3 – Water Quality

Overview

This section summarizes water quality in the subwatersheds within the SWMACC District based on a review of existing environmental monitoring data and reports. In order to evaluate stressors and responses throughout the watersheds, available water quality data were compared to water quality criteria set by the Oregon Department of Environmental Quality (DEQ). This section provides an initial analysis of existing water quality monitoring data and makes preliminary comparisons to conditions in contributing subwatersheds. Further analysis of the contributing areas and WES management activities in these areas will be performed during the watershed assessment phase.

Data Reviewed

This analysis consisted of evaluating existing data, reports, and modeling results. Key data sources are listed below:

- Tualatin Subbasin Total Maximum Daily Load (TMDL) – DEQ ,2001
- Brown and Caldwell, Task 2 for work order 3, Environmental Data Analysis
- WES 2008-2009 Water Quality and Flow Monitoring Report
- USGS Gage 14207200 Tualatin River at West Linn OR – Water quality monitoring data
- Metro RLIS GIS Data – Watersheds, streams, roads
- Washington County Soil and Water Conservation District – Lower Tualatin Watershed Analysis
- Macro Invertebrate Data (WES 1999, and ABR 2000 and 2010 reports)

Watershed Conditions

Water quality conditions in the Tualatin River Basin have been poor for some time. These water quality conditions are a product of human activities (land uses, land practices, etc) and geography (slopes, soils, vegetation, etc) across the entire watershed. The SWMACC District is located in the lower portion of the Tualatin River basin and consists of only 2 percent of its area (**Figure 1**). The District includes only the last 7-3/4 miles of the Tualatin River main stem. The geographic location of the District limits its ability to affect water quality conditions in the main stem. These conditions may, however, effect subwatershed-specific actions. Therefore, this section discusses water quality in the District by briefly describing water quality criteria for the Tualatin River watershed and water quality conditions in the main stem Tualatin River but the main focus of the discussion is on water quality conditions in the Tualatin River tributaries within the SWMACC District.

Water Quality Criteria

As early as the 1970s the Tualatin River was identified as “water quality limited” in accordance with the Clean Water Act (CWA). Water quality limited streams are those that do not meet established water-quality standards even after the implementation of standard technology to control point source discharges. Once a river has been designated water quality limited, the CWA requires that total maximum daily loads (TMDLs) be developed for that water body to meet the established water-quality standards. A TMDL study determines the total amount of a pollutant (from all point and non-point sources) that can enter a specific water body without violating the water quality standards.

In the 1970s, the main sources of pollution in the Tualatin River basin were four wastewater treatment plants (WWTP): Durham, Rock Creek, Hillsboro, and Forest Grove. All four WWTPs discharged high concentrations of ammonia and phosphorus into the main stem of the Tualatin River but the Hillsboro and Forest Grove WWTP did not discharge into the Tualatin River during the summer months. The high ammonia concentrations often caused significant in-river nitrification during the summer, resulting in a high oxygen demand and low dissolved oxygen (DO) concentrations downstream of the plants. In addition, large populations of phytoplankton thrived in the main stem during the summer; the algal blooms and subsequent population crashes contributed to violations of the State of Oregon minimum DO standard, maximum pH standard, and action level for nuisance algal growth (Rounds 2010).

In 1988, DEQ developed the first TMDL on the Tualatin River for ammonia and total phosphorus. The ammonia TMDL was written to address problems with low DO, while the total phosphorus TMDL was written to address problems with nuisance algal growth and the resultant high pH in the main stem from RM 3.4 to 24. This TMDL had both a point source and non-point source component. In terms of point sources the WWTPs upgraded their removal capacity of total phosphorus. The non-point source component focused on Designated Management Agencies (DMA), which included Clackamas County, implementing Best Management Practices (BMPs) that reduced the total phosphorus (DEQ 2001).

In 2001 the TMDL for the Tualatin River Watershed was revised based on additional water quality testing. The 2001 TMDL revised the phosphorus and ammonia TMDLs and developed additional TMDLs for temperature, bacteria, DO, volatile solids, chlorophyll a and pH (DEQ 2001).

Table 3-1 lists key DEQ water quality standards. OAR 340-041 water temperature criteria Figures 340A and 340B designate the lower Tualatin River Watershed to be salmon and trout rearing and migration habitat with salmon and steel head spawning use occurring in Fanno Creek from January 1 to May 15.

Table 3-1: Key DEQ water quality standards for the Tualatin River.

Parameter	DEQ Standard	Units	Comment
Minimum Dissolved Oxygen (DO)	6.5	mg/L	mg=milligram, L=liter
Bacteria (30 day log mean)	126	E. coli/100 ml	No single sample to exceed 406, ml=milliliter
Temperature (7 day average max)	64.4	^{o}F	55.4 during spawning periods,
pH	6.5-8.5		
Nuisance Algal Growth	15	µg/L	Chlorophyll a, µg =microgram
Total Phosphorus (main stem)	0.09 – 0.11	mg/L	
Total Phosphorus (tributaries)	0.04 - 0.19	mg/L	

DEQ administers several different water quality standards for temperature. The applicable temperature standard varies depending on the watershed, aquatic species, and the time of year. The temperature standard listed in **Table 3-1** is applicable throughout most of the watersheds within the District. However, during salmon and steelhead spawning season (January 1 to May 15) the standard is 55.4 ^{o}F in Fanno Creek.

The 2001 TMDL identified several factors within the watershed which may contribute to exceedances of these water quality standards. Potential factors are listed below:

- DO – High ammonia and volatile solid concentrations in point and non-point sources further discussed below. Decomposition of organic matter in water increases the carbonaceous biochemical oxygen demand (CBOD) within the water column. Respiration of zooplankton and

algal species such as Chlorophyll a as well as decomposition of algal detritus. Increased water temperatures will also reduce the amount of oxygen in water by decreasing its solubility and increasing the rate of nitrification and the decay of organic matter.

  - Ammonia – High ammonia concentrations cause nitrifying bacteria to use large amounts of DO to convert ammonia into nitrite and nitrate. Summer discharges from the Durham and Rock Creek WWTPs. Other sources of ammonia were considered to be relatively insignificant.
  - Settleable Volatile Solids – Solids that are at least partially composed of organics entering the water body through bank erosion or near stream erosion, discharges, and surface runoff which may or will settle to the streambed. Decomposition of solids in sediments that contain organics increases the sediment oxygen demand (SOD).

- Bacteria – Effluent from wastewater treatment plants, sanitary sewer systems, failing septic systems, and confined animal feeding operations throughout the watershed. Direct deposition into surface waters by birds and other animals as well as illegal dumping of wastes to storm sewer system or directly into surface waters.
- Temperature – Point source effluent with high temperatures, increased solar radiation as increased levels of sunlight reach the stream surface due to decreased riparian zone vegetation. Other factors include channel morphology, hydrology, climate, and geographic location.
- pH – High phosphorus concentrations from point and non-point sources increase algal growth which in turn elevate pH values.
  - Nuisance Algal Growth – Phosphorous concentrations are the main cause of algal growth. Other factors include low velocities and warm temperatures.
  - Phosphorus – Naturally occurring phosphorus concentrations in the groundwater add to the phosphorus loading from the WWTPs.

NPDES Permits

The SWMACC's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit covers the portion of the City of Rivergrove which lies within Clackamas County and the unincorporated portions of the District within the Portland metropolitan area's urban growth boundary (**Figure 4**) that drain to the SWMACC or County-owned surface discharging storm sewer system. Areas drained by drywells and privately owned storm sewers are mot regulated by the MS4 permit..

Tualatin River Main Stem

Water quality in the main stem Tualatin River was studied extensively as part of the 1998 and 2001 TMDL studies. The following is a brief summary of the water quality conditions within the lower Tualatin River watershed.

DO levels in the lower Tualatin River (between RM 39 to 3.4) have been a concern since the original 1998 Tualatin River TMDL was created. Critical DO levels on the main stem Tualatin River generally occur in late summer and early fall. DO data, taken from 1976 to 1995 at USGS gage 14207500 (at the mouth of the Tualatin River), dropped down to 5 to 7 mg/L during July and August sampling. More recent average daily DO levels, taken at USGS gage 14206800 (RM 9.9), from July 2009 to October 2009 ranged from 4.61 mg/L on August 19 to 6.77 mg/L October 4. The minimum DO level (6.5 mg/L) was

routinely exceeded throughout this period. Algal blooms in this area are a major contributing factor to the low DO levels recorded.

Excessive algal growth (specifically chlorophyll a alga) and resulting pH criterion violations are most likely to occur during the summer months. The lower main stem of the Tualatin River from RM 3.4 (the LOC dam) to RM 33.3 (Farmington Road) routinely exceeds the action level for nuisance algal growth (DEQ 2001). This same reach has historically been listed as water quality limited due to high pH values. It has since been removed from the 303 (d) listing for pH. The last year that experienced any significant pH violations associated with algal blooms was in 1995 (DEQ 2001). It appears that the control of phosphorus (from both point and non-point sources) and increased flow augmentation has lead to a significant reduction in pH violations.

The 2001 TMDL states that the bacteria levels in the Tualatin River are close to meeting the water quality standard. However, at almost every sample location, samples are still collected on a periodic basis that exceeded 1000 E.coli per 100 ml. In addition at several sample locations the standard is exceeded more than 10 percent of the time.

The Tualatin river experiences prolonged warming with maximum temperatures typically happening during the high ambient air temperatures and low river flows occurring in July and August. Water temperature data, taken from 1974 to 1995 at USGS gage 14207500 (at the mouth of the Tualatin River), routinely reached 68 to 75 ^{o}F during these months. These values are high enough to induce cold water fish mortality in a matter of days to weeks. Temperatures that induce cold water fish mortality are shown in Table 3-2.

Table 3-2: Modes of Thermally Induced Cold Water Fish Mortality (DEQ, 2001).

Modes of Thermally Induced Fish Mortality	Temperature Range (^{o}F)	Time Till Death
Instantaneous Lethal Limit	>90	Instantaneous
Incipient Lethal Limit	70 – 77	Hours to Days
Sub-Lethal Limit	64 – 74	Weeks to Months

Exceedances of water quality criteria for arsenic, iron, and manganese are common throughout the Tualatin River Watershed. It appears that arsenic, iron and manganese are mobilized in Tualatin River groundwater due to their natural presence within local alluvial deposits. The USGS concluded that regional patters of arsenic occurrence in the Tualatin River are not consistent with either industrial or agricultural sources (DEQ 2001).

SWMACC District Tributaries

The Tualatin River tributaries within the SWMACC District (**Table 2-1**) have not been identified as being water quality limited. WES has routinely monitored the water quality of many of these tributaries for a period of time in the years since June 1996. The locations of these monitoring stations are shown in **Figure 4**. **Table 3-3** further describes the location of these water quality sampling sites.

Table 3-3: SWMACC District Water Quality Sampling Location Descriptions (see Swanson Table)

Site ID	Location Description
1	Fields Creek at SW Elderberry Lane
2	Unnamed Tributary 2 at Ribera Lane
4	Athey Creek at SW Borland Road
5	Saum Creek at SW Halcyon Road
9	Data included in B&C report we need a Location and GIS Point
11	Pecan Creek at SW Mossy Brae Road
12	Shipley Creek at SW Shadow Wood Drive
13	Wilson Creek at SW Long Farm Road
15	South Rock Creek at Morgan Road
201/Childs Outfall	Outfall at SW Childs Road and SW Terry Road
202/ Brookman Outfall	Outfall at SW Brookman Road

The water quality sampling data from these locations is based on site-specific information and provides a good basis for watershed characterization. However there are some limitations associated with this information:

- The data from grab samples represents conditions during a specific snapshot in time. Ambient water quality can vary considerably within short periods of time, especially during storm events.
- A wide variety of factors in the watershed affect water quality such as the location of impervious surfaces, land uses and practices, air deposition of pollutants, vegetation, channel stability, as well as BMPs within the watershed.

Brown and Caldwell Task 2 Environmental Data Analysis

In 2008 Brown and Caldwell (B&C) conducted a water quality trend analysis on samples taken at Sites 1, 2, 4, 5, 11, 12, and 13 from 1996 to 2008 for the County. This trend analysis examined wet season (November through April) data sets for the following parameters: ammonia, E.coli, nitrate, orthophosphate, total phosphorus (TP), and total suspended solids (TSS). The results of this analysis are summarized below:

- Mean TSS concentrations were highest in Shipley Creek (approximately 15 mg/L). The highest single sample concentrations occurred in Unnamed Tributary 2 (approximately 2,400 mg/L), Saum Creek (approximately 670 mg/L) and Shipley Creek (approximately 900 mg/L). Trend analysis determined that TSS concentrations in Pecan Creek are on an upward trend. This trend could be poorly managed runoff from logging on forest land and new development in urban areas, increased traffic on streets, and poor land management practices. Pecan Creek is not heavily developed with only 5 percent impervious area. Land use in the watershed includes 23 percent residential, 15 percent farmland, and 11 percent forestland.
- Mean nitrate concentrations were highest in Unnamed Tributary 2 (approximately 2.75 mg/L), and Saum Creek (approximately 1.95 mg/L). Unnamed Tributary 2 also had the highest concentration sample of approximately 6 mg/L. The date and time of this sample was not indicated. Trend analysis indicated that nitrate concentrations in Athey and Pecan Creek are on an upward trend. These trends could be due to increased use of fertilizers, onsite septic systems, and land and animal practices. Athey Creek is approximately 10 percent impervious area. Land use in the watershed includes 30 percent residential and 19 percent farmland.

- Ammonia concentrations ranged from 0 to 0.3 mg/L in Site 9, Athey Creek and Saum Creek. Trend analysis determined that ammonia concentrations in Athey and Saum Creek are on a downward trend. Downward trends in the data indicate that the implementation of BMPs was affective.
- TP data for each site ranges greatly; the data is arranged in box plot format and the reviewers where not able to determine the mean concentrations at each site. The reviewers were able to determine that the mean TP concentrations at all sampling locations were below 0.12 mg/L, which is within the range of the Phosphorous standard for Tualatin River tributaries (0.04 to 0.19 mg/L). The highest single sample TP concentrations occurred at Unnamed Tributary 2 (approximately 5.3 mg/L), Athey Creek (Approximately 1.7 mg/L), and Shipley Creek (approximately 2.4 mg/L). Trend analysis determined that the TP concentrations in Athey Creek are on a downward trend.
- E. Coli sampling at all of the sites have multiple single samples that are greater than the 406 E. Coli per 100 ml. The highest bacteria sample being on the order of 6000 most probable number (MPN) per 100 ml occurred on Unnamed Tributary 2. This tributary also contained the highest mean E.Coli level which was approximately 200 MPN per 100 ml. The standard for E.Coli is based on a 30 day log mean, the data available in this study was not organized by time and the reviewers were not able to determine if the bacteria standard was exceeded. Trends in E.Coli sampling data were not found.
- Mean orthophosphate levels were highest in Shipley Creek (approximately 0.4 mg/L). Trends in the data were not found for Orthophosphate.

Datasets that do not exhibit a trend may indicate that water quality is not degrading or continuing to degrade despite continued development in the watershed.

The peak values discussed are extremes, some of which may have been caused due to equipment or operator error. However, these extremes coupled with the mean sample concentrations provide a basis for describing the water quality concentration levels that have been recorded throughout historical monitoring in District watersheds.

The B&C report mentions a Task 1 memo that discussed the available data for analysis. We would be interested to get a copy of it from the County. DO and temperature data in the SWMACC district were not analyzed in this study however, other documentation mentions routine temperature monitoring. The raw data for the SWMACC district monitoring sites would be useful for the next phase of this analysis. Additionally, water quality data for SWMACC District site 9 was provided but the location is not included in either the document or GIS water sampling location points provided by WES.

WES Assessment of Habitat Conditions and Invertebrate Assemblages in the Streams of the Lower Tualatin River Basin

In 1999, the County conducted a "habitat conditions and invertebrate assemblages" study on several subwatersheds within the SWMACC District. As part of the study single sample pH values, DO concentrations, and temperatures were taken at multiple locations throughout the tributaries. Data was taken from October of 1998 to the beginning of March 1999. **Appendix A** illustrates the results of the water quality sampling conducted in this report. These results are discussed below:

- Values for pH, both above and below the 6.5 to 8.5 standard, were found in all of the Tualatin River tributaries analyzed except Unnamed Tributaries 1 and 3. Specific values were not available, and the data was not grouped based on the DEQ pH standard.

- DO concentrations measured were primarily above the minimum 6.5 mg/L standard. Measurements in the upper watersheds of Unnamed Tributaries 2 and 4 as well as Pecan Creek indicate a potential exceedence, however the data range is rather broad from 6.1 to 8 mg/L.

This data only indicates the water quality at a single point in time at these streams and does not confirm a long term trend. Additional data over a longer period of time will need to be analyzed to further characterize the water quality in these streams.

WES 2008-2009 Water Quality and Flow Monitoring Report

The County monitors water quality on a routine and storm event basis within the SWMACC District. The annual water quality and flow monitoring report from 2008 to 2009 reported sampling from sites 2, 11, 12, 13, 201, and 202. Sampling at sites 201 and 202, which are outfalls, was only conducted during storm events. Water quality parameters discussed include temperature, pH, DO, nitrate, ammonia, total phosphorous, and bacteria. The results of this sampling are discussed briefly below:

- Temperature monitoring from July of 2008 indicated cool tributary temperatures with the coolest water temperature occurring at Shipley Creek and the warmest temperatures were recorded at Unnamed Tributary 2 at SW Ribera Lane. Storm event monitoring at outfalls 201 and 202 ranged from 42 to 55.4^{o}F.
- Most of the pH values that were collected during the reporting period were between 6.5 and 8.5 units. Five of the sites recorded pH values below the standard with the lowest being 5.4 in Unnamed Tributary 2 at SW Ribera Lane.
- DO concentrations collected during the reporting period were generally above the standard. During storm event monitoring on November 12, 2008, DO levels at the SW Brookman Road outfall (site 202) was 6.0 mg/L.
- Total phosphorous concentrations were highest in the tributaries during the December 2008 storm event sampling. The highest concentrations were found in Unnamed Tributary 2 at SW Ribera Lane (0.96 mg/L), Shipley Creek (0.52 mg/L), and at the SW Brookman Road Outfall (0.32 mg/L).
- E. Coli was sampled a total of nine times in the tributaries and three times in the outfalls during the 2008 to 2009 sampling period. The single sampling bacteria maximum standard of 406 E.Coli/100ml was exceeded twice in Unnamed Tributary 2 at SW Ribera Lane, five times in Pecan Creek and Shipley Creek, and three times at each outfall. **Table 3-4** summarizes the E.Coli sampling data.

Table 3-4. SWMACC District 2008 to 2009 E.Coli Sampling Summary

Sampling Location	Maximum Sample		Minimum Sample	
	Date	E.Coli (MPN/100ml)	Date	E.Coli (MPN/100ml)
2	12/29/08	866	4/20/09	10
11	12/29/08	1413	1/12/09	127
12	4/20/08	1300	1/12/09	23
13	11/12/08	365	4/20/09	10
201/Childs Outfall	12/29/08	>2419	3/15/09	980
202/ Brookman Outfall	11/12/08, 3/15/09	>2419	12/29/09	1120

This discussion will include more information on monitoring practices, and parameter sampling data in the next draft. Are historical annual water quality monitoring reports available dating back to 1994? If so we would like copies of these documents and any of the data that is available in excel format.

DEQ Tualatin River TMDL

Summarizing Fanno Creek water quality information from the TMDL to be discussed in the next draft.

Groundwater

Septic systems, sanitary sewers, and UICs to be discussed in next draft.

Data Gaps

The following are data gaps or deficiencies in existing information that limits our understanding of the water quality within the SWMACC District:

- Limited to no data is available for South Rock Creek, Unnamed Tributaries 1, 3 to 6, Tate Creek, and Ball Creek. Water quality sampling locations provided by WES show sampling site 15 on South Rock Creek. However, none of the documentation references site 15.
- Available bacteria, phosphorus, ammonia, nitrate, and TSS testing data used in the 2008 B&C report did not allow for a timescale to concentration analysis. Raw data used in this analysis would be useful for further analysis in the watershed action plan phase.
- Available pH, DO, and temperature data indicates the water quality at a single point in time at these streams and does not confirm a long term trend. Additional data over a longer period of time will need to be analyzed to further characterize the water quality in these streams.
- Raw sampling data from WES analyses and historic sampling reports would provide a more comprehensive analysis.

Water quality data gaps are generally focused on the need for longer term water quality data instead of single sample data from tributaries.

References and Bibliography

Brown and Caldwell 2008. Technical Memorandum 2 summarizing Task 2 for Work Order 3 Environmental Data Analysis. For Clackamas County WES.

Cole 2000. Assessment of Macroinvertebrate Communities of the Tualatin River Basin, ABR Inc, Unified Sewerage Agency and Tualatin River Watershed Council, 2000

DEQ 2001. Tualatin River Subbasin Total Maximum Daily Load (TMDL), Oregon Department of Environmental Quality, August 2001

Rounds 2010. PN356 Tualatin River Basin Water Quality Assessment, Oregon Science Center Active Projects. Viewed 6/30/10 at http://or.water.usgs.gov/projs_dir/pn356/pn356.html

WES 1999. Assessment of Habitat Conditions and Invertebrate Assemblages in the Streams of the Lower Tualatin River Basin. Water Environment Services, September 1999

WES 2008. MS4 NPDES Permit Stormwater Management Plan for Surface Water Management Agency of Clackamas County and the City of Rivergrove.

WES 2009. 2008-2009 Water Quality and Flow Monitoring Report for the Surface Water Management Agency of Clackamas County's Municipal Separate Storm Sewer System Permit #101348 and Tualatin TMDLS, October 2009

WES 2009. MS4 NPDES Permit Compliance Annual Report for Clackamas County Service District No. 1 (including the City of Happy Valley) and the Surface Water Management Agency of Clackamas County (including the City of Rivergrove) July 1, 2008 – June 30, 2009 & Tualatin Sub-basin TMDL Annual Report July 1, 2008 – June 30, 2009 & Willamette River TMDL Annual Report March 1, 2008 – June 30, 2009 (Appendix C Monitoring Results SWMACC)