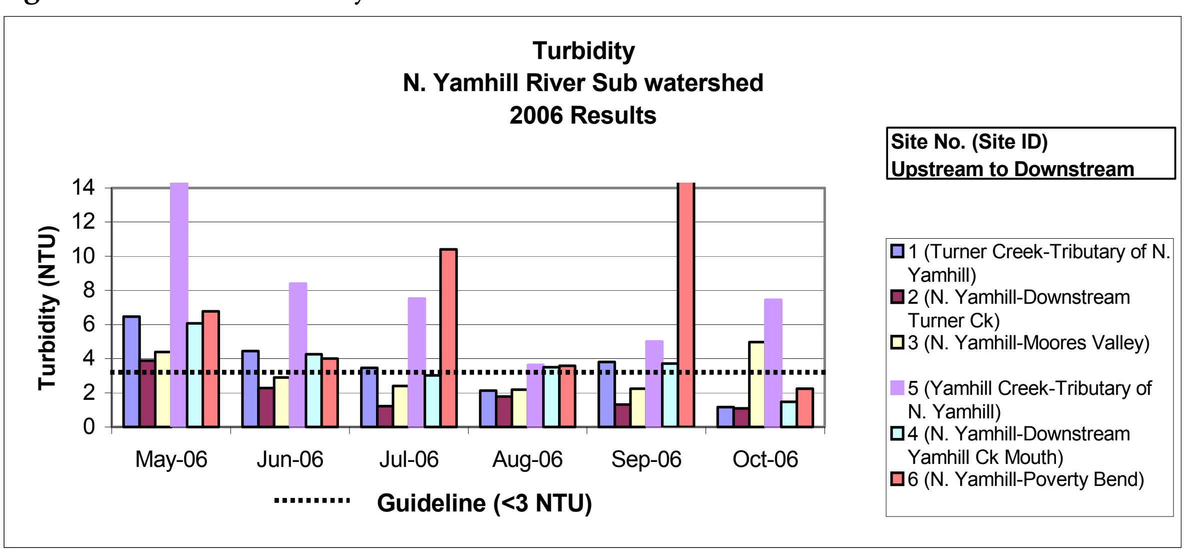
Figure 3.7a shows that Site No. 2 (N. Yamhill) met the guideline of less than 3 NTUs throughout the 2005 monitoring season. All other sites exceeded the guideline at least one month between May and October. Site No. 6 on the N. Yamhill, had relatively high turbidity values in May and September, as did Site No. 1 (Turner Creek) in July.   Site No. 5 (Yamhill Creek) exceeded the turbidity guideline during the entire sampling season.

Figure 3.7a 2005 Turbidity North Yamhill River



During 2006, as shown in figure 3.7b, on the N. Yamhill River and the tributaries (Turner Creek and Yamhill Creek), no one site met or fell below the turbidity guideline, although site No. 2 (N. Yamhill) only exceeded the guideline once in May 2006. All other sites exceeded at least 2 or more times during the 2006 sampling season. Again in 2006, Yamhill Creek (site No. 5) exceeded the guideline for the entire sampling season.

Figure 3.7b 2006 Turbidity North Yamhill River



Panther Creek Subwatershed Turbidity

Figure 3.8a shows that site No. 7 (Upper Panther Creek) was the only site in the Panther Creek subwatershed, which consistently met the turbidity guideline during the 2005 monitoring season.

Figure 3.8a 2005 Turbidity Panther Creek

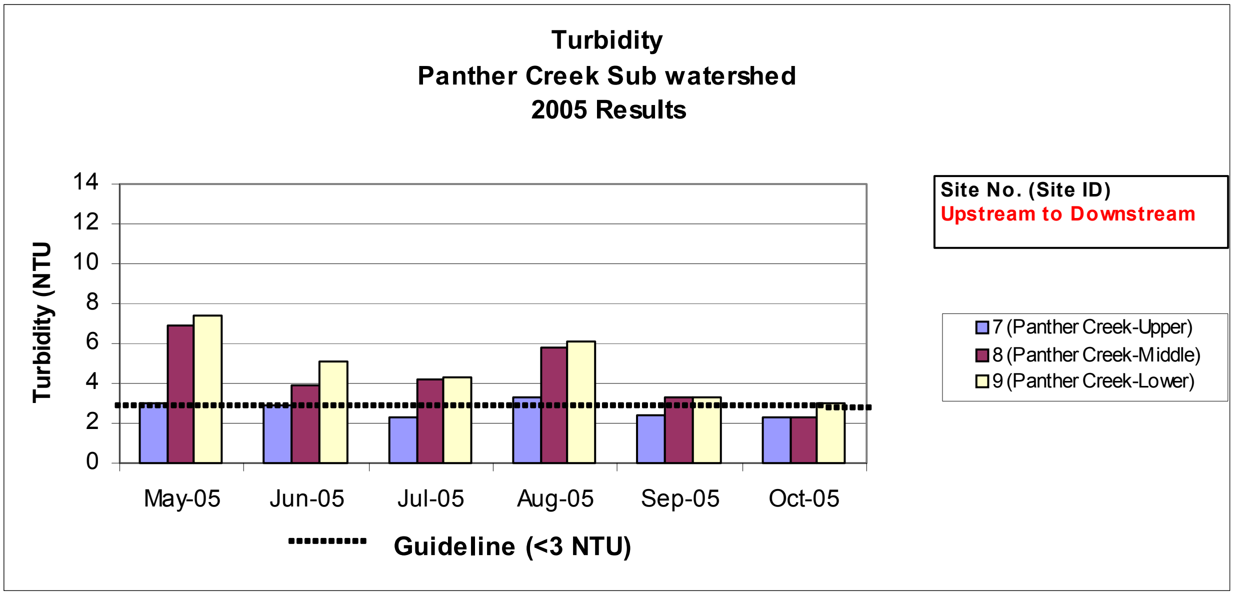
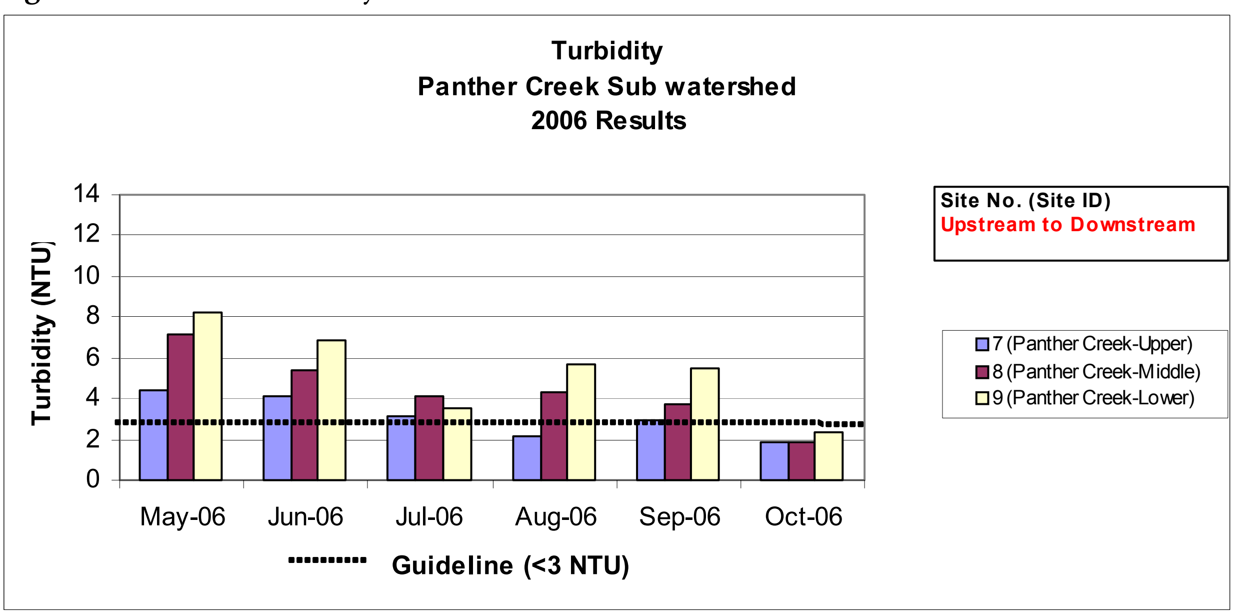


Figure 3.8b shows that all Panther Creek sites exceeded the guideline at least 3 or more times.

Figure 3.8b 2006 Turbidity Panther Creek



Baker Creek Subwatershed Turbidity

On Baker Creek (Figure 3.9a), turbidity consistently increased upstream to downstream. The site where turbidity values consistently met the guideline in 2005 was at site No. 10 (Upstream of Rainbow Lake). At site Nos. 16 and 17 on Baker Creek in 2005, Turbidity was consistently measured above the guideline of 3 NTUs throughout the sampling season (there was no sample measurement taken in August at site No. 16 due to lack of accessibility due to a construction project on the bridge above the site).

Figure 3.9a 2005 Turbidity Baker Creek

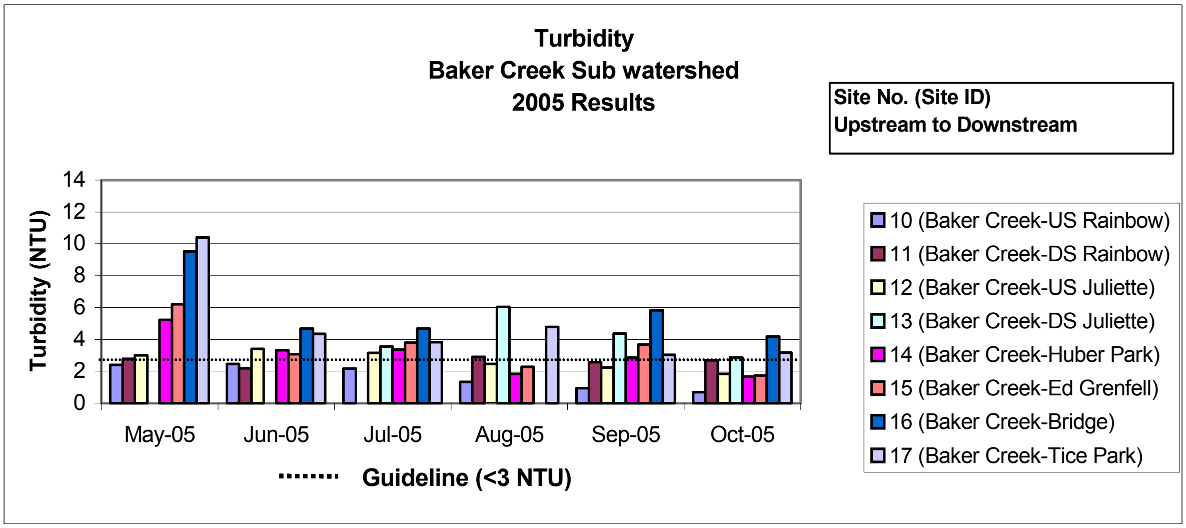
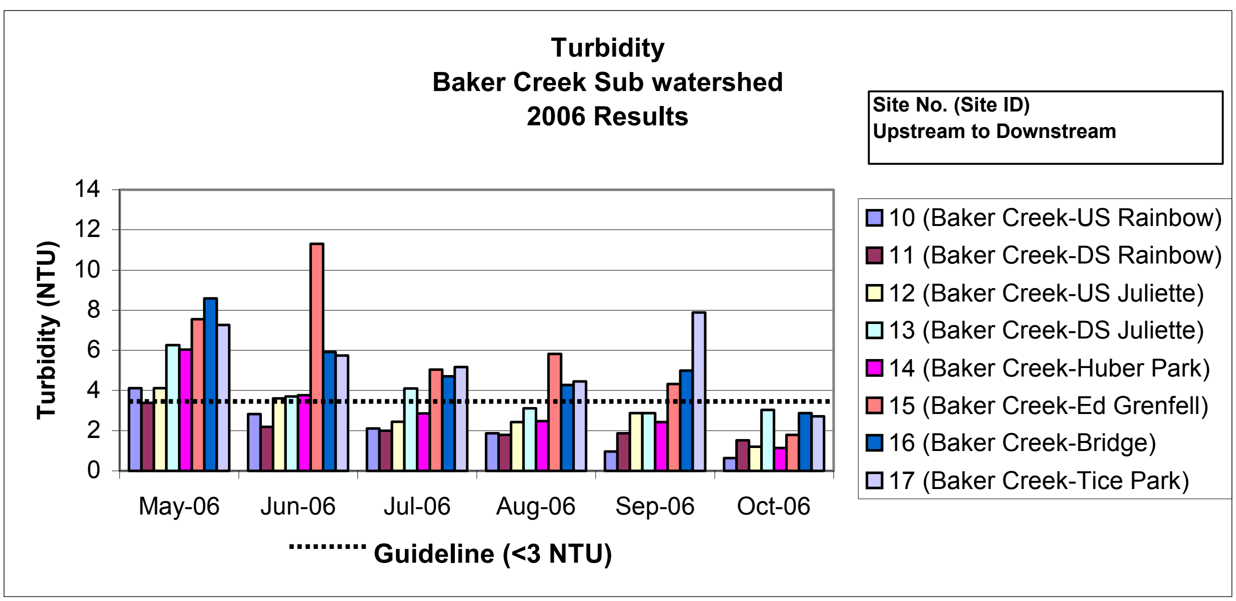


Figure 3.9b shows that in 2006, Site Nos. 10 & 11 met the guideline except for one exceeding measurement in May at both sites. All other sites exceeded the guideline at least 2 or more times. Site Nos. 13, 15, 16, & 17 exceeded the guideline 4 times each.

Figure 3.9b 2006 Turbidity Baker Creek

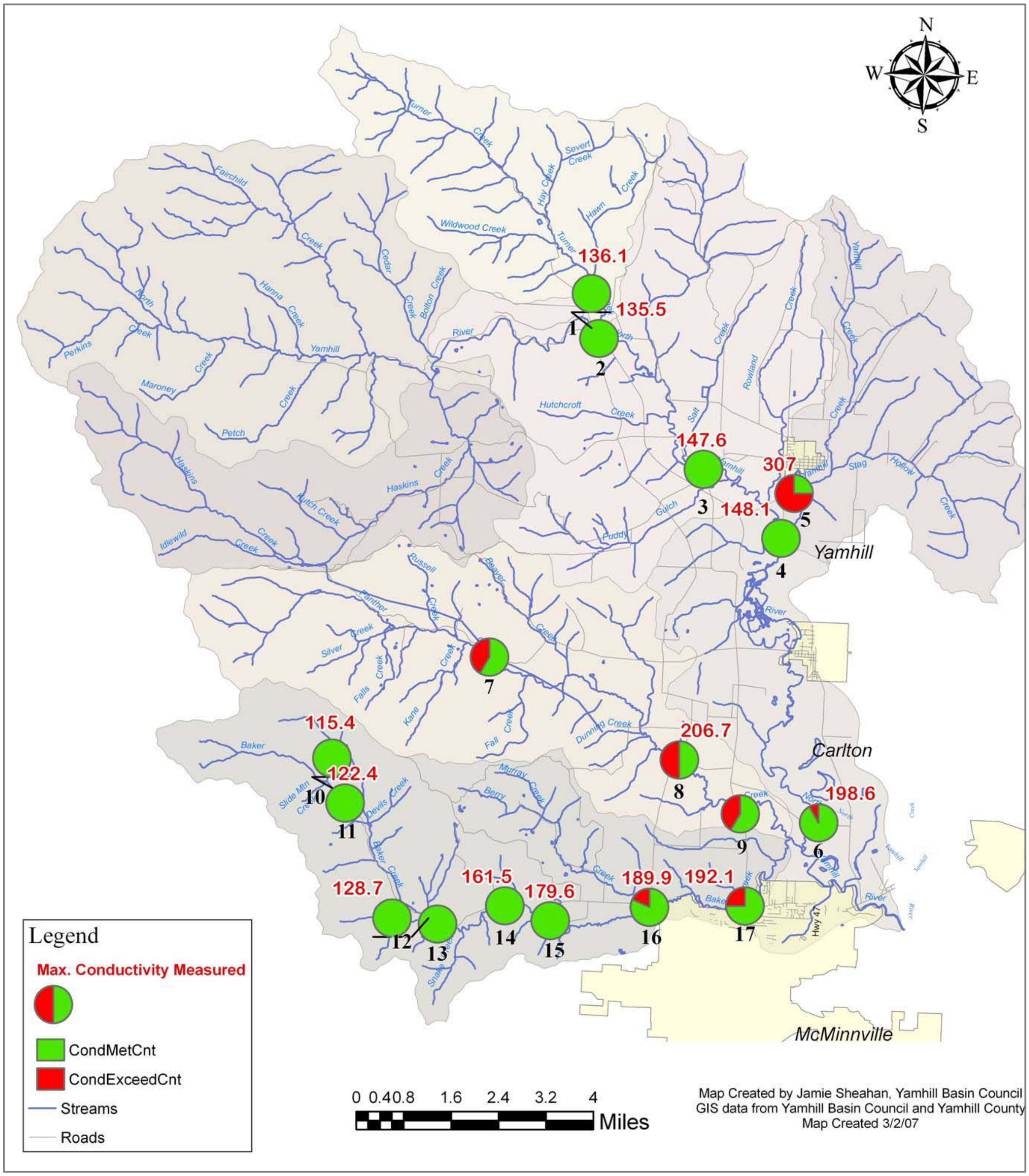


Conductivity

There is no DEQ standard for conductivity, but as a guideline, samples are expected to be less than 180 Microsiemens/cm (mhos/cm) in the Yamhill Basin.

Map 3.5 shows percentage of samples that exceeded the turbidity guideline for both years. The maximum turbidity value measured from the 2005/2006 sampling season is also indicated next to each site.

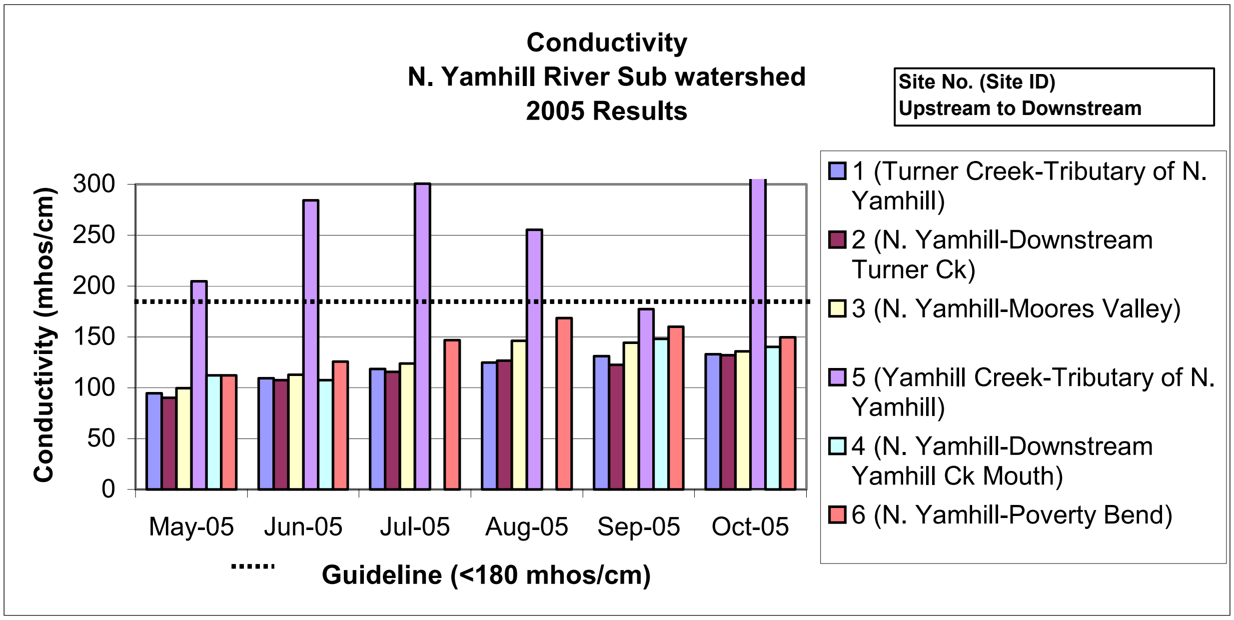
Map 3.5 Conductivity Results 2005/2006



North Yamhill River and Tributaries Conductivity

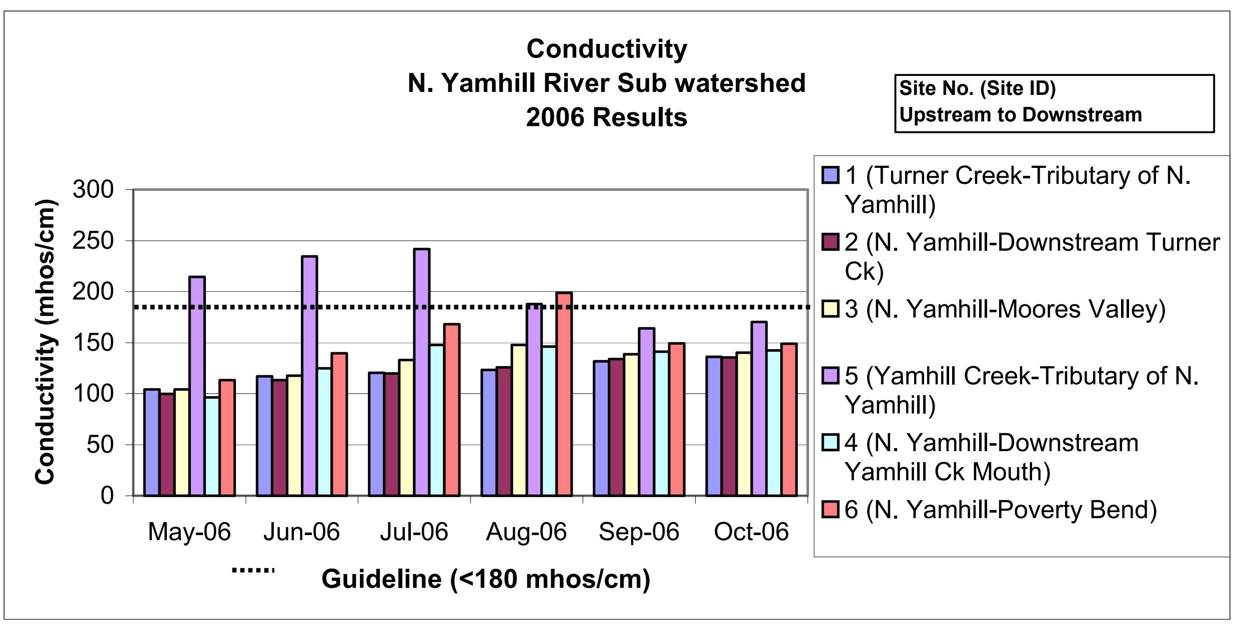
In 2005, on the North Yamhill River, all sites except for the tributary (site No. 5) met the suggested guideline for conductivity. Conductivity readings at Yamhill Creek (see figure 3.10a) were two to three times higher than any other site.

Figure 3.10a 2005 Conductivity North Yamhill River Subwatershed



As shown in 3.10b, site No. 5 (Yamhill Creek) did not meet the guideline 4 out of 6 sampling times in 2006. Only one other site exceeded the guideline (site No. 6 - N. Yamhill in August).

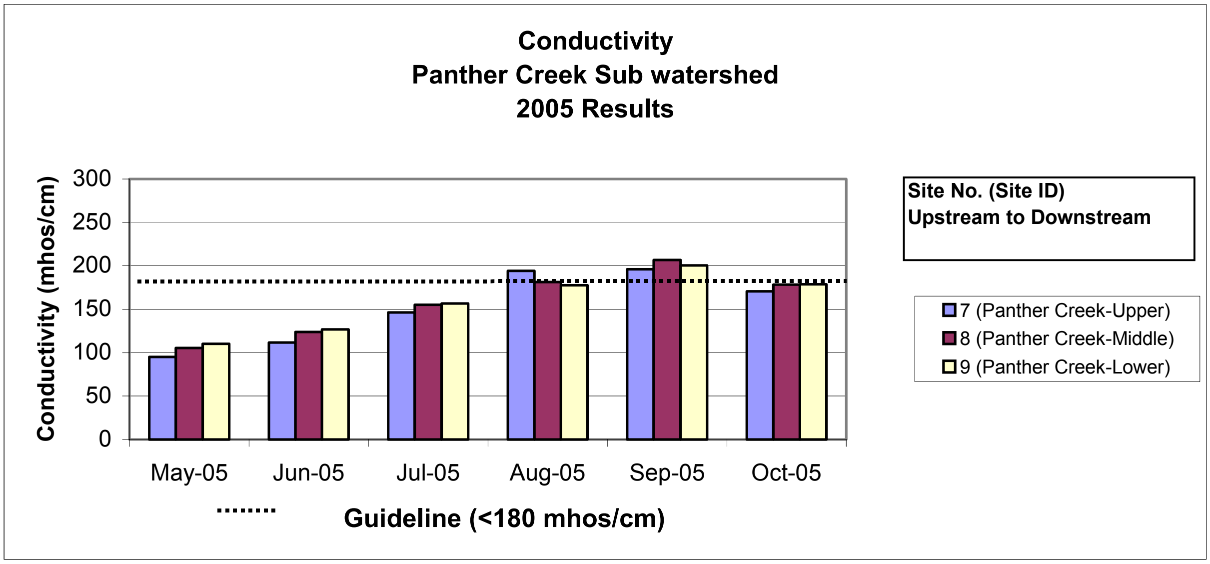
Figure 3.10b 2006 Conductivity North Yamhill River Subwatershed



Panther Creek Subwatershed Conductivity

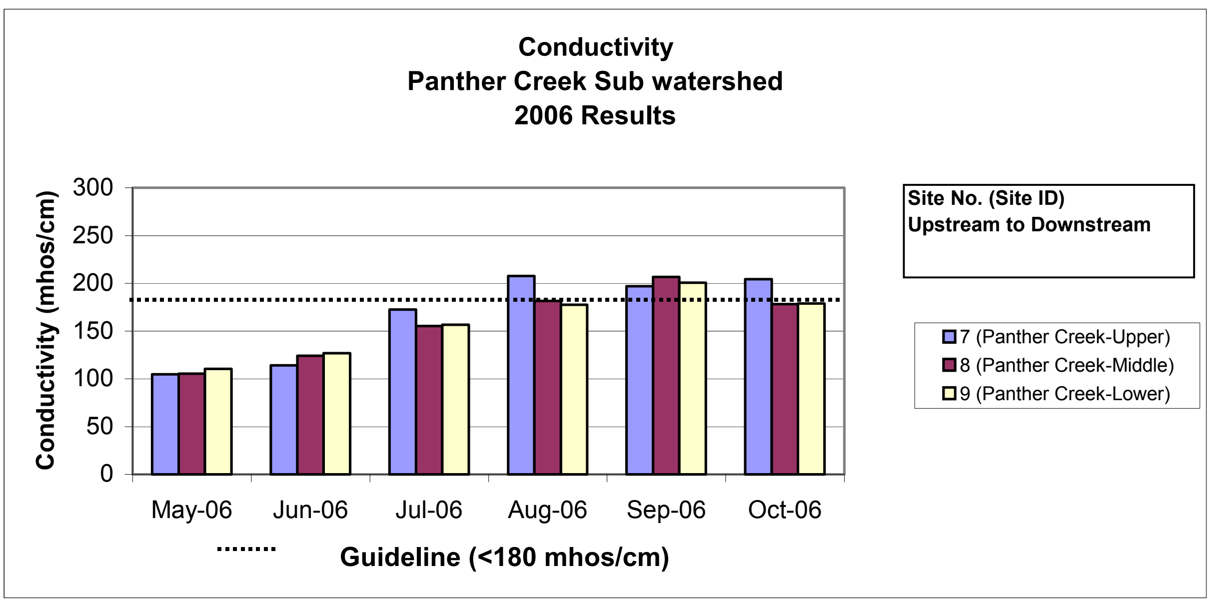
In 2005, on Panther Creek, all three sites met the guideline for conductivity from May through July, and again in October. Figure 3.11a shows that in the summer months of August and September, all three sites exceeded the guideline for conductivity.

Figure 3.11a 2005 Conductivity Panther Creek River Subwatershed



Again, in 2006, as shown in figure 3.11b, all sites on Panther creek met the guideline from conductivity from May through June. Site Nos. 8 &9 (Middle & Lower Panther Creek) exceeded the guideline from July through October, while Site No. 7 (Upper Panther Creek) exceeded the guideline from August through October.

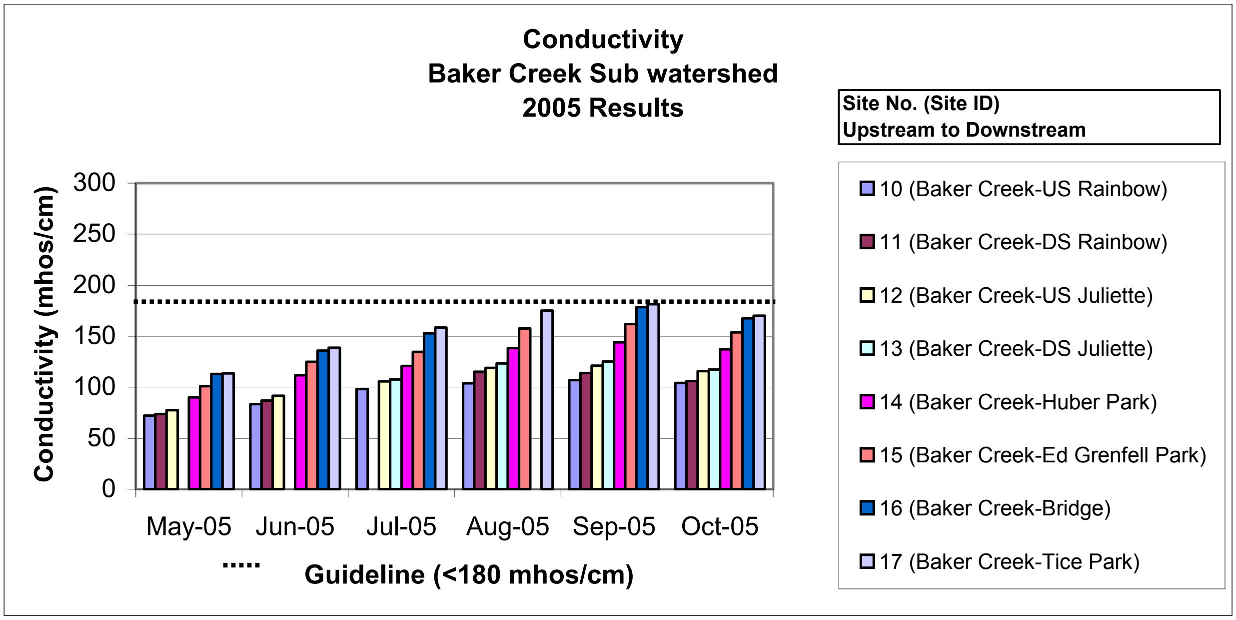
Figure 3.11b 2006 Conductivity Panther Creek River Subwatershed



Baker Creek Subwatershed Conductivity

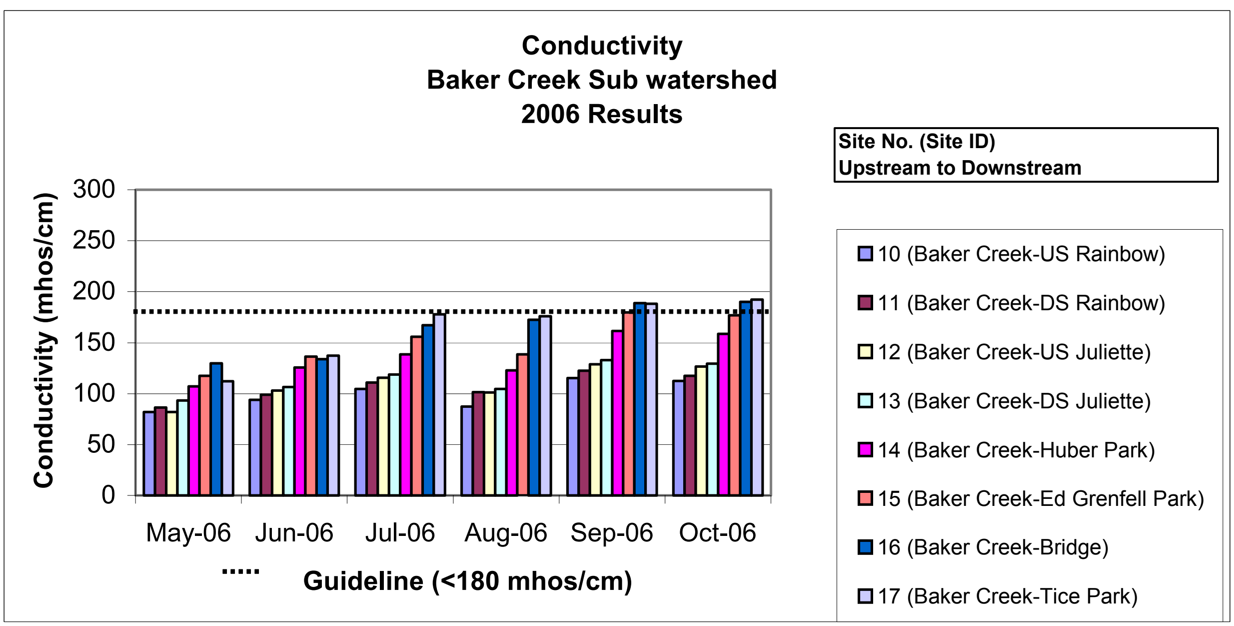
As shown in figure 3.12a, all sites on Baker Creek met the guideline for conductivity throughout the 2005 monitoring season.

Figure 3.12a 2005 Conductivity Baker Creek Subwatershed



In 2006, as shown in figure 3.12b, site Nos. 16 & 17 exceeded the guideline in September & October.

Figure 3.12b 2006 Conductivity Baker Creek Subwatershed



Escherichia coli (E. coli)

The DEQ standard for E. coli is a geomean (average) of less than 126 cells/100mL for five samples taken over 30 days. Table 3.1 indicates whether or not each site on North Yamhill River (and the tributaries of Turner Creek and Yamhill Creek), and the sites in the subwatersheds of Panther Creek and Baker Creek met or did not meet the State of Oregon's E. coli geomean standard of <126 cells/100mL. The corresponding geomean value for each site, indicating how much each site fell above or below the standard, is also shown.

Table 3.1 E. coli results – Met or did not meet DEQ standard

	2005		*2006*	
Site No. Subwatershed/Site Name	E. Coli Met or Did Not Meet State Standard	E. Coli Geomean Value (>126 Cells/100 mL exceeds standard)	E. Coli Met or Did Not Meet State Standard	E. Coli Geomean Value (>126 Cells/100mL exceeds standard)
1. N. Yamhill River/Turner Creek	**Did Not Meet Standard**	**185.66**	**Did Not Meet Standard**	**137.19**
2. N. Yamhill River	**Did Not Meet Standard**	**162.85**	Met Standard	120.48
3. N. Yamhill River	**Did Not Meet Standard**	**228.56**	Met Standard	125.65
4. N. Yamhill River	Met Standard	99.64	**Did Not Meet Standard**	**160.03**
5. N. Yamhill River/Yamhill Creek	Met Standard	51.60	**Did Not Meet Standard**	**177.95**
6. N. Yamhill River	Met Standard	87.85	Met Standard	81.45
7. Panther Creek/Upper	**Did Not Meet Standard**	**1014.65**	**Did Not Meet Standard**	**2234.92**
8. Panther Creek/Middle	**Did Not Meet Standard**	**809.91**	**Did Not Meet Standard**	**501.27**
9. Panther Creek/Lower	**Did Not Meet Standard**	**463.69**	**Did Not Meet Standard**	**670.09**
10. Baker Creek/Upper Rainbow Lake	Met Standard	16.79	Met Standard	25.90
11. Baker Creek/Lower Rainbow Lake	Met Standard	10.77	Met Standard	10.31
12. Baker Creek/Upper Juliette Dam	Met Standard	29.50	Met Standard	19.14
13. Baker Creek/Lower Juliette Dam	Met Standard	72.59	Met Standard	97.10
14. Baker Creek/Huber Park	**Did Not Meet Standard**	**141.08**	**Did Not Meet Standard**	**266.48**
15. Baker Creek/Ed Grenfell Park	**Did Not Meet Standard**	**255.96**	**Did Not Meet Standard**	**220.17**
16. Baker Creek/Bridge	**Did Not Meet Standard**	**164.14**	**Did Not Meet Standard**	**309.07**
17. Baker Creek Tice Park	**Did Not Meet Standard**	**381.61**	**Did Not Meet Standard**	**253.73**

North Yamhill River and Tributaries E. coli

In 2005, the 2 upstream sites of the North Yamhill River (sites Nos. 1 & 3) and the tributary, Turner Creek (site No. 2), did not meet the standard, with the highest E. coli measurement at site No. 3 (228.56 Cells/100 mL). The 2 downstream sites in the North Yamhill River (site Nos. 4 & 6) met the standard, as well as the tributary, Yamhill Creek (Site No. 5).

In 2006, Turner Creek tributary (site No. 2) did not meet the standard, while sites 1& 3 met the standard. Site No. 4 on the N. Yamhill River did not meet the standard in 2006 as well as the tributary, Yamhill Creek (site No. 5).
The only site which did not meet the standard during 2005 & 2006 was the Turner Creek tributary site (No. 2).

Panther Creek Subwatershed E. coli

In 2005, all 3 sites on Panther Creek were exceedingly high, with the highest geomean value of 1014.65 at the upper Panther site (site No. 7), decreasing downstream from site Nos. 8 and 9 (809.91 and 463.69, respectively). All three sites exceeded the State standard in 2005.

In 2006, all three sites exceeded the standard again, with site No. 7 (upper Panther Creek) with a higher value at this site during the second year (2234.92).

Baker Creek Subwatershed E. coli

During 2005, The 4 upstream sites on Baker Creek (site Nos. 10-13) met the standard, while the 4 sites further downstream (Site Nos. 14-17) on Baker Creek did not meet the standard.

Again, in 2006, the 4 upstream sites, met the standard (site Nos. 10-13), while the 4 sites further downstream (Site Nos. 14-17).

Stream Flow/Discharge

Tables 3.2a & 3.2b, and Figures 3.13a & 3.13b , show stream discharge (flow) values for the three sites monitored - one within each subwatershed. Daily rainfall is also shown on figure 3.13a&b from June through October of 2005 and May through October 2006 during flow data collection dates to indicate precipitation events before and after flow measurements were taken at each site.

Site No. 2 is the uppermost site monitored on the North Yamhill River, site No. 8 is the middle site monitored in the Panther Creek subwatershed, site No. 9 is the lowermost site monitored on Panther Creek, and site No. 17 is the furthest downstream site in the Baker Creek. The Panther Creek site for monitoring flow in 2005 was changed from the original plan to monitor at the site closest to the mouth of Panther Creek (Site No. 9) to the middle Panther Creek site (No. 8) due to safety concerns. During the second month of the 2006 season, flow measurements were changed back to the originally intended site (No. 9), as the site was again considered safe to measure flow.

Flow measurements were taken monthly, from June through October, towards the end of each month. As is expected, flow rates decrease from June through August and gradually begin increasing during the last months of the summer, with periodic rain events and gradual recharge to the stream systems from groundwater recharge.

In 2005, the inconsistent peak on the North Yamhill River site (No. 2) for September was likely due to the peak in precipitation preceding the flow data collection. Flow for the other two sites (Nos. 8 and 17; Middle Panther and Lower Baker Creek, respectively) for September 2005, were measured prior to the peak rain event.

Table 3.2a 2005 Stream Discharge/Flow

Site No.	Site Name	**Stream Discharge - (cfs)**				
Month Measured ➔		June	July	August	September	October
2	N. Yamhill	28.11	20.86	12.1	14.92	13.43
8	Panther-Middle	6.19	2.68	1.41	1.92	3.69
17	Baker Creek-Tice Park	11.98	5.42	2.73	2.12	4.9

Table 3.2b 2006 Stream Discharge/Flow

Site No.	Site Name	**Stream Discharge – (cfs)**					
Month Measured ➔		May	June	July	August	September	October
2	N. Yamhill	63.53	22.93	11.25	7.45	6.24	10.94
8	Panther-Middle	20.49					
9	Panther-Lower		4.94	2.17	.83	1.15	1.53
17	Baker Creek-Tice Park	13.81	3.35	2.44	2.88	1.26	3.87

Flow measurements were consistently lower in 2006, as expected from less rainfall and fewer rain events during the months from June through October. Stream flow was visibly lower during the 2006 monitoring season.

Figure 3.13a 2005 Stream Discharge/Flow Summarized by Subwatershed[7]

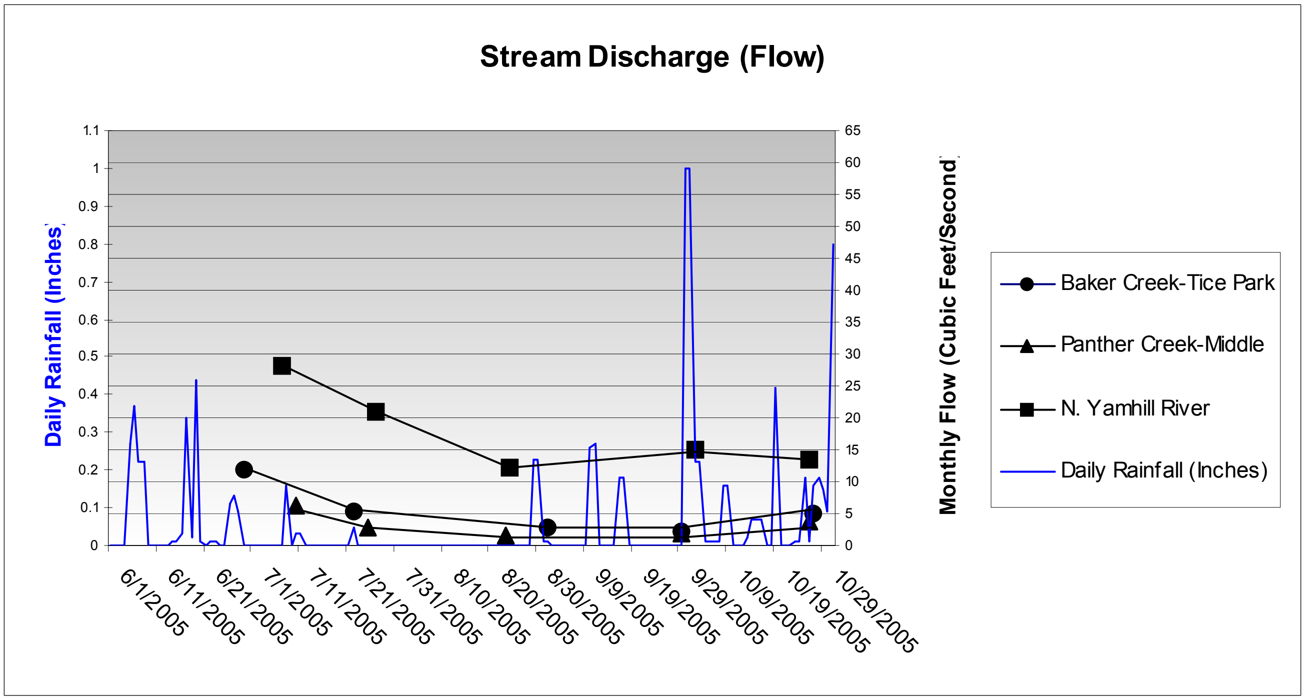
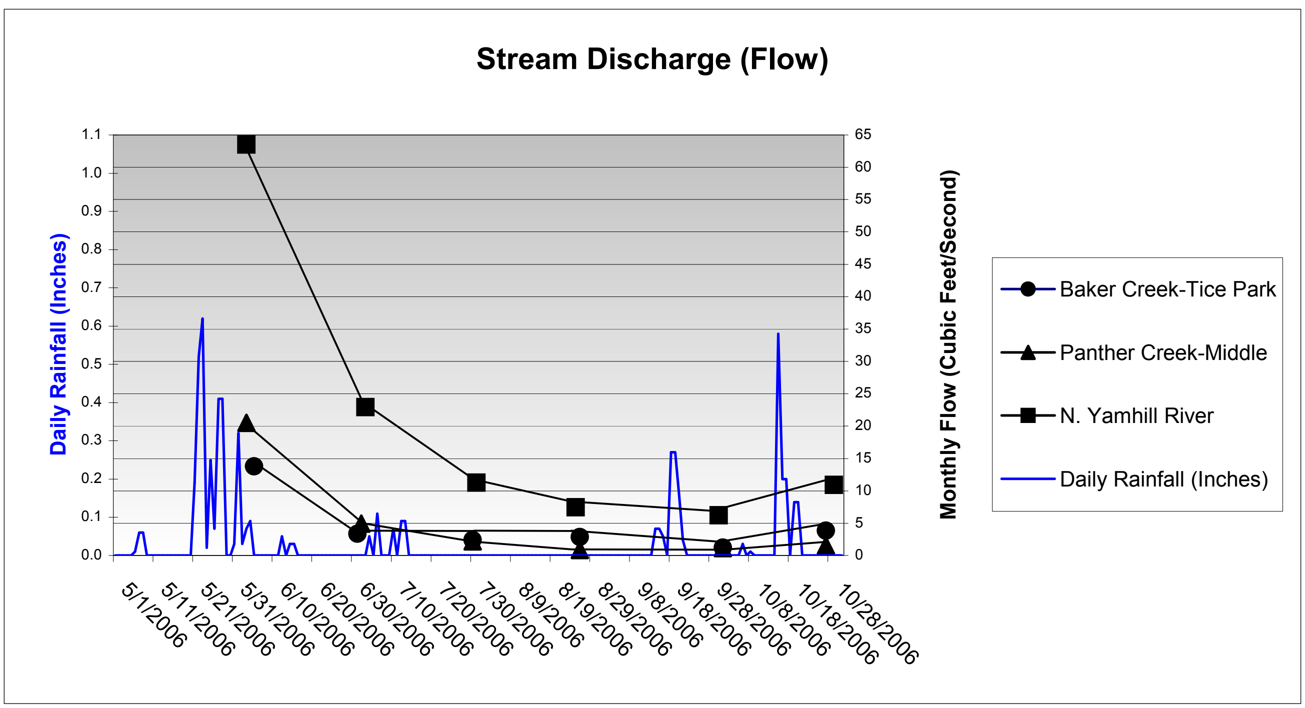


Figure 3.13b 2006 Stream Discharge/Flow Summarized by Sub watershed[7]



[7] Line connection flow data points DO NOT represent continuous flow. These lines were only drawn for the purposes of readability of the charts

Benthic Macroinvertebrates

There is no specific DEQ standard for benthic macroinvertebrates[8]. Sites were chosen based on sufficient stream flow, presence of riffles and representation of the North Yamhill River subwatershed. Nine of the 17 sites were sampled in 2005 and fewer sites (7) were sampled in 2006, due to sampling time and the cost of identification. Benthic Index of Biological Integrity (B-IBI) values were calculated and values of > 40 indicate no impairment, 30-40 indicate slight impairment, 20-30 indicate moderate impairment, and < 20 indicate severe impairment.

In 2005, all sites evaluated for impairment using the B-IBI indicated some level of impairment except at site No. 10 (Upper Rainbow Lake) on Baker Creek.

Table 3.3a 2005 Macroinvertebrate Scores and Summary Habitat Statistics

Site No.	Subwatershed (Site Name)	B-IBI Score[9]	Impairment Level (Based on B-IBI Score	Average Slope (%)	Average Canopy Cover (%)	Average Wetted Width (ft)
1	Turner Creek (Trib. of N. Yamhill River)	32	Slight	.91	80	20
2	N. Yamhill River	22	Moderate	.94	70	42
3	**N. Yamhill River**	**16**	**Severe**	*No Habitat Data Collected (only macroinvertebrates were collected at these sites)*		
6	**N. Yamhill River**	**12**	**Severe**			
7	Panther Creek (Upper)	22	Moderate	1.15	73	26
10	Baker Creek (Upstream Rainbow Lake)	44	None	3.14	54	16
11	Baker Creek (Downstream Rainbow Lake)	24	Moderate	1.94	87	21
14	Baker Creek (Huber Park)	36	Slight	.41	56	21
15	Baker Creek (Ed Grenfell Park)	28	Moderate	1.7	80	24

In 2006, all sites indicated some level of impairment, ranging from slight to moderate.

Table 3.3b 2006 Macroinvertebrate Scores and Summary Habitat Statistics

Site No.	Subwatershed (Site Name)	B-IBI Score*	Impairment Level (Based on B-IBI Score	Average Slope (%)	Average Canopy Cover (%)	Average Wetted Width (ft)
1	Turner Creek (Tributary of N. Yamhill River)	24	Moderate	.8	68	19
2	N. Yamhill River	28	Moderate	1.0	78	40
7	Panther Creek (Upper)	30	Slight	.48	65	25
10	Baker Creek (Upstream Rainbow Lake)	36	Slight	1.3	52	17
11	Baker Creek (Downstream Rainbow Lake)	36	Slight	2.89	87	17
14	Baker Creek (Huber Park)	23	Moderate	1.2	60	25
15	Baker Creek (Ed Grenfell Park)	30	Slight	.63	73	24

[8] From the Oregon Administrative Rules, 340-041-0011 states that "Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities."
[9] B-IBI: Benthic Index of Biotic Integrity

North Yamhill River and Tributaries Macroinvertebrates

In 2005, in the North Yamhill River subwatershed, the upstream site No. 1 (Turner Creek, tributary of the North Yamhill River) and No. 2 (North Yamhill River) indicated slight and moderate impairment, respectively, while the downstream sites in this subwatershed, Nos. 3 and 6 indicated severe impairment.

In 2006, site Nos. 1 & 2 (Turner Creek tributary and North Yamhill River, respectively) both indicated moderate impairment. Macroinvertebrates were not collected at site Nos. 3 & 6 during 2006.

Panther Creek Subwatershed Macroinvertebrates

In 2005, the one site scored for B-IBI on Panther Creek (No. 7, Upper Panther Creek) indicated moderate impairment.

In 2006, this same sight on Panther Creek indicated only slight impairment.

Baker Creek Subwatershed Macroinvertebrates

In 2005, on Baker Creek, site No. 10 (upstream of Rainbow lake) indicated no impairment, with a moderate impairment at site No. 11 (downstream of Rainbow lake). Downstream at Huber Park (Site No. 14) indicated slight impairment, and moderate impairment further downstream at Ed Grenfell Park (site No. 15).

Habitat as Compared to Macroinvertebrate Scores

In 2006, Site No. 10 (upstream of Rainbow Lake) indicated slight impairment. Site No. 11 (downstream Rainbow Lake) indicated only slight impairment in 2006. Site No. 14 (Huber Park) indicated moderate impairment in 2006. Finally, site No. 15 indicated only slight impairment in 2006.

Of significance to note regarding the habitat data collected is at site No. 10, where there was no indication of impairment in 2005 and only slight impairment in 2006 to the macroinvertebrate community, the slope was significantly higher than at the other sites and the average wetted width was also relatively lower than other sites measured for habitat data. The slope was lower in 2006 due to the actual length of the stretch measured. In 2005, measurements were taken further upstream where the gradient becomes rapidly steeper, thus accounting for a higher average slope in 2005. It also can be noted that site No. 10 (upstream Rainbow Lake) had relatively good water quality results in other parameters throughout the 2005/2006 sampling seasons.

Because no habitat measurements were taken at sites 3 and 6 on the N. Yamhill River due to safety and lack of wadability, no comparisons can be made between the “severe” impairment scores to macroinvertebrates and habitat statistics.

Chapter 4 – Conclusion & Discussion

Conclusion

The data collected during the 2005/2006 Water Quality Monitoring Project provided important background information as to the water quality conditions within the North Yamhill subwatershed.

Monthly monitoring during the low-flow summer months, in conjunction with snapshot annual collection of habitat and aquatic insect data, in the three subwatersheds of the North Yamhill River (and tributaries), Panther Creek, and Baker Creek can be viewed as an indicator of the overall condition of the North Yamhill subwatershed and serve as a valuable tool for further studies and direction for possible restoration efforts.

Below is a summary of select highlights of **positive findings** and **findings of concern** for the entire North Yamhill River Watershed, followed by a more in-depth summary of highlights for each subwatershed, i.e. the North Yamhill River main stem and tributaries (including Turner Creek and Yamhill Creek), Panther Creek, and Baker Creek.

Highlights of Positive Findings:

- Relatively colder temperatures on Yamhill Creek (tributary of the North Yamhill River); Met the state standard most of monitoring season in 2006 (no continuous temperature recordings in 2005)
- Baker Creek uppermost site did not exceed temperature standard during 2005 and only briefly in late July during 2006
- High dissolved oxygen values and low turbidity values on upper Baker Creek sites
- The Panther Creek uppermost site met the dissolved oxygen standard during most of 2005 and 2006 (only one sample fell below the standard during July of 2006)
- Conductivity consistently met the guideline on the North Yamhill River (including the tributary, Turner Creek), as well as on Panther Creek from May-July of 2005 and 2006, and Baker Creek lowermost sites only went slightly above the guideline during September and October of 2006.
- No impairment to macroinvertebrates at uppermost Baker Creek site during 2005 (slight impairment during 2006)
- Only slight to moderate impairment to macroinvertebrates at sites sampled on Baker Creek, Panther Creek, 1 out of 3 sites sampled on the North Yamhill River, and Turner Creek (tributary of the North Yamhill River converging just upstream of the uppermost North Yamhill River site)
- E. coli levels on upper Baker Creek sites consistently met state standards during 2005 and 2006, as did the most downstream site on the North Yamhill River (at Poverty Bend Road)

Highlights of Findings of Concern:

- Significantly high levels of E. coli on Panther Creek (highest levels at uppermost site); Also high Conductivity
- Low Dissolved Oxygen and High Conductivity on Yamhill Creek along with relatively high turbidity values during both sampling years
- Severe impairment to macroinvertebrates on N. Yamhill River at 2 sites (Moores Valley Road and Poverty Bend Road sites)
- Decreasing water quality upstream to downstream on Baker Creek; consistently did not meet E. coli standards on 4 downstream sites; Turbidity values exceed guideline at downstream sites during 2005 and 2006
- Elevated temperatures in all three subwatersheds during Summer months (except Yamhill Creek); most sites exceeding standard for salmonid rearing as well as being detrimental to other aquatic life

Possible explanations for significant findings within each sub watershed:

North Yamhill River and Tributaries

Severe impairment to macroinvertebrates at 2 North Yamhill River sites may be due to degraded substrate and habitat conditions. Both sites were noted to be very silty and lacking sufficient habitat for adequate aquatic insect survival.

Slight to Moderate impairment to macroinvertebrates found upstream of the abovementioned sites on the North Yamhill River and on the tributary, Turner Creek maybe due to better habitat conditions (i.e., presence of cobble, woody debris, higher flow, etc.) as well as consistently higher DO values and lower turbidity.

Yamhill Creek's significantly low DO values may be due to slow flow due to low gradient throughout the stream and lack of habitat conditions creating riffles and mixing in the stream. It should be noted that upstream Yamhill Creek dries up during the summer months and flow is decreased as a result. Although, it should also be noted, during the summer months, the site sampled remained deep and temperatures remained cold.

Of note also on Yamhill Creek were the relatively high conductivity values measured. This may be due to the natural geology of the area from which the stream is fed. It is also possible that Yamhill Creek may be predominantly fed from groundwater, which could account for the low temperatures and high conductivity.

Elevated temperatures within the North Yamhill sub watershed during summer months is likely due to significantly decreased flow and water levels. It should be noted that during 2006, water levels were significantly lower than those of 2005, likely due to decreased rainfall, extreme high summer temperatures, and likely higher irrigation needs.

Panther Creek
The most significant finding on Panther Creek was the elevated E. coli levels. The most excessive measurements during both years came from the uppermost site. While the levels decreased upstream to downstream, the lower 2 sites were also excessively high. This may be a result of non-anthropogenic influences (not caused by humans), i.e. from livestock or wildlife (such as elk or beavers), but further investigation is needed before any conclusions can be made. The values are high enough to warrant further study.

Higher conductivity values during the later summer months on Panther Creek may also be an influence or correlate to the exceeding E. coli values.

While the Panther Creek elevated value for E. coli and conductivity, may not influence the results of the sites studied on the N. Yamhill River during 2005 and 2006, because it converges with the North Yamhill River below the most downstream site studied on the North Yamhill River at Poverty Bend, the water quality concerns of this creek may affect the North Yamhill River and its convergence with the Yamhill River.

Baker Creek
As was expected on Baker Creek, water quality decreased in general from upstream to downstream. Colder temperatures, higher dissolved oxygen, lower turbidity, lower conductivity, lower E. coli values were all present at the upstream sites and each parameter consistently degraded downstream.

The only sight with a scored value indicating no impairment to macroinvertebrates was the uppermost Baker Creek site (during 2005). This is to be expected with cold temperatures, high DO, low turbidity, good habitat conditions, and gradient variance.

E. coli levels on Baker Creek's uppermost sites were safely within E. coli standard levels. However, the consistent exceedance of E. coli levels on the lower 4 sites is of concern because of increased human interaction with the streams with several public parks within the stretch with measured elevated E. coli levels.

Possible general causes of degraded water quality:

Some possible reasons, as to why sites or streams within the North Yamhill subwatershed may have exceeded the standards or guidelines during the 2005/2006 North Yamhill Water Quality Monitoring Project are listed below by parameter:

Causes for sites to exceed Temperature standards:

- Lack of shading to the stream: reduced riparian (streamside) vegetation reduces shading and cooling effects on steams
- Alterations to stream morphology (e.g., widening or reduced depth): may be man-made changes or as occurs naturally

- Point source warm-water inputs: consistent or frequent warm increased temperature influences can alter stream temperature over time
- Increased algal growth: decreases reflection of heat from water surface; increases biological oxygen demand
- Low-flow or stagnant waters: can increase heat absorption rate
- High turbidity: increases heat absorption rate

Causes for sites to fall below Dissolved Oxygen standard:

- Increased temperature: decreases the stream's ability to hold dissolved oxygen
- Low-flow: decreases aeration
- Loss of substrate habitat: decreases riffle aeration from loss of cobble/boulder/etc. and other habitat (such as large woody debris)
- Biological oxygen demand (BOD): increases from sources such as sewage or increased plant matter in the stream

Causes for sites to exceed Turbidity guideline:

- Erosion inputs upstream of sites: transport of sediment from increased sediment input upstream
- Loss of riparian vegetation: can lend to increased streamside erosion and sediment transport

Causes for sites to exceed Conductivity guideline:

- Urban or agricultural runoff: sewage or leaky septic tanks or nutrients from fertilizers are possible sources
- Natural geological conditions

Causes for sites to exceed E. coli standard:

- Increased animal waste: possible sources may be natural or from farming practices
- Human waste: possible sources may be sewage runoff or leaky septic systems

Causes for low Stream Discharge (Flow):

- Decreased rainfall: primary source for aquifer recharge for low-flow seasons
- Depleted aquifers: decreases water supply to streams during summer months
- Low gradient: decreases/slows flow
- Irrigation demands: diverts upstream flow for irrigation purposes
- Impediments such as dams, culverts, natural debris jams

Causes for impairment to macroinvertebrate communities:

- Increased temperature: many of the macroinvertebrates that are indicators of water quality are sensitive to temperature
- Increased turbidity: turbid conditions lend to clogging of gills, increased temperatures, clogged interstitial spaces (gaps between substrates, e.g. rocks, where many macroinvertebrates habitat)

- Pesticide & fertilizer inputs: Many sensitive species may be affected by chemical/nutrient inputs
- Decreased dissolved oxygen: essential for the survival of sensitive water quality indicator species
- Decrease in natural/native vegetation: many sensitive species thrive on native flora
- Habitat disturbance: aquatic insects depend on natural stream conditions including healthy substrate conditions (cobble, boulders, pebbles, woody debris, detritus, etc.)

Water quality improvements recommendations as a result of this study:

- Decrease stream Temperature throughout watershed
- Increase dissolved oxygen – e.g.,Yamhill Creek, the North Yamhill River at Poverty Bend Road, and Panther Creek
- Reduce stream turbidity at sites with consistently higher values
- Improve Aquatic Insect Habitat – e.g., the North Yamhill River at Moores Valley Road and Poverty Bend Road

Possible actions, activities and practices to improve water quality:

- Plant trees to shade stream, reduce temperature, reduce erosion and filter pollutants
- Stream bank plantings, roadside seeding of ditches can reduce erosion and filter pollutants
- Large woody debris placement to capture gravels and slow stream velocities, make food for aquatic insects and refuge for fish
- Irrigation efficiency, domestic water conservation, storing more water in wetlands/floodplains/ground instead of running it off right away, will all contribute to increased stream flow
- Repair leaky septic tanks, fence off livestock from streams, manure management, dispose of pet waste to reduce *E.coli*

While much data was collected during the 2005/2006 monitoring season, and results for each sub watershed were indicated, specific conclusions as to why particular sites have compromised water quality cannot be determined solely from data results. Further research into problem or suspect areas would need to be conducted in order to infer or determine what specific issues may be causing impaired stream conditions. Sharing the results of this study with the community and stakeholders gives us an opportunity to engage in discussions which may provides hints at what some of the causes of water quality impairment might be. The results do however, provide the Council with a scientific basis to reach out to landowners provide technical assistance, encourage voluntary restoration and water quality improvement projects, and develop educational and outreach programs that target the identified issues.

Discussion

The Yamhill Basin Council's monitoring project had an accomplished monitoring in 2005 and 2006 thanks to the dedication and time of many hardworking volunteers, council members, and technical advisors.

Three presentations of the results were delivered to the community at large as well as to the Yamhill Basin Council and interested parties highlighting the results of the monitoring project. Much discussion evolved at these presentations. The Council will continue to deliver presentations on the results to the community and other organizations as requested, as well as provide printed and electronic copies of the results. Of particular interest to the Council as well as presentation participants were the significant results within each sub watershed, e.g. degrading water quality on Baker Creek (upstream to downstream), high E. coli levels on Panther Creek, severe impairment to macroinvertebrates on the North Yamhill River, and surprisingly low temperatures on Yamhill Creek in conjunction with low dissolved oxygen levels, high turbidity measurements, and high conductivity readings.

At these community presentations and in development of this report several questions arose as to the possible causes for significant findings. Further study and possible future monitoring projects are recommended for areas of concern.

Possible further investigations and monitoring:

- **Increase awareness of *E.coli* levels to Panther Creek residents**. Provide education on and encourage voluntary investigation and repairing of leaky septic tanks; best management practices for livestock and pets. Additional, but more expensive studies could include DNA Testing to identify sources of E. coli.
- **Further research into Yamhill Creek.** Possibly a hyporheic stream system (groundwater fed) thus accounting for high conductivity and low temperatures. A groundwater die test is a possible investigative tool to assess the source of Yamhill Creek. Longtime local resident and historian, Gordon Zimmerman of Yamhill, discusses the very shallow groundwater table in his book, *A Song of Yamhill*.
- **Continued baseline monitoring on Baker Creek** to observe changes and trends as urban development grows/land use changes.
- **Additional baseline monitoring on the North Yamhill River** to assess water quality issues as indicated by severe impairment to aquatic insect communities. Possible additional habitat studies on the sites of concern, although natural conditions, such as low gradient and silty deposits, of this stretch of the river may not be conducive to thriving macroinvertebrate communities
- **Measuring of additional water quality related parameters** that affect aquatic life and human health. These could include: nutrients, pesticides, and toxins as well as continued measurements of dissolved oxygen, temperature, turbidity , pH, and conductivity.

Closing Statement

By Jamie Sheahan, YBC Watershed Coordinator

The Yamhill Basin Council has been conducting monitoring data since 1998. We live in a rural watershed where citizens and stakeholders continually ask questions such as: *"What is the state of our Watershed"*, *"Is our water quality improving or getting worse"*. We also live in a watershed where hundreds of private landowners are voluntarily changing practices or implementing projects to improve water quality and habitat. We have a responsibility to our community to provide these answers, to show the effectiveness of the hard work being done on the ground and to address the water quality concerns identified.

We can now summarize the state of the North Yamhill Watershed from this project and from the overall Yamhill Basin from our 2003-2004 water quality monitoring project. Unfortunately, the score isn't so high.

With the water quality monitoring data from the last four years, we have a substantial baseline from which to track these changes over time to show trends of improving or degrading water quality. Due to constraints of funding and volunteer time, we will likely not be able to conduct trend monitoring on an annual basis, but will hope to revisit and track these sites for baseline comparison studies again in the future.

As the North Yamhill Water Quality Monitoring Project has come to completion, we are met with a sense of accomplishment and a drive to move forward and help stakeholders understand and participate in addressing the concerns we found. But, we are also saddened by the end of this project. We will miss the landowners and their families who we visited on a monthly basis. We will miss getting in the streams, getting our boots wet and getting a hard days work done. We will miss educating volunteers on the reason for and methods of taking each measurement, and we will miss all those volunteers who gave so devotedly.

But this project completion is just another beginning. You will still find us wading in our streams, assisting landowners, working together, educating our community, and serving as the eyes, ears, and voice of our watershed.

As always, we encourage residents and stakeholders to contact us for more information and learn about actions you can take to be part of this effort to improve our streams.

In final remarks, the Yamhill Basin Council would like to send a sincere and well-deserved thank you to Denise Schmit, for implementing this project with her keen attention to detail, quality assurance, and her demonstrated dedication to learning about, understanding, and sharing these watershed findings.

Chapter 5: Riparian Reference Project

Introduction

The Riparian Reference Project was included as part of the 2005/2006 Water Quality Monitoring Project to identify and assess potential riparian reference sites in the lower elevations of the Yamhill Basin.

The goals of the project were to:

1. Identify reference sites, i.e. sites which have been relatively undisturbed for many years, through the use of aerial photographs
2. Contact local landowners of the selected sites and gain access for field verification and accessibility for analysis of riparian conditions
3. Develop a field data sheet to be used in the assessment of the riparian areas through collaboration with the Oregon Department of Environmental Quality (DEQ) and Oregon Department of Agriculture (ODA)
4. Assess the selected reference sites according to the developed protocol and provide data to interested agencies (including DEQ and ODA)

Through selection of sites, from aerial photographs, the intent of the project is to identify "reference" sites for DEQ's potential near-stream land cover types identified for the Yamhill River (DEQ, 2004) and for ODA's site capability assessment. The data collected in the reference study is intended to be used in determining shade potential for the Yamhill Temperature TMDL (Total Daily Maximum Load). The data in this report will be provided to DEQ and ODA for these purposes.

Understanding local "reference sites" offers:

- a look at what riparian buffers may look like many years after planted
- a look at the plants and their community structure along riparian areas
- an insight into planning riparian restoration projects
- a look at the potential for streamside buffers to shade streams and reduce stream temperatures

Through several meetings with DEQ, YBC and ODA partners, we established a goal of collecting information at 4-5 reference sites, which would be representative of different eco-regions. Sites were selected in lower elevations of the watershed (as many studies have already been conducted on upland forested streams). For the purpose of this study, a "**riparian reference site**" is a streamside buffer which has had relatively **minimal human disturbance**. We would not expect to find untouched or pristine streamside forests in the lower elevations of the watershed.

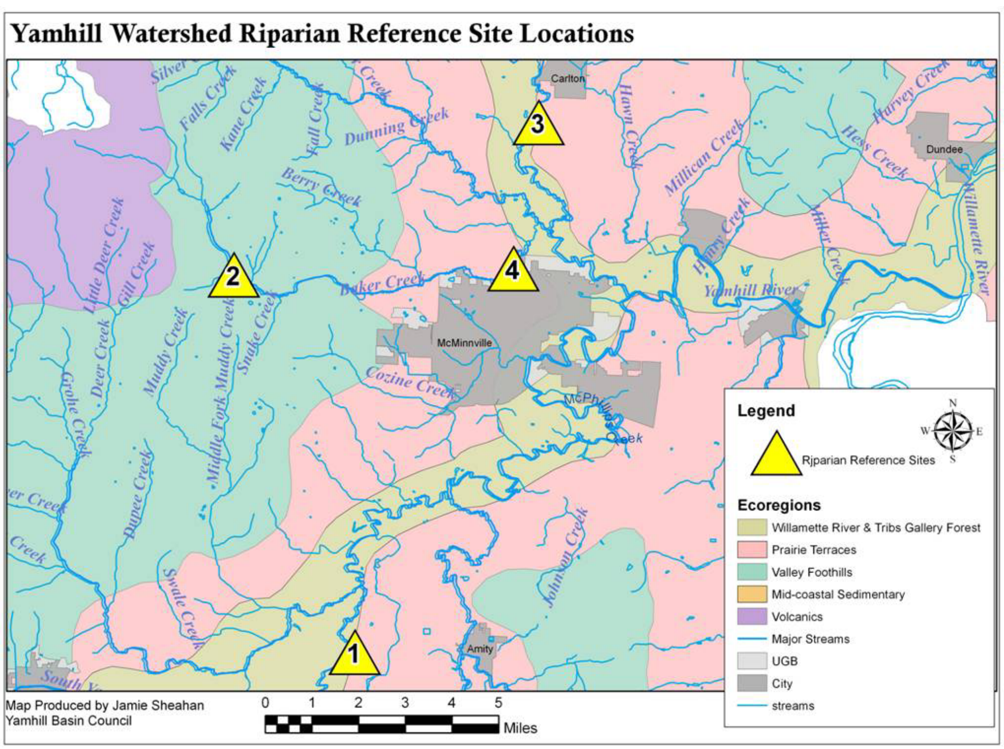
Site Identification and Selection:
The site identification involved several steps, including: 1) potential site identification using GIS, 2) site visits to potential sites, 3) selection of final reference to sites, 4) data collection at four reference sites, and 5. reporting of findings.

The GIS Analysis was conducted by the YBC Watershed Coordinator, with GIS software use from Yamhill County GIS, and assistance from ODA and DEQ. Various GIS layers were uploaded into the project file and included: Streams, Riparian Condition Unit layers for each subwatershed, Roads, Taxlots, Ecoregions and Soils. The Riparian Condition Units were developed by the YBC during the Watershed Assessment phase. Stream reaches with potential reference conditions were selected and extracted from the various subwatersheds and included: Conifers >50ft, Hardwoods>50ft, and Mixed>50ft. This methodology did not incorporate prairie, wetland or shrub type of riparian buffers. The potential reference stream reaches were then overlayed on the Yamhill County digital Orthophoto (2005 1 meter resolution flyover) to further assess conditions and outline potential sites. Detailed digital aerial photos of several local streams were obtained from ODA were also used in this aerial assessment.

Through this analysis, ten potential sites and landowners were identified and mapped. The Council obtained landowner permissions and coordinated initial site visits to eight of the sites to assess access, conduct visual site assessments and establish field and data collection protocol.

A final selection of four sites was made, which represented various Ecoregions, streams sizes and plant composition/structure. The sites were located on a tributary of Baker Creek, on the mainstem of Baker Creek near McMinnville, on the North Yamhill River, and on a tributary of the South Yamhill River (See Map 5.1).

Map 5.1 Riparian Reference Sites



Field Methods

Through collaboration with DEQ and ODA, a field sheet was developed to collect data at each site. Several plots were measured at each site (approximately 60-100 square feet) in the general plot arrangement as shown below in Figure 5.1.

Photo 5.1 Riparian Shade Measurement

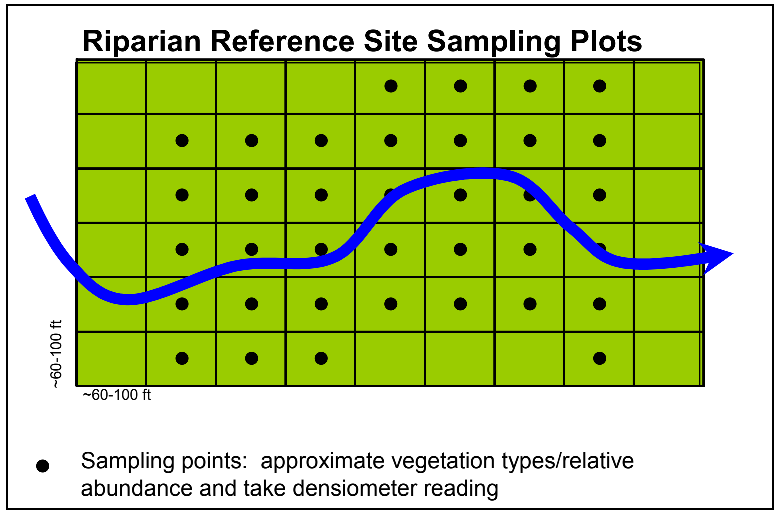


Figure 5.1 Riparian Plot Layout - Generalized

The following data were collected within each plot:

- **Densiometer (Shade)** Readings: 3 random readings within each plot. If the difference was greater than 4 between the lowest and highest reading, 3 additional random reading were taken.
- **% Cover:** Read as if looking from above (by height layer). E.g., how much of ground is first covered by trees (conifer and deciduous), shrubs, grasses/sedges, and bare ground.
- **Dominant Species:** Within each layer, the major dominant species was identified
- **% Species Dominance:** The percent of the identified dominant species within each layer was estimated. I.e., how much of identified dominant species represented the cover in the plot (e.g., if Oregon Ash was the dominant species for deciduous cover, what percent of the cover was Oregon Ash was deciduous cover)
- **Bank Location:** Each plot was either identified as Left Bank or Right Bank of stream/river (facing downstream).
- **GPS:** Latitude and Longitude was measured at the center of each plot if signals were received from the GPS unit. An Etrex Summit GPS unit from Yamhill SWCD was used. Accuracy (in feet) of equipment at time of measurement was recorded.

▪ **Canopy height** was measured at each site from the measurement of one tree representing an average height throughout the site. A clinometer and tape measure were used for tree height measurement.

▪ **Bankful Width** was measured at each site at one representative width surrounding the plot summary area.

▪ **% Cover, % Dominant Species,** and **% Species Dominance** was collectively decided upon between the Monitoring Technician and volunteers. If subjective measurements differed between data collecting participants, additional visual readings were done, until an agreed upon percentage was concluded.

Photo 5.2 Riparian Plant Identification

Plant species were identified by the experience and knowledge of volunteers and Monitoring Technician, as well as with the aide of a native northwest plant guide when needed (Pojar & Mackinnon, 1994).

The field sheet used for data collection is shown in Figure 5.2 on the following page.

Figure 5.2 Riparian Field Data Sheet

Riparian Reference Site Field Sampling Sheet

Site Name: ____________ Collected by: ______________________________

Site Number ____________ Canopy Hgt*: ______________________________

Date: ____________ Bankful Width: ______________________________

Time started: ____________ *One tree representative of average canopy height was measured

Plot #

1	VEG COVER					*Notes, sketches, etc*
	Conifer	Decid	Shrub	Grass/ herb	Bare ground	
% Total Cover						
Dominant Species						
% Sp. Dominance						
Veg Ht.(ft)*	Canopy	Midstory	Shrub	Densiometer	L/R Bank	
	See above					
GPS (Ctr)			Plot Size			

2	VEG COVER					*Notes, sketches, etc*
	Conifer	Decid	Shrub	Grass/ herb	Bare ground	
% Total Cover						
Dominant Species						
% Sp. Dominance						
Veg Ht.(ft)	Canopy	Midstory	Shrub	Densiometer	L/R Bank	
	See above					
GPS (Ctr)			Plot Size			

3	VEG COVER					*Notes, sketches, etc*
	Conifer	Decid	Shrub	Grass/ herb	Bare ground	
% Total Cover						
Dominant Species						
% Sp. Dominance						
Veg Ht. (ft)	Canopy	Midstory	Shrub	Densiometer	L/R Bank	
	See above					
GPS (Ctr)			Plot Size			

4	VEG COVER					*Notes, sketches, etc*
	Conifer	Decid	Shrub	Grass/ herb	Bare ground	
% Total Cover						
Dominant Species						
% Sp. Dominance						
Veg Ht.(ft)	Canopy	Midstory	Shrub	Densiometer	L/R Bank	
	See above					
GPS (Ctr)			Plot Size			

5	VEG COVER					*Notes, sketches, etc*
	Conifer	Decid	Shrub	Grass/ herb	Bare ground	
% Total Cover						
Dominant Species						
% Sp. Dominance						
Veg Ht.(ft)	Canopy	Midstory	Shrub	Densiometer	L/R Bank	
	See above					
GPS (Ctr)			Plot Size			

Results

The data were summarized by calculating averages for each plot of each reading and is shown below in Table 5.1.

Table 5.1 Summary of Riparian Reference Site Conditions by site

1) McPhillips Creek AVG.	VEG COVER				
	Conifer	Deciduous	Shrub	Grass/ herb	Bare ground
% Total Cover	0%	68%	73%	31%	23%
Dominant Species	NA	Ash/Oak	Snowberry	Sedge/Nettle	
Veg Ht.(ft)*	Canopy Height	Densiometer	% shade	Bankfull Width	Left/Right Bank
	66	2.72	84%	20 ft	5/1

Notes: McPhillips Creeks is a small tributary to the South Yamhill River, southwest of McMinnville. The vegetation community was mostly native vegetation, with predominantly Oregon Ash in closest proximity to the banks. Oregon White Oak was also very present within the floodplain. The site typically experiences widespread inundation during the wetter winter season and my run dry in late summer. The shrub layer was dense, diverse and patchy. The topography was generally flat below the bench.

Photo 5.3 McPhillips Creek

2) Baker Ck Trib AVG.	VEG COVER				
	Conifer	Deciduous	Shrub	Grass/ herb	Bare ground
% Total Cover	54%	23%	8%	57%	38%
Dominant Species	Western Red Cedar	Big Leaf Maple	Vine Maple	Sword Fern	
Veg Ht.(ft)*	Canopy Height	Densiometer	% shade	Bankful Width	Left/Right Bank
	100	0.8	95%	16 ft	0/5

This tributary to Baker Creek is the highest elevation site and is dominated by conifer species. Western Red Cedar was the dominant canopy, with some mixing of Big Leaf Maple. Hemlock seedlings were observed. The topography is steep and canyon-like and the site is very shaded.

Photo 5.6 Baker Creek tributary

3) N. Yamhill AVG.	VEG COVER				
	Conifer	Deciduous	Shrub	Grass/ herb	Bare ground
% Total Cover	2%	76%	47%	16%	40%
Dominant Species	Douglas Fir	Big Leaf Maple	Snowberry	Sedge	
Veg Ht.(ft)*	Canopy Height	Densiometer	% shade	Bankful Width	Left/Right Bank
	84	1.39	92%	35 ft	0/5

The site was located along the North Yamhill River south of Carlton. The river banks were typical of the area with deep incision and steep banks. The canopy was comprised of mixed deciduous mature trees: maple, oak and ash. The shrub layer was dominated by snowberry but had other species, such as ninebark, present. There was a significant presence of bare ground, which may result from frequent flooding.

Photo 5.5 North Yamhill River

4) Tice Woods AVG.	VEG COVER				
	Conifer	Deciduous	Shrub	Grass/ herb	Bare ground
% Total Cover	10%	19%	40%	65%	34%
Dominant Species	Douglas Fir	Big Leaf Maple	Hazelnut/ Blackberry	Grass	
Veg Ht.(ft)*	Canopy Height	Densiometer	% shade	Bankful Width	Left/Right Bank
	48	6.39	62%	25 ft	0/5

This site was located along Baker Creek near the City of McMinnville and had a mixed conifer/deciduous canopy. There was a significant presence of large wood in the stream. Invasive blackberry was more predominant at this site than others.

Photo 5.6 Baker Creek

References

Ishii, J. (2005). *2003-2004 Water Quality Monitoring Final Report*. McMinnville, OR: Yamhill Basin Council.

Leoni, M. (2001). *North Yamhill Watershed Assessment*. McMinnville, OR: Yamhill Basin Council.

Oregon Plan for Salmon and Watersheds. (1999). *Water Quality Monitoring Technical Guide Book.* Version 2.0.

Pojar, J. & MacKinnon, A. (1994). *Plants of the Pacific Northwest Coast*. Vancouver, BC: Lone Pine Publishing.

Yamhill Basin Council. (2003). *Quality Assurance Project Plan*. YBC WQMP 2003-2005. McMinnville, OR.

Yamhill Basin Council. (2005). *North Yamhill River Watershed Monitoring Project 2005-2007. Quality Assurance Project Plan*. McMinnville, OR.

Yamhill River Subbasin Local Advisory Committee. (1999). *Yamhill River Subbasin Agricultural Water Quality Management Area Plan.* Guidance Document. McMinnville, OR.

U.S. Census Bureau. *State and County Quick Facts*. June 28, 2006. http://quickfacts.census.gov/qfd/states/41/41071.html

Appendix D: DEQ Data Quality Matrix

Data Quality Matrix
DEQ04-LAB-0003-GD
Version 3.0

Oregon Department of Environmental Quality
February 2004
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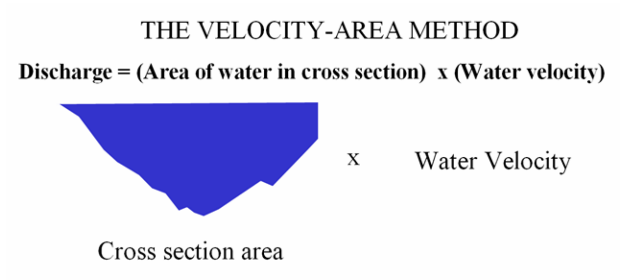
Data Validation Criteria for Water Quality Parameters Measured in the Field

Data Quality Level	Quality Assurance Plan	Water Temperature Methods	pH Methods	Dissolved Oxygen Methods	Turbidity Methods	Conductivity Methods	Bacteria Methods	Data Uses
A+	DEQ QAPP approved by DEQ QA Officer	Thermometer Accuracy checked with NIST standards A ≤ ± 0.5°C P ≤ ± 1.5°C	Calibrated pH electrode A ≤ ± 0.2 S.U. P ≤ ± 0.3 S.U.	Winkler titration or calibrated Oxygen meter A ≤ ± 0.2 mgL^{-1} P ≤ ± 0.3 mgL^{-1}	Nephelometric Turbidity meter A ≤ ± 5% Standard value P ≤ ± 5%	Meter with temp correction to 25°C A ≤ ± 7% of standard value P ≤ ± 10%	DEQ Approved Methods Absolute difference between log-transformed values P ≤ 0.6 log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments)
A	External QAPP	External Data Thermometer Accuracy checked with NIST standards A ≤ ± 0.5°C P ≤ ± 1.5°C	External Data Calibrated pH electrode A ≤ ± 0.2 S.U. P ≤ ± 0.3 S.U.	External Data Winkler titration or calibrated Oxygen meter A ≤ ± 0.2 mgL^{-1} P ≤ ± 0.3 mgL^{-1}	External Data Nephelometric Turbidity meter A ≤ ± 5% Standard value P ≤ ± 5%	External Data Meter with temp correction to 25°C A ≤ ± 7% of standard value P ≤ ± 10%	External Data DEQ Approved Methods Absolute difference between log-transformed values P ≤ 0.6 log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments)
B	Minimum Data Acceptance Criteria Met	Thermometer Accuracy checked with NIST standards A ≤ ± 1.0°C P ≤ ± 2.0°C	Any Method A ≤ ± 0.5 S.U. P ≤ ± 0.5 S.U.	Winkler titration or calibrated Oxygen meter A ≤ ± 1 mgL^{-1} P ≤ ± 1 mgL^{-1}	Any Method A ≤ ± 30% P ≤ ± 30%	Meter with temp correction to 25°C A ≤ ± 10% of standard value P ≤ ± 15%	DEQ Approved Methods Absolute difference between log-transformed values P ≤ 0.8 log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments) with professional judgment
C		A > ± 1.0°C P > ± 2.0°C	A > ± 0.5 S.U. P > ± 0.5 S.U.	A > ± 2 mgL^{-1} P > ± 2 mgL^{-1}	A > 30% P > 30%	A > ± 10% P > ± 15%	Absolute difference between log-transformed values P > 0.8 log	Void data. Not used for 303(d) and 305(b) assessments
D		Missing Data	Missing Data	Missing Data	Missing Data	Missing Data	Missing Data	Missing Data
E	No QAPP provided	No Precision Checks	Any Method No Precision Checks	Any Method No Precision Checks or A ≤ ± 2 mgL^{-1} P ≤ ± 2 mgL^{-1}	Any Method No precision checks	Meter without routine calibration No precision checks	Any Method No precision checks	Informational purposes only
F	See accompanying notes							

Appendix E: Flow/Stream Discharge Methods

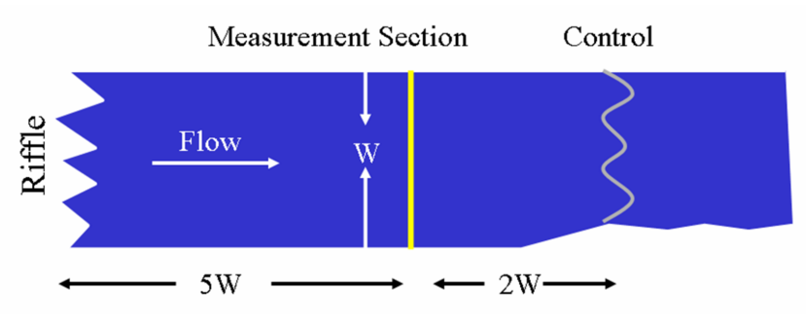
Stream Discharge: The volume of water which passes a stream transect in a given time, usually expressed in cubic feet per second (cfs) or cubic meters per second (cms).

RANGE: Most streams measured using the method described below will range from 1 cfs to 200 cfs. During the dry season stream discharges, sometimes referred to as “flows”, tend to decrease gradually. In contrast, over the course of a year the range of values for a stream vary so significantly that portraying the values on a normal graph is usually impractical. For example, the USGS has measured stream flow on the Willamette River at Salem for 88 years and have recorded values ranging from 2,470 cfs (1940) to 348,000 cfs (1923).



MEASUREMENT METHOD: We use the velocity area method to calculate stream discharge. This method estimates the area of the stream by breaking the stream channel into multiple smaller rectangular cells. The width of each cell is measured with a measuring tape or “tagline” that is strung across the stream perpendicular to the direction of flow. The depth is measured with a special wading rod called a “top setting rod”. The field technician attaches a velocity meter to the top setting rod to measure the velocity of the water moving through the cell. Velocity meter types used by the DEQ include mechanical meters (standard Price AA and pygmy) or electromagnetic Marsh-McBirney FlowMate.

<u>Where to measure</u>:
Finding a good cross section of a stream for taking a flow measurement is critical to collecting an accurate measurement. The area above your cross section should be straight and uniform enough to allow for uniform flow. The streambed should be stable and free of large rocks, weeds, and protruding obstructions (USGS, 2000). The diagram to the left shows the preferred scenario for a flow site with 5 times the width of the channel straight above the cross section to the nearest riffle and 2 times the width downstream to the control that is “pulling” the water through the cross section. This control is often some type of increased steepness in the stream. You may alter a channel by removing rocks and debris before starting your measurement but never make any changes to the cross section once you start the measurement.



<u>How many measurements:</u>
For a high quality measurement the field staff should capture no more than 5% of the total flow in a single cell. This is particularly important in channels where the bottom is highly irregular. For this reason it is recommended that a stream be broken up into 20 to 30 separate cells when doing a stream discharge measurement. To minimize the number of cells needed on a relatively even bottomed cross section, a skilled technician will use wider cells in areas with lower stream velocities and depths and narrower cells in areas with deeper faster water.

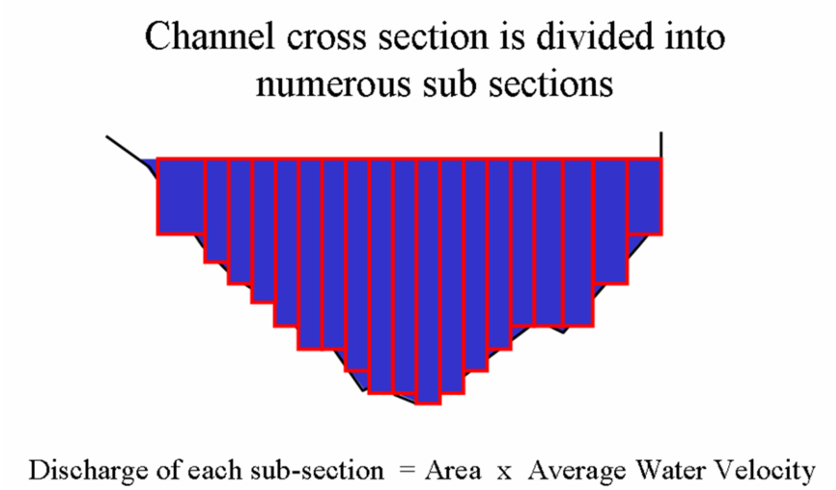
The number of velocity measurements one takes in each cell is dependent on the type of flow meter used and the depth of the water. When using a Marsh-McBirney FlowMate or a standard Price AA meter take a single measurement at depths less than 2.5 ft. If using a pygmy meter a single measurement can be used only for depths less than 1.5 ft. Single depth measurements are taken at 60% of the total depth (that would be 0.6 ft from the surface at a 1 ft deep point). If more than one measurement is required you must take a measurement at 20% and 80% of the total depth.

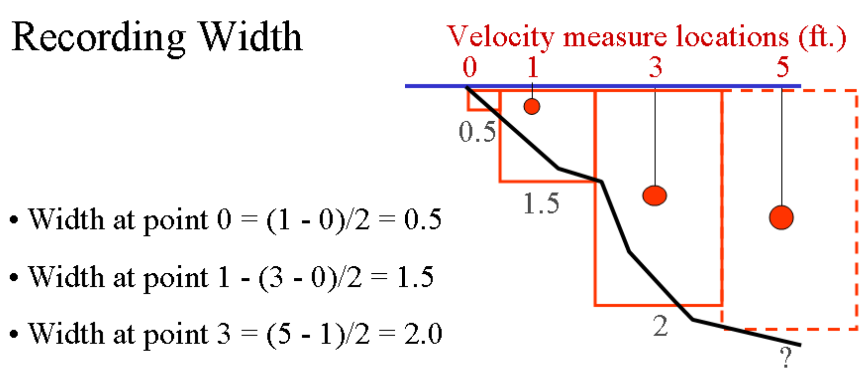
Using the top setting rod:
The top setting rod has an octagonal rod graduated for measuring depth in tenths of a foot. The round rod, to which you attach the flow meter, and handle are specially designed to allow you to quickly and easily set the velocity meter at the correct depth. The round rod is graduated to represent whole feet and the handle through which the rod slides is graduated to represent tenths of a foot. When you align the line marked 1 on the round rod, with the line marked 6 on the handle, the rod sets the velocity meter at 60% of the depth of a 1.6 ft total depth. By doubling or halving a total depth measurement, you can calculate the settings for measurements at 20% or 80% of depth, respectively. For example, with the depth of 1.6 ft. setting the rod to 3.2 would put the meter at 20% of the 1.6 ft depth and setting the rod at 0.8 would represent 80% of 1.6 ft depth.

Measuring velocity:
When taking a flow measurement, the top setting rod should be held at the tagline which is pulled taught across the stream and secured on each bank. You should stand at least 3 inches behind the rod and eighteen inches to the side to allow water flow freely past the meter. Velocity measurements should be an average of 40 seconds of continuous recordings to accommodate for natural variations in local velocities. If water is not flowing perpendicular to the tag line you may need to adjust your velocity to prevent overestimating the total discharge. For detailed descriptions of how to take a stream discharge measurement see the U.S. Geological Survey Water Resources Division document *Measurement of Stream Discharge by Wading* by K. Michael Nolan and Ronald R. Shields published in 2000, Water Resources Investigations Report 00-4036.

EQUIPMENT CARE: The mechanical meter maintenance and use is described in the U.S.G.S. Office of Surface Water publication 85.07 and 85.14 for thorough description of use an maintenance of these meters. See the Marsh-McBirney FlowMate manual for information on use and maintenance of this equipment.

SAFTEY: Wading in streams can be very dangerous. Do not work alone. In water where you may be swept from your feet, wear a floatation device. Before attempting to wade across a stream look downstream for potential hazards such as rapids, low hanging branches or logs that can trap a swimmer. No stream discharge measurement is worth risking a serious injury or death.





Example data sheet

Cell #	Tape Dist. (ft)	Width (ft)	Depth (ft)	Area (ft^2)	Meas. Depth (%)	Velocity (ft/sec)	Discharge (cfs)	% Total Discharge
1.	RWE 38	0.5	0		NA	0	0	0
2.	37	1.5	0.6	0.9	0.6	0.24	0.216	
3.	35	2	1.1	2.2	0.6	0.67	1.47	
4.	33		1.2					
5.	Etc.							

Discharge in each cell is calculated individually and summed. Calculating discharge in each cell as the measurement is taken is useful for identifying when you may have used too wide a cell.

REFERENCE:
USGS, 2000. *Measurement of Stream Discharge by Wading* By K. Michael Nolan and Ronald R. Shields
Water Resources Investigations Report 00-4036, version 1.1. ISBN: 0-607-96337-9
For sale by
USGS Information Services
Box 25286, Building 810
Denver Federal Center
Denver, CO 80225
(888) ASK-USGS

Appendix F: Oregon DEQ LASAR Database (User Instructions)

Laboratory Analytical Storage and Retrieval Database of Monitoring Data (LASAR)

What is LASAR?

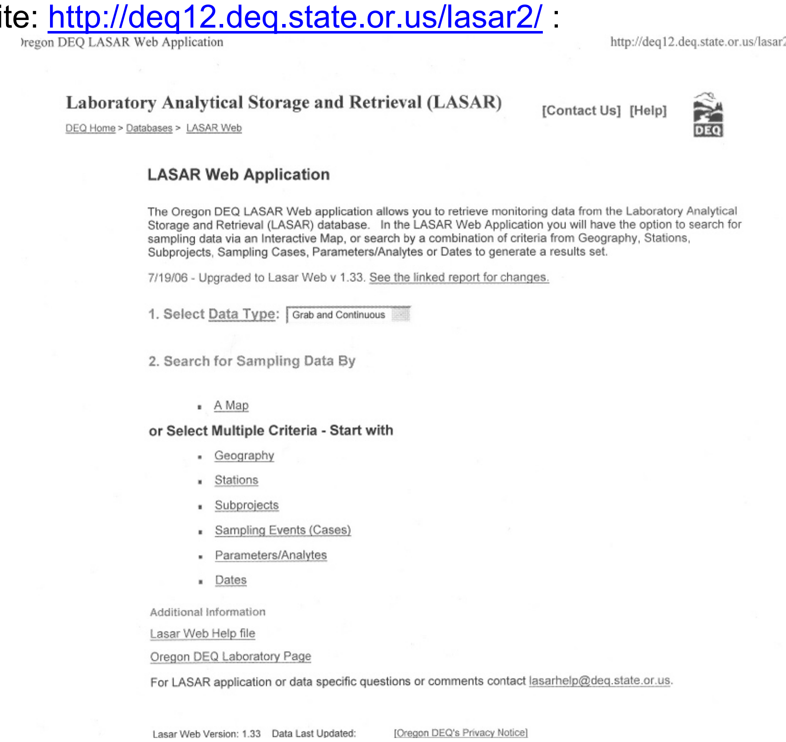
“The Oregon DEQ LASAR Web application allows you to retrieve [air and water quality] monitoring data from the Laboratory Analytical Storage and Retrieval (LASAR) database. In the LASAR Web Application you will have the option to search for sampling data via an Interactive Map, or search by a combination of criteria from Geography, Stations, Subprojects, Sampling Cases, Parameters/Analytes or Dates to generate a results set.” The results set can be downloaded in a comma delimited file format.

What is our connection?

The Yamhill Basin Council has been submitting our monitoring data to the Oregon DEQ for inclusion in the online monitoring database they are creating. Each of our sites has been assigned its own unique station id and the data we submit is associated with that id. If a sampling site is relocated on a stream but still within 2 miles of the previous site, then it will be given the same station id.

So how do I use it?

Go to the website: http://deq12.deq.state.or.us/lasar2/ :


)regon DEQ LASAR Web Application   http://deq12.deq.state.or.us/lasar2

Laboratory Analytical Storage and Retrieval (LASAR)   [Contact Us] [Help]

DEQ Home > Databases > LASAR Web

LASAR Web Application

The Oregon DEQ LASAR Web application allows you to retrieve monitoring data from the Laboratory Analytical Storage and Retrieval (LASAR) database. In the LASAR Web Application you will have the option to search for sampling data via an Interactive Map, or search by a combination of criteria from Geography, Stations, Subprojects, Sampling Cases, Parameters/Analytes or Dates to generate a results set.

7/19/06 - Upgraded to Lasar Web v 1.33. See the linked report for changes.

1. Select Data Type: Grab and Continuous

2. Search for Sampling Data By

- A Map

or Select Multiple Criteria - Start with

- Geography
- Stations
- Subprojects
- Sampling Events (Cases)
- Parameters/Analytes
- Dates

Additional Information

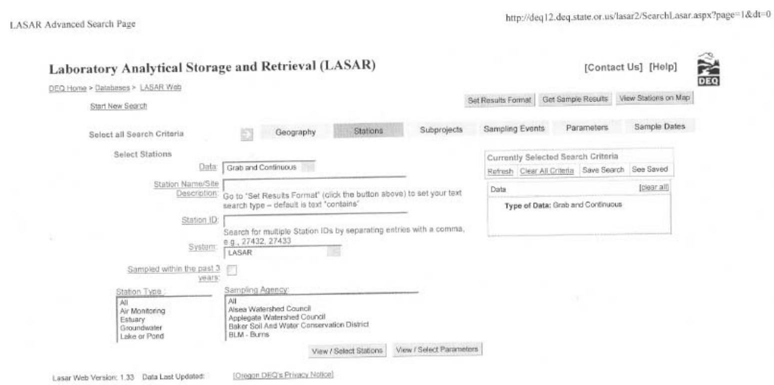
Lasar Web Help file

Oregon DEQ Laboratory Page

For LASAR application or data specific questions or comments contact lasarhelp@deq.state.or.us.

Lasar Web Version: 1.33   Data Last Updated: [Oregon DEQ's Privacy Notice]

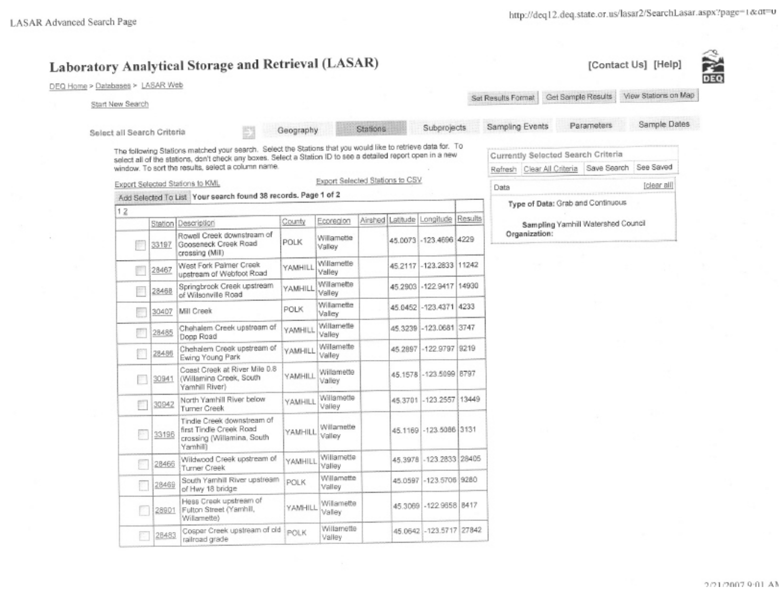
Select Data Type: **Grab and Continuous**
Multiple Criteria, start with: **Stations**
You will now be taken to the next screen:



Find *Sampling Agency*: and locate **Yamhill Watershed Council**

click **[view/select stations]** button

A list of our sites will appear.


LASAR Advanced Search Page http://deq12.deq.state.or.us/lasar2/SearchLasar.aspx?page=1&dt=0

Laboratory Analytical Storage and Retrieval (LASAR) [Contact Us] [Help]

DEQ Home > Databases > LASAR Web

Start New Search

Set Results Format | Get Sample Results | View Stations on Map

Select all Search Criteria | Geography | Stations | Subprojects | Sampling Events | Parameters | Sample Dates

The following Stations matched your search. Select the Stations that you would like to retrieve data for. To select all of the stations, don't check any boxes. Select a Station ID to see a detailed report open in a new window. To sort the results, select a column name.

Export Selected Stations to KML | Export Selected Stations to CSV

Add Selected To List **Your search found 38 records. Page 1 of 2**

1 2

	Station	Description	County	Ecoregion	Airshed	Latitude	Longitude	Results
☐	33197	Rowell Creek downstream of Gooseneck Creek Road crossing (Mill)	POLK	Willamette Valley		45.0073	-123.4696	4229
☐	28467	West Fork Palmer Creek upstream of Webfoot Road	YAMHILL	Willamette Valley		45.2117	-123.2833	11242
☐	28468	Springbrook Creek upstream of Wilsonville Road	YAMHILL	Willamette Valley		45.2903	-122.9417	14930
☐	30407	Mill Creek	POLK	Willamette Valley		45.0452	-123.4371	4233
☐	28485	Chehalem Creek upstream of Dopp Road	YAMHILL	Willamette Valley		45.3239	-123.0681	3747
☐	28486	Chehalem Creek upstream of Ewing Young Park	YAMHILL	Willamette Valley		45.2897	-122.9797	9219
☐	30941	Coast Creek at River Mile 0.8 (Willamina Creek, South Yamhill River)	YAMHILL	Willamette Valley		45.1578	-123.5099	8797
☐	30942	North Yamhill River below Turner Creek	YAMHILL	Willamette Valley		45.3701	-123.2557	13449
☐	33196	Tindle Creek downstream of first Tindle Creek Road crossing (Willamina, South Yamhill)	YAMHILL	Willamette Valley		45.1169	-123.5086	3131
☐	28466	Wildwood Creek upstream of Turner Creek	YAMHILL	Willamette Valley		45.3978	-123.2833	28405
☐	28469	South Yamhill River upstream of Hwy 18 bridge	POLK	Willamette Valley		45.0597	-123.5706	9280
☐	28901	Hess Creek upstream of Fulton Street (Yamhill, Willamette)	YAMHILL	Willamette Valley		45.3069	-122.9658	8417
☐	28483	Cosper Creek upstream of old railroad grade	POLK	Willamette Valley		45.0642	-123.5717	27842

Currently Selected Search Criteria

Refresh | Clear All Criteria | Save Search | See Saved

Data [clear all]

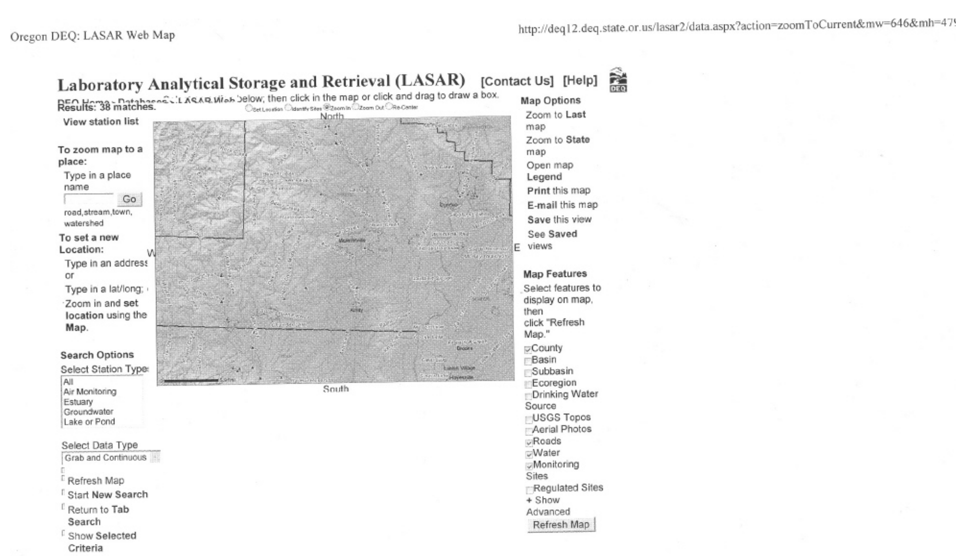
Type of Data: Grab and Continuous

Sampling Organization: Yamhill Watershed Council

To see the data associated with a site click on the station number, another window will open with a list of data sets associated with that site. To view the data, you can click on [View All Station Data] or on an individual sample set of data (click on the count).

NOTE: If there is temperature data for the site you might want to be selective of what to view. There is a count of how many data points there are and that relates to how long it will take to load the data. So if you are asking to view a large data set be patient.

If you click on the [View Stations on Map] you will be taken to the interactive map.



You will see triangles of the different monitoring sites. If you set "identify sites" at the top of the map, you can then click on any of the triangles to get more information about that site and data associated with it.

Note: If you select **A Map** at step 2 on the first screen, then a map of Oregon appears. You should set the "Subbasin" on (right side of map) and "Zoom in" (top of map) then click on Yamhill county several times. There will be triangles of different colors identifying different types of monitoring that is going on in the basin. By setting "Identify sites" (top of map) then clicking on one of the triangles you can get information on the sample site, including who is sampling and what is being sampled. Kind of interesting if you have the time to poke around. You can always limit the number of triangles that you see by selecting "Start new search" on the bottom left of the map. It will then take you to the above set of screens.