CHAPTER 6
Water Quality: Tryon Creek Watershed

This chapter characterizes the water quality of the Tryon Creek Watershed. It includes:

- Background
- Water Quality Monitoring Program
- Water Quality Modeling
- Water Quality Assessment
- Modeling Results
- Summary

BACKGROUND

The Bureau of Environmental Services (BES) manages the public sanitary sewer collection and treatment facilities, monitors for water quality, and is responsible for the stormwater facilities located within Portland's portion of the Tryon Creek Watershed. BES is actively involved in the Tryon Creek Watershed Council and is working cooperatively with citizens, businesses, and other agencies to develop a Tryon Creek Watershed stewardship program.

Major BES milestones include development of the following documents:

- *Upper Tryon Creek Corridor Assessment (1997)* - This study consisted of a comprehensive assessment of the natural resources, channel conditions, and hydrology of the stream corridor upstream of Tryon Creek State Park including Tryon, Falling and Arnold Creeks.

- *Public Facilities Plan (1999)* – The 1999 Public Facilities Plan evaluated City facilities associated with storm and sanitary sewage service including treatment facilities. The plan identified system deficiencies and recommended projects.

In July 2000, BES initiated work on the comprehensive *Fanno and Tryon Creeks Watershed Plan.* The *Watershed Plan* will build on previous BES management efforts in the watershed, including addressing regulatory requirements of the Clean Water Act and the Endangered Species Act. (Tryon Creek is listed as water quality limited for temperature under Section 303(d) of the Clean Water Act.) The *Watershed Plan* will provide the technical/scientific basis for achieving and meeting specific watershed, stream, infrastructure, habitat, and water quality improvement and restoration objectives in the watershed. This water quality characterization is an important component of the *Watershed Plan.* (See the Introduction to this document for additional background information about the *Watershed Plan*.)

WATER QUALITY MONITORING PROGRAM

BES's water quality monitoring program is a key component of the water quality characterization and is the major source of available water quality data for the characterization.

BES's Water Pollution Control Laboratory provides sample collection, laboratory analyses, and flow monitoring services. The water quality monitoring program has five basic objectives:

- Determine recent and current water quality conditions to determine and compare compliance with water quality standards, criteria, TMDL limits, and support of beneficial uses.
- Determine general temporal trends in environmental conditions: increasing/ decreasing, improving/degrading.
- Determine the effectiveness of specific environmental management activities and initiatives (e.g., best management practices).
- Understand pollutant sources and the relationship between land uses and water quality.
- Comply with regulatory requirements for monitoring and reporting.

Key elements of BES's monitoring program for the Tryon Creek Watershed are described below:

Fixed-Station Water Quality Monitoring

BES has been monitoring instream water quality in Tryon Creek monthly since 1997. Initially, sampling was limited to one site located on the mainstem of Tryon Creek at SW Boones Ferry Road. This sampling site is located in the mid-part of the watershed, downstream from the major commercial and residential development. In December of 2004, two additional sampling locations were added in the upper Tryon Creek watershed where preliminary characterization analysis had identified priority areas for additional water quality data collection. These two sites are located on the mainstem of Tryon Creek upstream and downstream of the two major transportation corridors (Barbur Boulevard and I5 Freeway) in the watershed. Figure 6-1 and Table 6-1 show the three current sampling sites. Water quality analyses include 14 field and laboratory parameters as shown in Table 6-2.

Figure 6-1
Tryon Watershed Sampling Locations

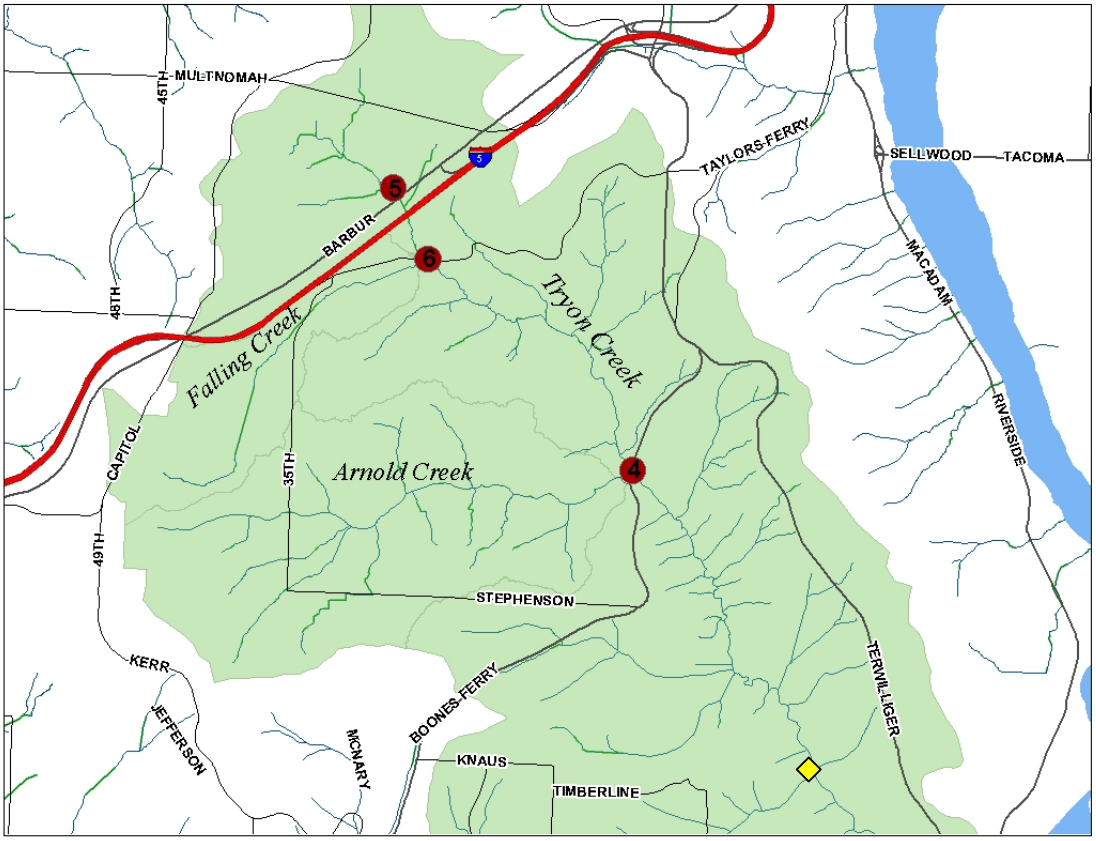


Table 6-1
Current BES Water Quality Monitoring Sites

Site	Description	Start	Frequency
4	Tryon Creek (10750 SW Boones Ferry Road)	8/19/97	Monthly
5	Upper Tryon Creek (SW 26 Way and Barbur Blvd.)	12/06/04	Monthly
6	Tryon Creek below Falling Creek (9323 SW Lancaster Road)	12/06/04	Monthly

Table 6-2
Water Quality Monitoring Summary for Tryon Creek

Parameter	Reporting Limit Units	Monitoring Frequency
Ammonia Nitrogen	1 mg/l	Monthly
Nitrate-Nitrogen	0.1 mg/l	Monthly
Nitrite–Nitrogen	0.01 mg/l	Monthly
Ortho Phosphorous	0.02 mg/l	Monthly
Total Phosphorous	0.03 mg/l	Monthly
Total Solids	1 mg/l	Monthly
Total Suspended Solids	1 mg/l	Monthly
E. *coli*	1 MPN/100ml	Monthly
Temperature[1]	Degrees Celsius	Hourly (May-Oct)
Dissolved Oxygen[1]	0.1 mg/l	Monthly
pH[1]	0.1	Monthly
Conductivity[1]	1 micro ohms/cm	Monthly
BOD5	2 mg/l	Monthly
Total Oil and Grease	5 mg/l	Monthly

[1]Field Meaurement

Temperature Monitoring

BES installed and has maintained a continuous temperature recorder during the summer season (May through October) since 1998 at the Boones Ferry Road sampling location. The temperature recorder provides hourly temperatures at this site. Additional temperature recorder installations are scheduled for the other two sampling locations beginning in summer 2005.

Flow Monitoring

Through a cooperative agreement with BES, the U.S. Geological Survey (USGS) has maintained a streamflow monitoring station on Tryon Creek near Nettle Creek in the lower Tryon Creek Watershed since 2001 (USGS Gage 14211315). (Further discussion of flow monitoring results can be found in Chapter 4, Hydrology: Tryon Creek Watershed).

Fanno–Tryon Storm Monitoring Project

To further characterize pollutant loads from different land uses, BES established four stormwater sampling sites in the Fanno Creek and Tryon Creek Watersheds that represent the predominant land use types in these watersheds: residential, multi-family residential, commercial, and transportation (highways). A total of four storms were sampled at these sites between September 2000 and January 2001.

Additional storm event monitoring is scheduled for the three fixed station sampling sites during 2005 and 2006.

Data and Reporting

All of the collected water quality data are stored electronically in BES' Janus water quality data base and are available for retrieval, analysis, and reporting.

The water quality and flow data collected through this monitoring are used to determine the existing status of water quality in relation to state water quality standards and criteria. The monitoring is also essential for watershed planning and to assess the impact of various management activities in the watershed.

WATER QUALITY MODELING

Hydrologic/hydraulic and water quality models have been developed for the Tryon Creek Watershed to characterize water quality by better understanding streamflows and pollutant loadings. The current characterization uses the following models:

- **MIKE SHE/MIKE 11 (DHI):** MIKE SHE and MIKE 11 are integrated surface and groundwater programs that can be used to simulate hydrology, hydraulics, upland pollutant loadings, and instream water quality. MIKE SHE is a hydrologic model that converts precipitation falling on the watershed into runoff. MIKE 11 is a hydraulic model that routes runoff generated by MIKE SHE through modeled stream or conveyance system segments.

- **GIS/GRID Model:** BES developed this GIS-based model to estimate potential pollutant loadings within the watershed, based on factors that include land use, topography, impervious area, vegetation, soil type, slope, and precipitation. The model uses the same 100foot by 100-foot grid areas used by the MIKE SHE/MIKE11 model as the basis for analysis.

WATER QUALITY ASSESSMENT

Tryon Creek and its tributaries within the City of Portland are small headwater streams located within an urban environment. They exhibit many of the characteristics typical of urban streams, which result from changes in hydrology and increased pollutant loadings from urban development. These characteristics include altered flow patterns and degraded water quality.

Point sources of pollution to Tryon Creek include two stormwater outfalls classified as major outfalls under the City's National Pollutant Discharge Elimination System (NPDES) stormwater permit: WCMS #3826 – 243D and WCMS # 3826-367D. Combined, these two outfalls drain an area of 368 acres (BES 1993) discharging directly into Tryon Creek at Interstate 5 and the Pacific Highway and constitute the entire flow from the upper part of the watershed . The City is required to calculate seasonal pollutant load, investigate illicit connections, and evaluate the need for pollution reduction facilities for stormwater mitigation. Based on land use, these two outfalls contribute about 48 percent of the total suspended solids (TSS) watershed entering Tryon Creek for both wet and dry seasons (as calculated by the NPDES stormwater program).

Nonpoint sources of pollution are managed through implementation of the City's NPDES stormwater permit. This includes tracking stormwater quality in the watershed through analyses of land use and best management practices (BMPs). BES has developed a priority pollutant

matrix for the Tryon Creek Watershed, based on a stormwater quality load model. The matrix lists priority pollutants from various land uses. Elevated temperature, nutrients, and TSS are listed as high-priority pollutants in the watershed. This matrix helps select appropriate BMPs and management strategies to address stormwater quality issues.

Previous studies have shown that the Tryon Creek Watershed is seriously compromised because the large woody material has been depleted. The continued removal of wood from stream channels to facilitate recreation and facility maintenance destabilizes the channel and causes degradation. Under these conditions, each high-water event flows unchecked downstream, surging from side to side, eroding the streambank, and preventing the reestablishment of vegetation needed to help restabilize the channel. The loss of wood from these streams also affects the transport and storage of sediments. Large wood functions to temporarily store sediments within the channel. It also functions to slow and back up water, forcing flows out onto the floodplain area where sediments settle out. These deposits provide sites for vegetation to establish (National Riparian Service Team 2001).

This water quality characterization evaluates the water quality in the Tryon Creek watershed from three perspectives:

- *Framework for Integrated Management of Watershed and River Health* guidelines
- Oregon water quality index
- Water quality standards/303(d) listed parameters

Framework Guidelines

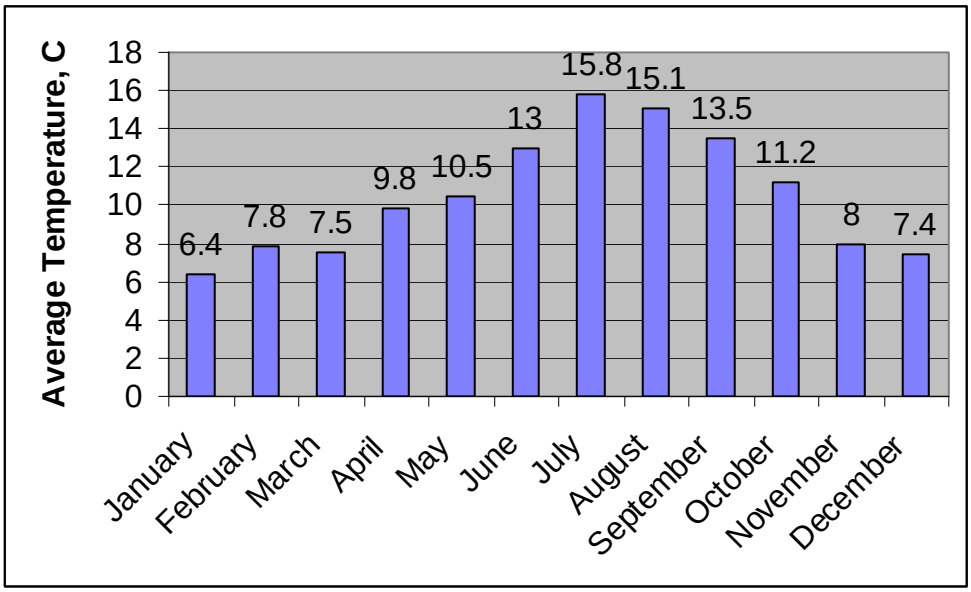
The City's Endangered Species Act (ESA) Program developed the *Framework for Integrated Management of Watershed and River Health* (Framework) in 2004. The *Framework* outlines scientific principles, four watershed health goals, and a process for developing and implementing watershed management plans. It identifies the following water quality indicators for evaluating watershed health:

- Temperature
- Dissolved oxygen
- Nutrients and chlorophyll a
- Total suspended solids
- Toxic contamination of water, sediment, and biota
- Groundwater quality
- 303(d) listed parameters
- Other parameters (as determined by the weight of evidence)

Specific watershed targets and metrics for evaluating these water quality indicators are currently being developed.

TEMPERATURE – Temperature is the only water quality indicator that does not currently meet water quality standards in the Tryon Creek Watershed. Figure 6.2 shows the average monthly temperatures based on the fixed station monitoring the Boones Ferry Road sampling location between 1997 and 2004.

Figure 6-2
Average Monthly Temperature[1]
Tryon Creek at Boones Ferry Road



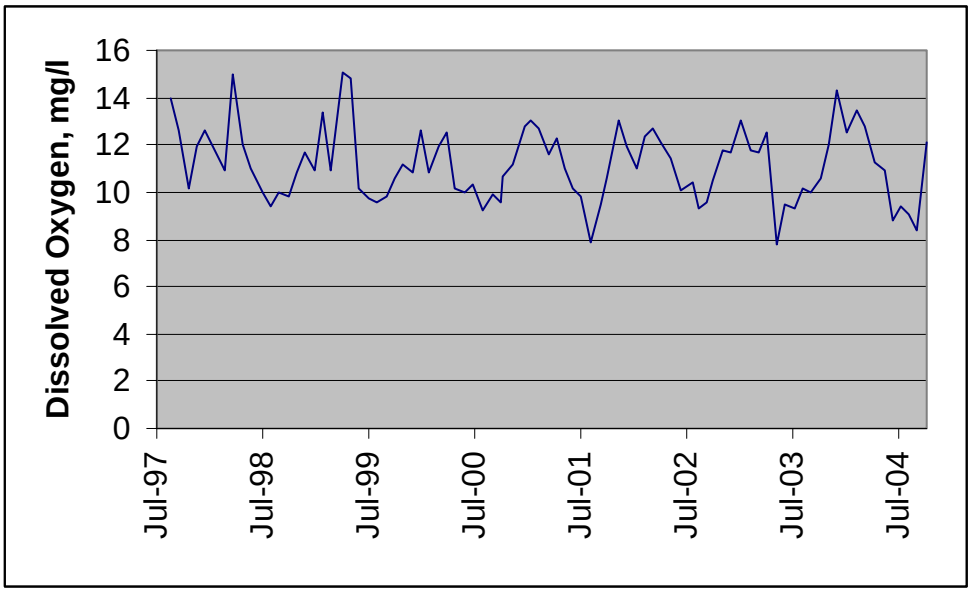
[1] Temperature data may not reflect maximum temperatures

The Figure shows the yearly cycle of instream temperatures with the solar radiation as the main source of heat resulting in maximum temperatures occurring during July and August. (Note: the displayed temperature data is summarized from the monthly ambient water quality monitoring at this site which was conducted at different times of day and therefore, does not represent the maximum instream temperatures).

A total maximum daily load (TMDL) for temperature is being developed. Temperature is discussed in more detail in the Water Quality Standards/TMDLs section, below.

DISSOLVED OXYGEN – Figure 6-3 shows results of monitoring of dissolved oxygen in Tryon Creek at the SW Boones Ferry Road sampling location. The dissolved oxygen concentrations reported meet the water quality criteria of 8.0 mg/l for cold-water aquatic life. The lowest dissolved oxygen concentrations occur during the late summer and are primarily the result of increased instream water temperatures.

Figure 6-3
Dissolved Oxygen Concentrations
Tryon Creek at SW Boones Ferry Road



NUTRIENTS and CHLOROPHYLL *A* - Nutrients have not been identified as a water quality concern in Tryon Creek. Figure 6-3 shows the results of total phosphorus monitoring at the Boones Ferry Road site. The highest total phosphorus concentrations are typically correlated with increased suspended solids concentrations as a result of storm events. The median total phosphorus concentration for all samples was 0.085 mg/l. For comparison, the target TMDL total phosphorus concentration in the Fanno Creek Watershed for both background and stormwater discharges is 0.13 mg/l.

Figure 6-4 shows the results of monitoring for nitrate-nitrogen (NO_3-Nitrogen) at the Boones Ferry Road site. The figure shows an annual cycle of nitrate concentrations with peak concentrations during the wet season (November – January) consistent with earlier studies in the Willamette Basin. (USGS 2003). It has been hypothesized that this is the result of flushing of nitrate from the shallow groundwater system as it becomes saturated in the winter.

Currently, there is no chlorophyll a data available for Tryon Creek.

Figure 6-3
Total Phosphorus Concentrations
Tryon Creek at Boones Ferry Road

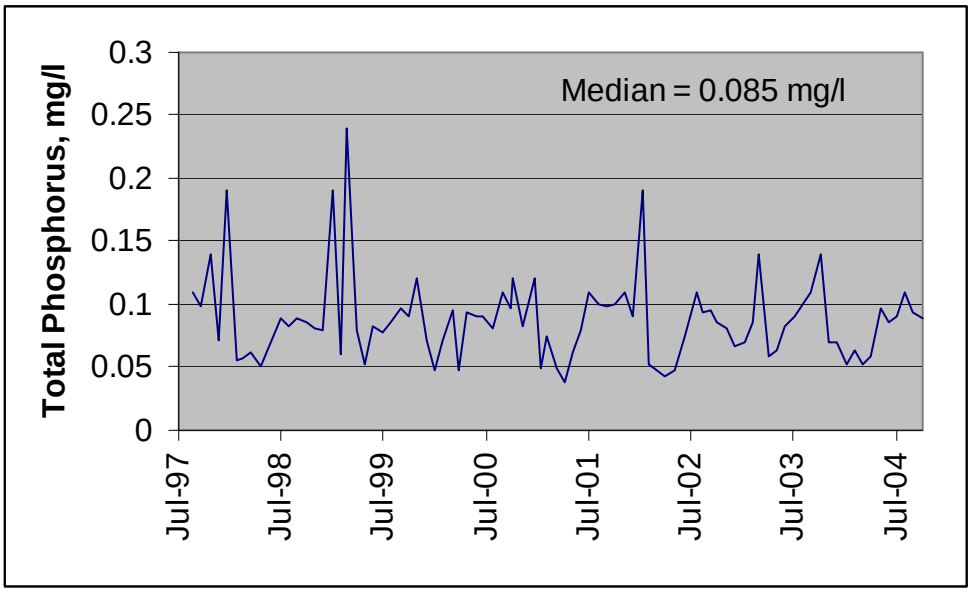
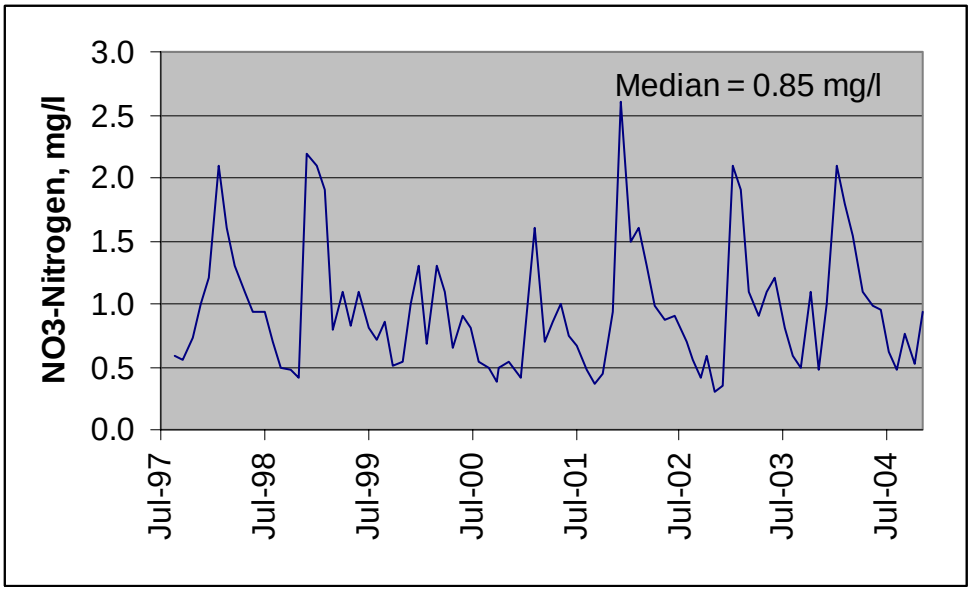
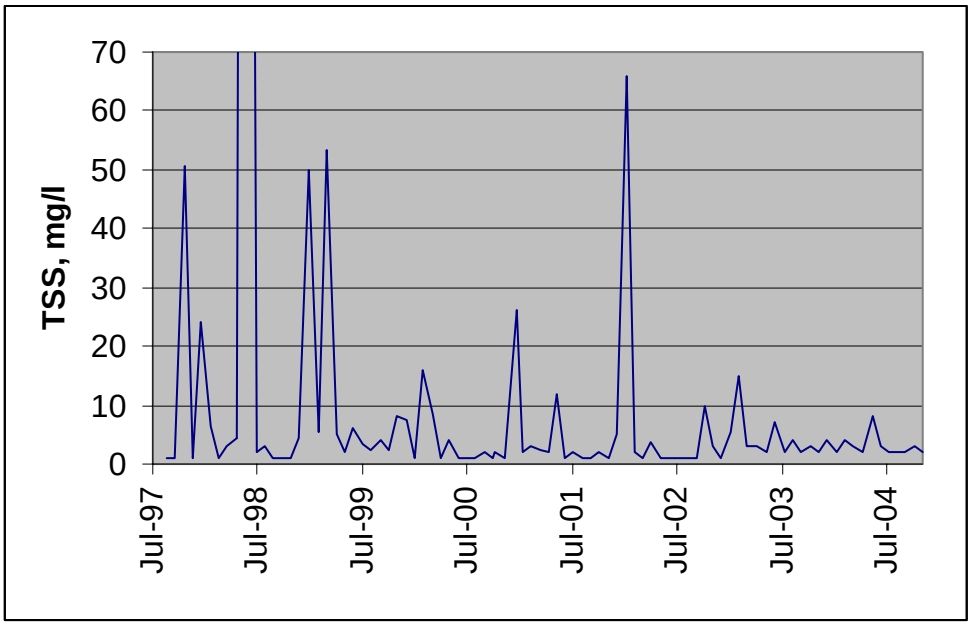


Figure 6-4
Nitrate-Nitrogen Concentrations
Tryon Creek at Boones Ferry Road



TOTAL SUSPENDED SOLIDS – Figure 6- 5 shows the results of monitoring for total suspended solids (TSS). The results show that the TSS concentrations are generally less than 5 mg/l except during storm events or extended wet periods when the total suspended solids (TSS) are elevated. There is no current water quality standard for TSS, but elevated TSS concentrations are a potential concern because many pollutants from urban areas are commonly associated with total suspended solids.

Figure 6-5
Total Suspended Solids
Tryon Creek at SW Boones Ferry Road



TOXICS - Toxics

Very limited water quality data are available for toxics in Tryon Creek or its tributaries. No data are currently available for organic contaminants (pesticides, herbicides, etc.). Available toxics data are limited to six metals that were sampled for three times in 1999 and early 2000 at the SW Boones Ferry Road site. Table 6-3 summarizes those monitoring results. It also shows the chronic and acute water quality criteria for the protection of aquatic life for the metals.

Table 6-3
Summary of Metals Concentrations
Tryon Creek at SW Boones Ferry Road

Parameter	Criteria		Sample Date		
	Acute	***Chronic***	***5/29/99***	***9/28/99***	***1/25/00***
Cadmium	1.8	0.66	<0.1	<0.1	<0.1
Chromium	980	120	0.93	0.42	1.59
Copper	9.2	6.5	1.49	8.73	2.55
Lead	34	1.3	0.85	0.77	1.13
Nickel	1,100	56	0.94	1.46	1.41
Zinc	180	180	6.64	11.6	11

Note: All concentrations in ug/l.

As shown, all samples met both the acute and chronic water quality criteria except a single sample that exceeded the chronic criterion for copper.

Very little data on toxics are currently available for the Tryon Creek Watershed. No toxic substances have been identified as exceeding water quality standards at this time. It should be noted that there are no current data on potential toxic organic pollutants such as pesticides or herbicides.

Based on the above findings, it is reasonable to assume that the existing water quality conditions in the Tryon Creek Watershed are causing some impairment of watershed health. This impairment can be further quantified when the appropriate targets and metrics are developed for the water quality indicators.

Oregon Water Quality Index

The Oregon Department of Environmental Quality (DEQ) initially developed the Oregon Water Quality Index (OWQI) in the 1970s. The OWQI methodology was further updated to its current form in 1995 to reflect advances in the knowledge of water quality and in the design of water quality indices. The purpose of the OWQI is to improve the understanding of water quality issues by integrating complex data into a single index score, which can be used to describe water quality status and to evaluate water quality trends (Cude 2000).

DEQ developed the OWQI to assess data collected through DEQ's Ambient River Water Quality Monitoring Network, with an emphasis on general recreational uses (fishing and swimming). As such, the OWQI is a general index of water quality and cannot be used to determine the quality of water for specific uses. It also should not be used to provide definitive information on water quality without considering all appropriate chemical, biological, and physical data (Cude 2000). The strengths of the OWQI, as well as other water quality indexes, are their use for comparing water quality among different locations and for assessing long-term trends.

DEQ and others have widely used the OWQI to report water quality status and trends in Oregon. The OWQI is currently included as a benchmark for Willamette River water quality in the City of Portland's annual Service Efforts and Accomplishments (SEA) Report report. BES incorporated the OWQI into its water quality monitoring program for the Tryon Creek Watershed in 1997.

The OWQI is calculated by integrating the measurement of eight water quality variables:

- Temperature (Temp)
- Dissolved oxygen (DO)
- Biochemical oxygen demand (BOD)
- pH
- Total solids (TS)
- Ammonia + nitrate nitrogen (NH3/NO3)
- Total phosphorus (TP)
- Fecal coliform (FC)

The OWQI is determined by first using a series of algorithms and equations to calculate a unit-less subindex value for each water quality variable. The individual subindex values are then aggregated into the overall index value (OWQI) based on an "unweighted harmonic square mean" of the subindex values. An index score of 100 corresponds to the highest water quality, and a score of 10 represents the poorest water quality. In addition, DEQ has established a descriptive narrative scoring system, ranging from very poor (0-59) to excellent (90-100).

Table 6-4 and Figure 6-6 show the OWQI and associated subindex values for the individual parameters. As shown, the overall OWQI for Tryon Creek at SW Boones Ferry Road is 74. Based on DEQ's descriptive scoring system, this would correspond to a "poor" water quality rating. As shown on Figure 6-7, however, this score is higher than the scores of other local urban streams, such as Fanno Creek and its tributaries.

Table 6-4
Oregon Water Quality Index Summary for Tryon Creek

	Mean Subindex Values								**Overall**	WQ
Location	NO3/NH3	TP	BOD5	TS	FC	DO	pH	Temp	**OWQI**	Rating
Tryon Cr	66	74	82	66	76	99	96	99	74	Poor

Notes:
Results of BES monthly ambient water quality sampling since 1997
Index Ranking: 0-59 Very Poor, 60-79 Poor, 80-84 Fair, 85-89 Good, 90-100 Excellent

The subindex results show that major factors lowering the overall OWQI include elevated nutrients (total phosphorus, nitrate, and ammonia nitrogen), total solids, and bacteria (fecal coliform).

Figure 6-6
Oregon Water Quality Index
Tryon Creek at SW Boones Ferry Road

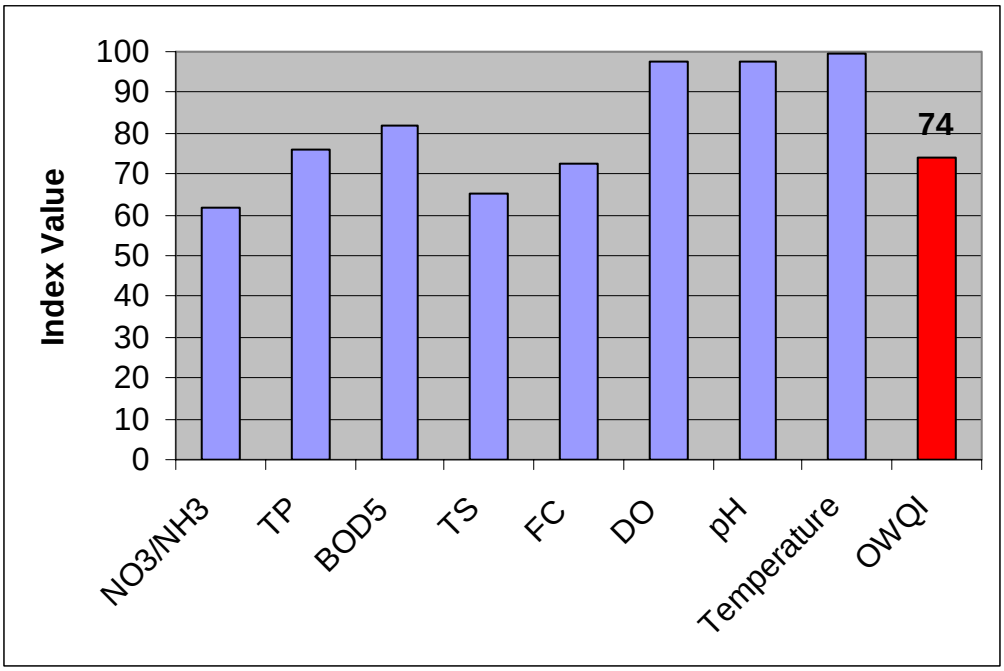
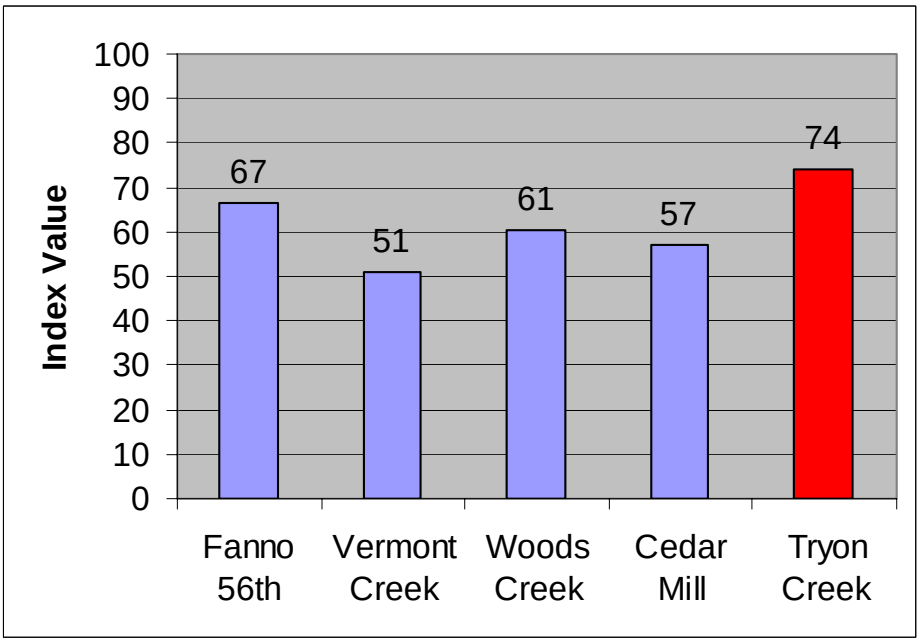


Figure 6-7
Oregon Water Quality Index
Local Urban Streams



Water Quality Standards/TMDLs

Designated Beneficial Uses

Pursuant to Oregon Administrative Rules (OAR), the Oregon Water Resources Commission establishes the beneficial uses of waters of the state. DEQ has identified Tryon Creek as waters of the state, with all designated beneficial uses applicable. Table 6-5 shows the designated beneficial uses for Tryon Creek.

Table 6-5
Tryon Creek Listed Beneficial Uses

Beneficial Uses	Tryon Creek
Public Domestic Water Supply	X
Private Domestic Water Supply	X
Industrial Water Supply	X
Irrigation	X
Livestock Watering	X
Anadramous Fish Passage	X
Salmonid Fish Rearing	X
Salmonid Fish Spawning	X
Resident Fish and Aquatic Life	X
Wildlife & Hunting	X
Fishing	X
Boating	X
Water Contact Recreation	X
Aesthetic Quality	X
Hydro Power	X
Commercial Navigation & Transportation	X

Water Quality Standards

Water quality standards and criteria that apply to the Willamette River Basin also apply to Tryon Creek and its tributaries. These standards are described in detail in OAR 340-041-0442. The standards are in place to protect the designated beneficial uses in the basin, including Tryon Creek. Table 6-6 lists the water quality standards and criteria for Tryon Creek.

Table 6-6
Water Quality Standards and Criteria in Tryon Creek Watershed

Parameter	Water Quality Standard	Criteria/Comments
Dissolved Oxygen (DO)	At least 8.0 mg/l	Cold water aquatic life.
	At least 90% saturation	If climate preclude attainment of 8.0 mg/l.
	At least 11.0 mg/l	Active salmonid spawning areas.
Temperature	18° C (64.4° F) maximum	Salmon and trout rearing and migration..
	13° C (55.4° F) maximum	Salmon and steelhead spawning.
Turbidity	Maximum of a 10% cumulative increase (NTU)	Relative to a control point immediately upstream of activity
pH	6.5 – 8.5	All other basin waters except Cascade lakes
Bacteria (E. *coli*)	126 organisms per 100 ml.	Based on a minimum of 5 samples
	406 organisms per 100 ml.	Maximum for any single sample
Dissolved Gases (CO_2, H_2SO_4, etc.)	No sufficient quantities allowed to cause objectionable odors	Objectionable odors are deleterious to aquatic life, navigation, or recreation
Development of Fungi	No sufficient quantities allowed	No deleterious effects on stream bottoms or aquatic life, or effects that are injurious to health, recreation, or industry
Total Dissolved Solids	100 mg/l	Willamette River and tributaries
Toxic Substances	No exceedence of natural background levels No exceedence of criteria listed in Table 20 from EPA	In waters of the state if amounts, concentrations, or combinations are harmful As published in *Quality Criteria for Water* (1986)

Temperature

Tryon Creek was listed on the State of Oregon 303(d) list in 1998 as water quality limited for temperature, based on exceedances of the 17.8^0 C (64^0 F) temperature standard for the protection of salmonid fish rearing and anadramous fish passage during the summer period. (Oregon water quality standard for temperature was revised in 1994 as shown in Table 6.6). Temperature Table 6-7 summarizes the 303(d) listing.

The listing included Tryon Creek between river miles 0 and 5 including the Nettle, Arnold and Falling Creek tributaries. As described previously, BES has maintained a continuous temperature recording monitor at the SW Boones Ferry Road site (at approximately river mile 2.5) since 1998 during the summer period.

Table 6-7
Summary of Tryon Creek 303(d) Listing for Temperature

Waterbody	Tryon Creek
River Mile	0 – 5
Parameter	Temperature
Criteria	Rearing, 17.8^0 C
Season	Summer
Status	303(d) list[1]
Sample Matrix	Water column
List Date	1998
Beneficial Uses	Salmonid fish rearing Anadramous fish passage

[1]Draft Willamette Basin TMDL, September 2004

Figure 6- shows the results of BES temperature monitoring at the SW Boones Ferry Road site for summer periods from 1998 through 2002. The monitoring results are consistent with the 303(d) listing and show that the 7-day average of the daily maximum temperatures frequently exceeds the water quality standard of 18.0^0 C during the summer period. As summarized in Table 6-8, maximum summer-period daily temperatures ranged from 20.0^0 to 21.9^0 C, and the 7-day average temperatures exceeded the standard from 25 to 42 days each summer.

Figure 6-8
7-Day Average of Daily Maximum Temperatures
Tryon Creek at SW Boones Ferry Road

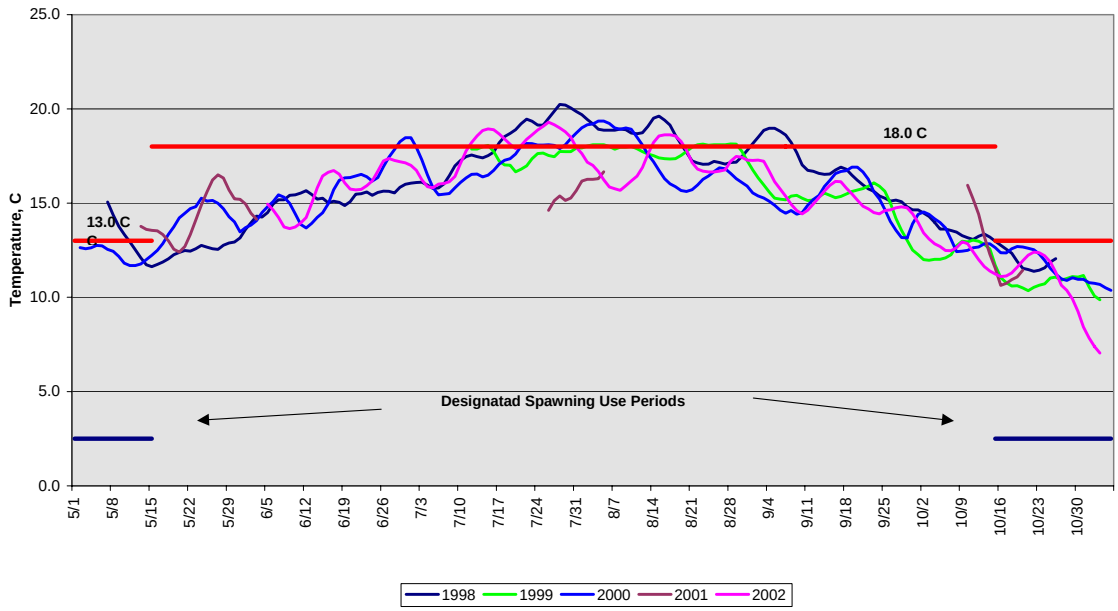


Table 6-8
Summary of Summer Instream Temperature
Tryon Creek at SW Boones Ferry Road

	Year				
	1998	1999	2000	2001	2002
Maximum day	21.9	21.1	20.3	Insufficent	20.0
Maximum 7-day average	20.2	18.1	19.4	data[1]	19.3
Number of days > 18.0^0	42	25	28		27

[1]Equipment malfunction

Figure 6-8 also shows the temperature standard of 13.0^0 C for the protection of salmonid spawning, incubation, and fry emergence for the applicable time periods.

Bacteria (*E. coli)*

The water quality standard for *E. coli* bacteria is established to protect the beneficial use of water contact recreation. The water quality standard for bacteria states that organisms of the coliform group commonly associated with fecal sources shall not exceed:

a. A 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five samples.

b. No single sample shall exceed 406 *E. coli* organisms per 100 ml.

Figure 6-9 shows the seasonal *E. coli* concentrations for Tryon Creek at SW Boones Ferry Road. The *E. coli* concentrations are from the total of 67 grab samples collected at this sampling location between 1997 and 2002. As shown , the single sample criteria of 406 *E. coli* organisms/100 ml is exceeded at times. This is consistent with monitoring results from other urban streams within Portland. Most of the exceedances of the standard are during periods of precipitation and increased streamflows. The frequency of sampling is not great enough to assess compliance with the standard of 126 *E. coli* organisms/100 ml based on a geometric mean of five consecutive samples.

Figure 6-9
***E. coli* Concentrations**
Tryon Creek at SW Boones Ferry Road
1997-2002

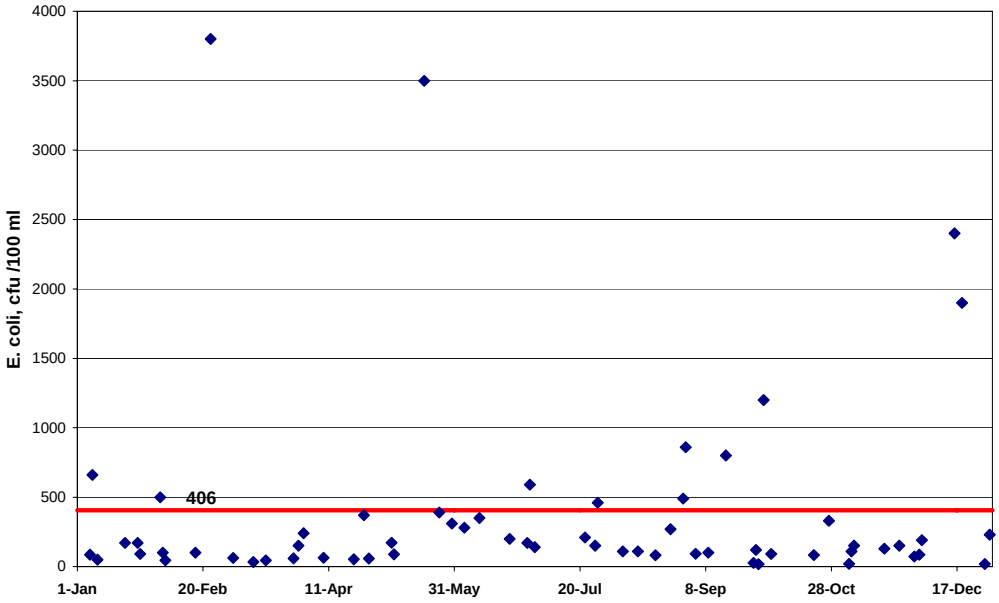


Table 6-9 summarizes the results of *E. coli* monitoring in the Tryon Creek Watershed. It includes results from the routine ambient water quality monitoring at the SW Boones Ferry Road site between 1997 and 2002, as well as monitoring results from the Falling Creek and Arnold Creek tributaries that were monitored between March 2001 and June 2002. The monitoring results are summarized for summer (June through September) and fall-winter-spring (October through May).

Table 6-9
Summary of Tryon Creek *E. coli* Monitoring

	Sampling Location					
	SW Boones Ferry Road		**Falling Creek**		**Arnold Creek**	
	Summer	***FWS***	***Summer***	***FWS***	***Summer***	***FWS***
Samples	22	45	5	11	5	11
Median	160	110	160	150	140	140
Minimum	17	18	74	11	65	11
10th Percentile	83	45	92	22	91	23
50th Percentile	170	110	160	150	140	140
90th Percentile	500	984	436	1,000	264	310
Maximum	860	3,800	580	1,100	320	340
No. > 406	5	7	1	4	0	0
% > 406	23%	16%	20%	36%	0%	0%

Notes:
Summer = June-September; FWS (fall, winter, spring) = October – May
All concentrations in cfu/100ml

The monitoring results show that the SW Boones Ferry Road site had a slightly higher frequency of exceeding the *E. coli* standard in the summer period than in the FWS period, with somewhat higher concentrations in the summer period. Tryon Creek is not currently listed on the 303(d) list as being water quality limited for bacteria. However, the results from the SW Boones Ferry Road site would meet the DEQ standard for 303(d) listing (10 percent of samples exceeding 406 *E. coli* organisms/100ml).

The monitoring results for the Falling Creek site were similar to the results from the SW Boones Ferry Road site. The Arnold Creek site did not show any exceedances of the single sample standard.

MODELING RESULTS

As discussed under the Water Quality Monitoring section above, BES has developed a GIS-based model for estimating pollutant loading potential. The model uses a grid system for delineating areas to be evaluated, which is compatible with the DHI MIKE 11 and MIKE SHE hydraulic and water quality models. For the Tryon basin, the grid model breaks the area into 100-foot by 100-foot grids. The model then uses a combination of land use, physical data (e.g., impervious area, vegetation, soils, slope), and rainfall data to predict the potential pollutant loading from each grid. For the Tryon basin analysis, the median pollutant load values from the ACWA stormwater database were used to estimate land use pollutant loads. See Map 12-Tryon Creek Total Suspended Solids Maps by Subwatershed in the Map Atlas.

Findings from analysis of the GIS grid modeling include:

- Because of the homogenous land use within the watershed (80-90 percent residential), the pollutant loading rates tend to be similar throughout the watershed.

- As expected, areas with higher concentrations of commercial and multi-family land uses exhibit higher potential pollutant loads.

- The major transportation corridor (Interstate –5) and associated commercial development show a higher potential pollutant loading.

- In general, the street systems tend to show higher potential loadings.

- The Grid model does not account for changes to pollutant loading caused by effects of flow routing or pollutant decay.

SUMMARY OF FINDINGS

Tryon Creek and its tributaries within the City of Portland exhibit many of the characteristics of many urban streams as a result of changes in hydrology, increased pollutant loadings, and other anthropogenic effects. These characteristics include altered flow patterns and degraded water quality.

The degradation in water quality and resulting impacts on watershed function and health are evident when evaluating the existing conditions using metrics such as the *Framework for Integrated Management of Watershed and River Health* guidelines or Oregon water quality index.

Specific water quality impairment within the Tryon Creek Watershed include 303(d) listing for temperature and elevated levels of bacteria, as summarized below:

TEMPERATURE

- Summer instream temperatures exceed the water quality standard of 64 degrees F for the protection of salmonid fish rearing.

- Shading of the stream is the major factor controlling instream temperature.

- Stream temperatures are elevated despite generally good shade conditions within the watershed.

BACTERIA (*E. coli)*

- E *coli* concentrations frequently exceed the water quality standard (406 counts/100ml) in grab samples.

- Instream bacteria concentrations are higher in the summer than the winter.
- Bacteria concentrations are higher during runoff (rainfall) events.

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