Lower Willamette Subbasin: DEQ's Water Quality Status and Trends Analysis for the Oregon Department of Agriculture's Biennial Review of the Agriculture Area Rules and Plans

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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

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Introduction

Purpose

Area rule and plans have been adopted by the Oregon Department of Agriculture (ODA) for the Lower Willamette Basin management area (603-095-3700 - 3760). Oregon statute and administrative rules require ODA to consult with the Department of Environmental Quality (DEQ) during the biennial review of Agricultural Water Quality Management Area Rules and Plans (ORS 568.930). Total Maximum Daily Load (TMDL) and Nonpoint Source (NPS) program staff conduct these reviews based on the Oregon Department of Agriculture's biennial review schedule of their area rules and plans[1]. ODA's Agriculture Water Quality Program is outcome based, similar to DEQ's TMDL and NPS programs which are water quality outcome based. The analysis of environmental and water quality data is used for implementing these programs as well as identifying data gaps.

The purpose of this document is to present data and analysis that will help DEQ fulfill its roles in the biennial review process described in the MOA between ODA and DEQ[1]. This document includes:

- Review of available data for water quality trends and whether waterbodies are achieving water quality standards and meeting TMDL agricultural load allocations
- Evaluation and comments on agricultural lands status and trends for achieving TMDL allocations that would apply to agricultural areas

This report presents an analysis of water quality data readily accessible from public databases and available in sufficient quantity to indicate status and trends. Additional data may exist but was not readily available at the time this report was compiled. DEQ will use available water quality data to answer the following questions:

- What is the status of water quality parameters downstream of agricultural land?
- What is the trend in water quality at key locations downstream of agricultural land?
- Are sites downstream of agricultural land meeting TMDL agricultural load allocations?

DEQ's basin coordinators review pertinent information including this report as part of ODA's biennial review. DEQ recommends changes and additions necessary to achieve water quality standards and meet TMDL agricultural load allocations through ODA's survey.

Basin Contact

Table 1- Basin coordinator contact information

Basin Coordinator	Telephone	Email
Andrea Matzke	503-229-5350	Matzke.andrea@deq.state.or.us

Background Information

Both the Willamette/Lower Willamette and Columbia Slough TMDLs apply to the Lower Willamette Agricultural Water Quality Management Area. Pollutants addressed in the TMDLs include: chlorophyll *a*, dissolved oxygen, phosphorus, bacteria, DDE/DDT, PCBs, lead, mercury, temperature, Dieldrin, and 2, 3, 7, 8 TCDD[2]. Load allocations written in these TMDLs are as follows:

Toxics:

- DDT (Johnson Creek):
  - Load allocations are expressed as a TSS target of 15 mg/l or a DDT reduction of 94%[2]
  - The applicable chronic freshwater DDT target is listed in Table 2
  - Separate allocations for DDT and DDE apply to the Columbia Slough TMDL
- Dieldrin (Johnson Creek):
  - ODEQ believes that achieving DDT criteria will also result in the attainment of Dieldrin criteria[2]

[1] https://www.oregon.gov/ODA/shared/Documents/Publications/NaturalResources/DEQODAmoa.pdf
[2] http://www.deq.state.or.us/wq/tmdls/docs/willamettebasin/willamette/chpt5lowerwill.pdf

- The freshwater chronic criteria for Dieldrin is 0.056 ug/l
- Separate allocations for Dieldrin apply to the Columbia Slough TMDL

Lead

- In the Columbia Slough TMDL, DEQ developed specific allocations for lead from several sources that took into account four different flow rates.

PCBs

- To address PCB and dioxin impairments in the Columbia Slough, DEQ established specific TMDL allocations for PCB and dioxin for several sources in the Columbia Slough.

Mercury[3,4]:

- Mercury has an aquatic life acute criterion of 2.4 ug/L and a chronic criteria of 0.012 ug/l per the Lower Willamette TMDL and table 30[4,5]
- The interim loading capacity of 94.6 kg/yr represents the total annual load of mercury (as calculated at the mouth of the Willamette River) associated with the water column guidance value concentration deemed to be protective of the beneficial use of fish consumption. For the mainstem Willamette River, Wasteload Allocations (WLA) for Point Sources total 3.7 kg/yr and Load Allocations (LA) for Nonpoint Sources total 90.1 kg/yr[6].

Nutrients and pH Criteria[3,4]:

- Chlorophyll a action level is 15 µg/L based on a three month average with a minimum of three samples. The Total Phosphorus interim target for the TMDLs in Columbia Slough and Fairview Creek is 0.1 mg/L, ortho-phosphate interim target is 0.02 mg/L based on EPA guidelines and DEQ best professional judgment. Measurements for pH must fall between 6.5 and 8.5.
- The total phosphate TMDL allocation addresses pH and chlorophyll a impairments. The presence of too much phosphorus in waterbodies can increase plant and algal production, which can cause pH levels to be too high or too low. The TMDL for phosphate applies April through October.

Bacteria[3,4]:

- Criteria: E. coli levels may not exceed a 30-day log mean of 126 E. coli organisms/100 mL, based on a minimum of five samples. No single sample may exceed 406 E. coli organisms/100 mL. The Willamette TMDLs for bacteria are based on specific percent reductions of bacteria for Johnson Creek (78%), Springbrook Creek (80%), and Fairview Creek (66%). The percent reduction developed for Johnson Creek was applied to all the other tributaries in the Lower Willamette Subbasin. The bacteria TMDL for the Columbia Slough is based on four different stream flows.

Temperature[3,4]:

- Criteria: For all temperature 303(d) listed waterbodies in the Lower Willamette Subbasin, Oregon's temperature standard specifies that sources of anthropogenic heating may result in no more than a 0.3° C increase in stream temperature. Since stream temperature results from cumulative interactions between upstream and local sources, the Lower Willamette Temperature TMDL considers all surface waters that affect the temperatures of 303(d) listed waterbodies. For example, only the mainstem of Johnson Creek is 303(d) listed for temperature, but to address this listing the TMDL will assign allocations for all surface tributaries in the watershed. This concept applies throughout the Subbasin. DEQ applied reach-specific shade targets to the Columbia Slough (applies to Fairview Creek) and Johnson Creek. DEQ used ecoregional shade curves to develop shade targets for the remaining waterbodies in the Lower Willamette.

Dissolved Oxygen (DO)[3,4]:

[3] https://www.oregon.gov/ODA/shared/Documents/Publications/NaturalResources/WillametteLowerAWQMAreaPlan.pdf
[4] http://www.deq.state.or.us/wq/tmdls/docs/willamettebasin/willamette/chpt5lowerwill.pdf
[5] http://www.deq.state.or.us/wq/standards/docs/tables303140.pdf
[6] http://www.deq.state.or.us/wq/tmdls/docs/willamettebasin/willamette/chpt3mercury.pdf

- Beneficial Uses Affected: Fish and Aquatic Life, Salmonid Spawning and Rearing
- Criteria: Dissolved oxygen must not be less than 6.5 mg/L. During spawning, DO must not be less that 11 mg/L unless conditions of barometric pressure, altitude, and temperature preclude attainment of the 11 mg/L. In such cases, DO levels shall not be less than 95 percent of saturation.
- For streams providing for cold-water aquatic life, DO must not be less than 8 mg/L, unless conditions of barometric pressure, altitude, and temperature preclude attainment of the 8 mg/L. In such cases, DO shall not be less than 90 percent of saturation.
- DEQ developed a waste load allocation for biochemical oxygen demand in the Columbia Slough TMDL to address low dissolved oxygen levels.

Table 2- DDD, DDE, and DDT criteria adapted from Table 40[7,8]

Chemical	Human Health Criteria		Aquatic Life Criteria (freshwater)		Aquatic Life Criteria (Saltwater)	
	Water + Org (ug/l)	Org only (ug/l)	Acute (ug/l)	Chronic (ug/l)	Acute (ug/l)	Chronic (ug/l)
DDD, -4,4’	0.000031	0.000031	---	---	---	---
DDE, -4,4’	0.000022	0.000022	---	---	---	---
DDT, -4, 4’	0.000022	0.000022	1.1	0.001	0.13	0.001
Mercury (Total)	---	---	2.4	0.012	2.1	0.025
Dieldrin	0.0000053	0.0000054	---	---	---	---
PCBs	---	---	2	0.014	10	0.03

Geographic Area for Analysis

The Lower Willamette Agricultural Water Quality Management Area (Management Area) is located in northwest Oregon surrounding the greater Portland Metropolitan area (Figure 1). The Management Area is bordered on the north by the Columbia River andColumbia Slough, Multnomah Channel, and the Columbia County line. The western border follows the Tualatin Mountains then heads east past the north side of the Lake Oswego (incorporated) city limits, to the Willamette River just north of the Forest Creek confluence. The boundary follows the Willamette River south to a point due east of Bolton then continues to the headwaters of Johnson Creek. From here, the eastern border follows a line east of the cities of Pleasant Home and Orient, skirts east and north of the city limits of Gresham, and then heads north between Wood Village and Troutdale to the Columbia River. The Management Area is almost entirely within Multnomah County and the northwest corner of Clackamas County with a small portion in Washington County. In total, the Management Area covers 234.49 sq. miles (129.97 square miles of which are within the city limits of Portland)[9].

[7] http://www.deq.state.or.us/wq/standards/docs/toxics/DDTmemo.pdf
[8] http://www.deq.state.or.us/wq/standards/docs/tables303140.pdf
[9] https://www.oregon.gov/ODA/shared/Documents/Publications/NaturalResources/WillametteLowerAWQMAreaPlan.pdf

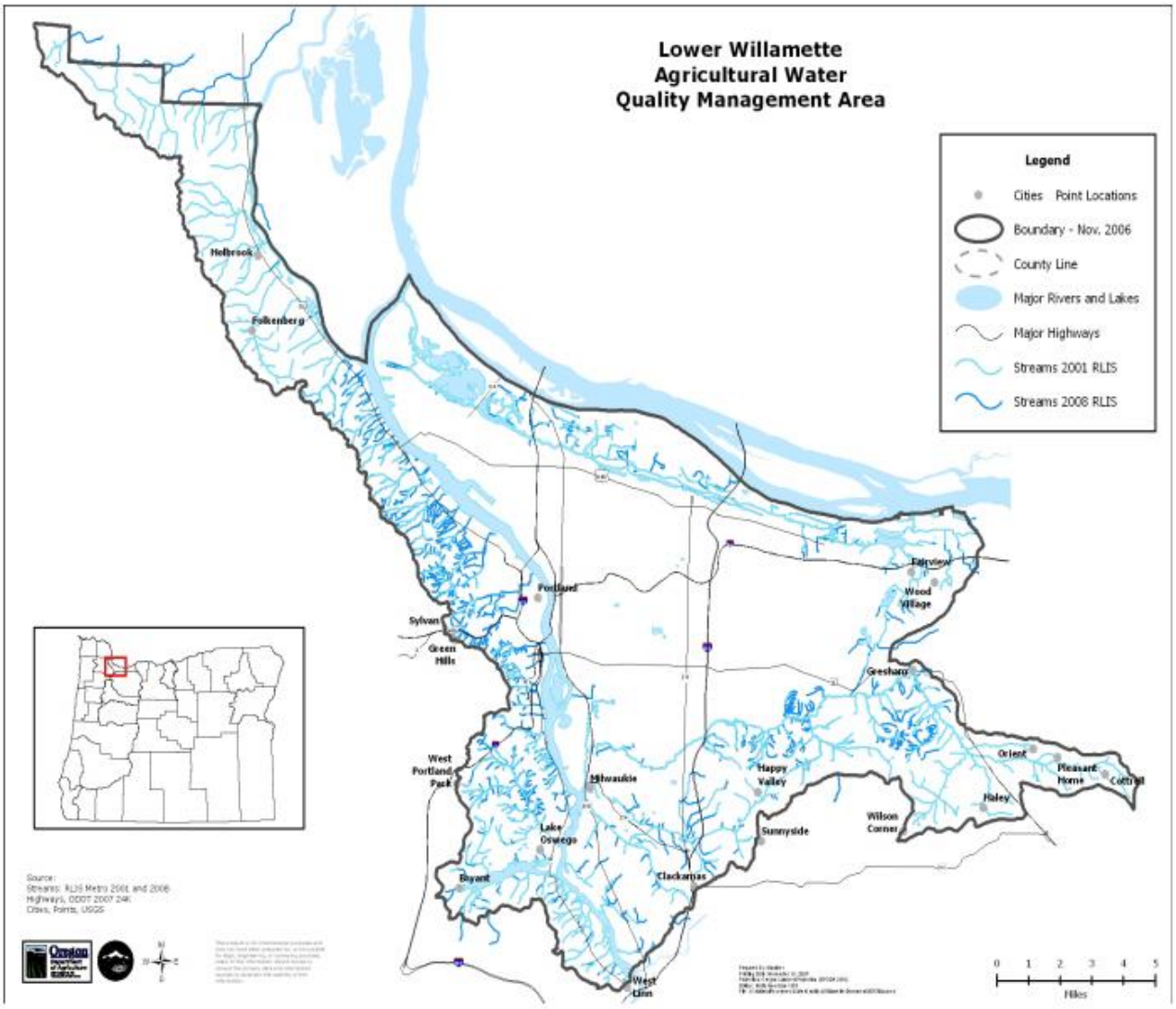

Figure 1-The Lower Willamette Basin Agricultural Water Quality Management area (ODA)

1. Methods

1.1 Data Sources

Analysts retrieved data from DEQ (LASAR), EPA (STORET) and USGS (NWIS) databases. The time period for the query was from January 1, 2000 to December 1, 2016. Parameters included in the query were temperature, pH, dissolved oxygen, and bacteria. The data returned were evaluated for data quality.DEQ data included A, B, and C level data determined following the DEQ's Laboratory Quality Manual. EPA and USGS data were included unless result comments indicated problems with the data. Recent data (after April 1, 2016) from the USGS was marked as provisional data and included in this analysis. For the Lower Willamette Subbasin, data for TSS, toxics, mercury, and bacteria were provided by the City of Gresham and used to show station status at some locations. Temperature status was assessed using data provided by the Johnson Creek Watershed Council and the East Multnomah SWCD.

1.2 Decision Criteria

Status and long-term trends of the data were assessed for evaluating water quality in relation to water quality standards or TMDL allocations. A decision criteria was created for selecting stations that had greater than eight years of data and/or data to address water quality status (

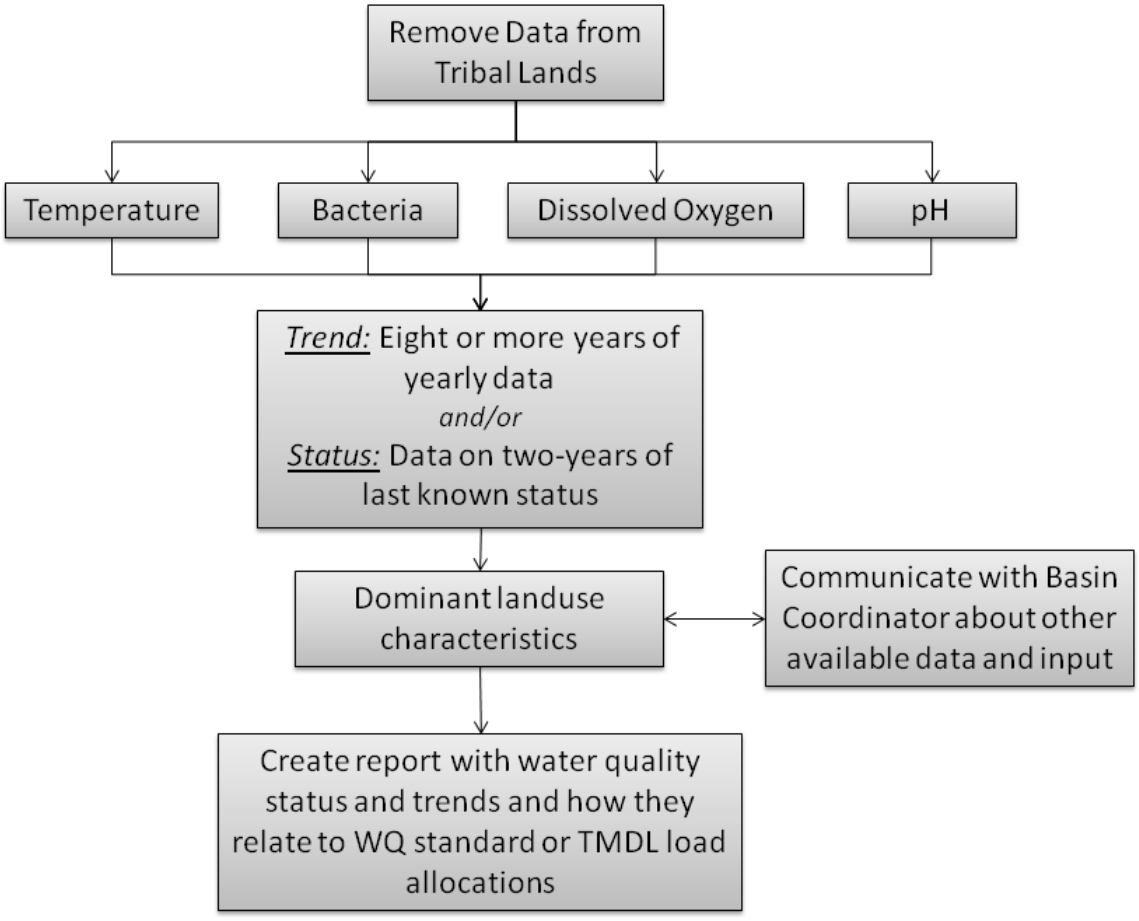

Figure 2). Stations that fit the criteria were sent to basin coordinator for their input on stations in the basin that had sufficient data that was not in one of the queried databases and that should also be included in this analysis. Data from reservation lands were eliminated because these lands are not covered in the Ag WQ management plans. Dominant land use characteristics were used as a station descriptor, not a deciding factor.

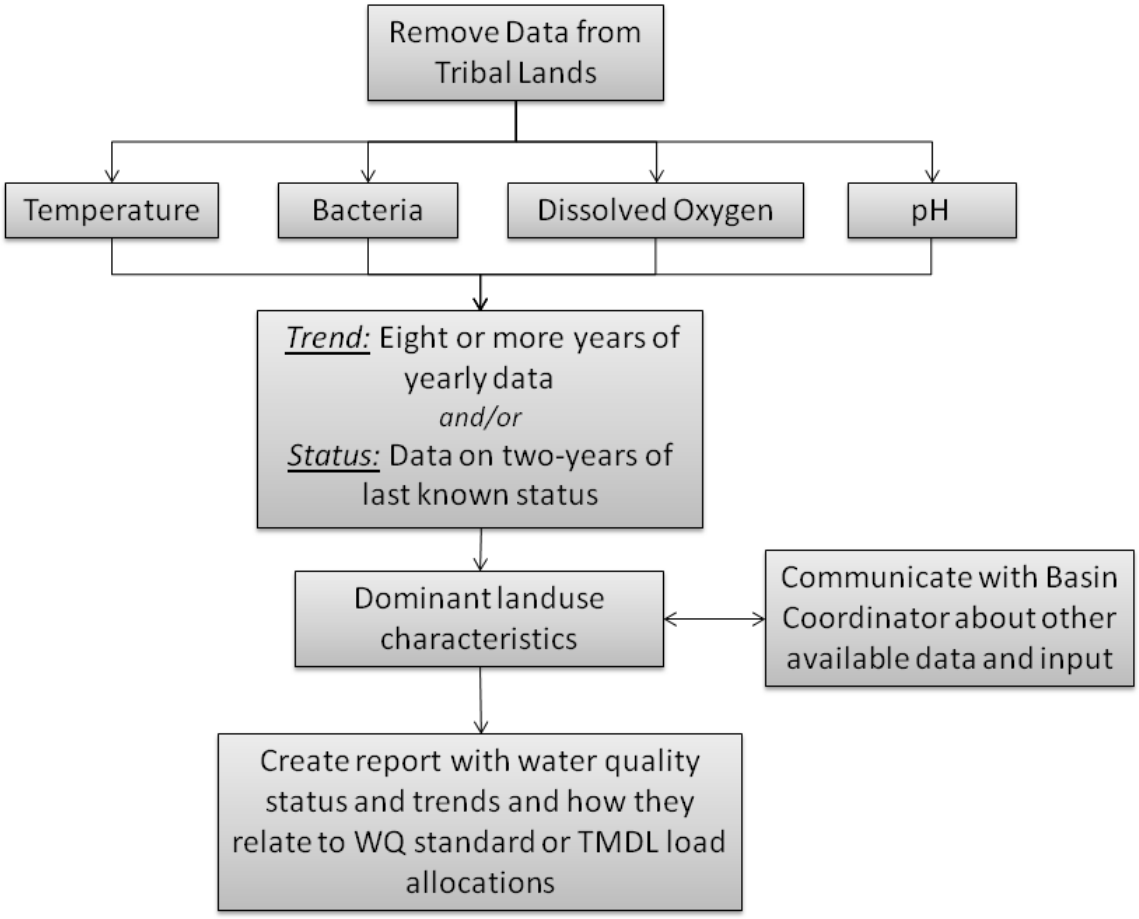

Figure 2- - Monitoring station decision criteria to ensure the stations contain sufficient data to represent status and trends for the waterbody

1.3 Analysis

DEQ compared pH results from both grab and continuous sample data to the water quality standard. The bacteria standard is based on the presence of *E. coli* compared to a single sample maximum and a geometric mean of five or more samples in a 90 day period. The temperature standard is based on the calculation of the seven day average of the daily maximum stream temperatures. Trends for pH and *E. coli* were assessed using Seasonal Kendall Analysis, which removes the influence of season-to-season fluctuations[10]. The Seasonal Kendall Analysis also indicates the significance and slope of the trend.

[10] Statistical Methods for Water Resources, p338

Dissolved oxygen (DO) was assessed by comparing the concentration to the water quality standard. If the DO concentration exceeded the water quality standard, but met the criteria for percent saturation at the same time, it was considered to be in compliance with the water quality standard. These points were noted in the plots using a different color. Fish use and spawning maps[11] and the DO criteria flow chart[12] were used to determine the applicable temperature and DO standards for the spawning and non-spawning time periods.

For temperature trend analysis, analysts used data only from stations with eight years of continuous hourly temperature data in each month during the query period. Data were not used if observations were missing for more than one day each month or if fewer than 22 hourly measurements were recorded during the day. These criteria resulted in no more than 10% missing data across each of the temporal periods of interest. Trends in the data were tested using a Mann Kendall test (Mann 1945). Trends were evaluated on the following metrics.

- Average Monthly 7-day average daily maximum
- Average Monthly daily degree hours > the applicable temperature standard.

Trends are more detectable with the average monthly daily degree hours that exceed the applicable temperature standard because the metric incorporates both magnitude and duration of temperatures; the 7-day average daily maximum only incorporates the magnitude of exceedance. Fish use and spawning maps[13] were used to determine the applicable temperature standards for the spawning and non-spawning time periods. Section 2.6 of this report includes graphs for stations with data that exceeded a water quality standard more than once and/or showed a positive or negative trend. When insufficient data was available, that was noted in the graphs.

Lower Willamette Subbasin Specific Water Standard Criteria[14]:

- pH
    - pH (hydrogen ion concentration). pH values may not fall outside the following ranges:
    - All basin waters (except main stem Columbia River and Cascade lakes): 6.5 to 8.5;
    - Cascade lakes above 3,000 feet altitude: 6.0 to 8.5.
- Temperature (340-041-0028; Figures 340A and 340B; Table 340A
    - The seven-day-average maximum temperature of a stream identified as having salmon and steelhead spawning use on subbasin maps and table may not exceed 13.0 degrees Celsius (55.4 degrees Fahrenheit) at the times indicated on these maps and tables;
    - The seven-day-average maximum temperature of a stream identified as having salmon and trout rearing and migration use on subbasin maps may not exceed 18.0 degrees Celsius (64.4 degrees Fahrenheit);
    - The seven-day-average maximum temperature of a stream identified as having a migration corridor use on subbasin maps and tables may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit).
- *E. coli* (340-041-0009):
    - A 90-day geometric mean of 126 E. coli organisms per 100 mL
    - No single sample may exceed 406 E. coli organisms per 100 mL
- Dissolved Oxygen (340-041-0016); Figures 340A and 340B; Table 340A
    - (1) For water bodies identified as active spawning areas in the places and times indicated on the following Tables and Figures (as well as any active spawning area used by resident trout species), the following criteria apply during the applicable spawning through fry emergence periods set forth in the tables and figures and, where resident trout spawning occurs, during the time trout spawning through fry emergence occurs:

[11] http://www.deq.state.or.us/wq/rules/div041tblsfigs.htm#f1
[12] http://www.oregon.gov/deq/WQ/Documents/Assessment/AssessmentMethodologyRep.pdf
[13] http://www.deq.state.or.us/wq/rules/div041tblsfigs.htm#f1
[14] http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_340/340_041.html

- (a) The dissolved oxygen may not be less than 11.0 mg/l. However, if the minimum intergravel dissolved oxygen, measured as a spatial median, is 8.0 mg/l or greater, then the DO criterion is 9.0 mg/l;
- (b) Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 11.0 mg/l or 9.0 mg/l criteria, dissolved oxygen levels must not be less than 95 percent of saturation;
- (2) For water bodies identified by the Department as providing cold-water aquatic life, the dissolved oxygen may not be less than 8.0 mg/l as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/l, dissolved oxygen may not be less than 90 percent of saturation. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 8.0 mg/l as a 30-day mean minimum, 6.5 mg/l as a seven-day minimum mean, and may not fall below 6.0 mg/l as an absolute minimum (Table 21);
- (3) For water bodies identified by the Department as providing cool-water aquatic life, the dissolved oxygen may not be less than 6.5 mg/l as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 6.5 mg/l as a 30-day mean minimum, 5.0 mg/l as a seven-day minimum mean, and may not fall below 4.0 mg/l as an absolute minimum (Table 21);

2. Results

2.1 Land Use

Dominant land uses in the Lower Willamette AgWQ management area include urban, forest, and agriculture (Table 3). Stations with the highest amount of agriculture are near the top of the watershed (Table 3, Figure 3), while stations near the mouth of the watershed are highly urbanized (Table 3, Figure 4-5).

Table 3. Summary table of watershed land use by station, only stations which have at least 8 years of yearly data (between 2000 and 2016) and/or are used to evaluate last known status; Items are in order of decreasing %Ag cover. Note the Willamette River watershed is much larger than others creating a slightly skewed perspective on agricultural cover. Source: 2011 NAIP

Station ID	Station Description	Ws Area (Km^2)	% Urban	% Forest	% Ag	% Range	% Other
USGS-14211400	Johnson Creek at Regner road, at Gresham, OR	48.0	42.0	20.5	32.6	3.0	1.8
USGS-14211499	Kelley Creek at se 159th drive at Portland, OR	12.7	39.6	27.4	28.2	4.3	0.6
USGS-14211500	Johnson Creek at Sycamore, OR	73.2	45.0	23.1	27.3	3.1	1.5
10611	Willamette River at Hawthorne Bridge	28921.7	7.6	52.1	20.4	16.7	3.3
10801	Swan island channel midpoint	28921.7	7.6	52.1	20.4	16.7	3.3
USGS-14211720	Willamette River at Portland, OR	28921.7	7.6	52.1	20.4	16.7	3.3
10332	Willamette River at SP&S RR Bridge (Portland)	28950.2	7.6	52.1	20.4	16.6	3.3
11321	Johnson Creek at SE 17th Avenue (Portland)	135.7	66.9	15.0	15.3	1.8	1.0
USGS-14211550	Johnson Creek at Milwaukie, OR	135.7	66.9	15.0	15.3	1.8	1.0

Station ID	Station Description	Ws Area (Km^2)	% Urban	% Forest	% Ag	% Range	% Other
11201	Columbia Slough at Landfill Road	119.5	93.3	0.8	1.7	0.8	3.4

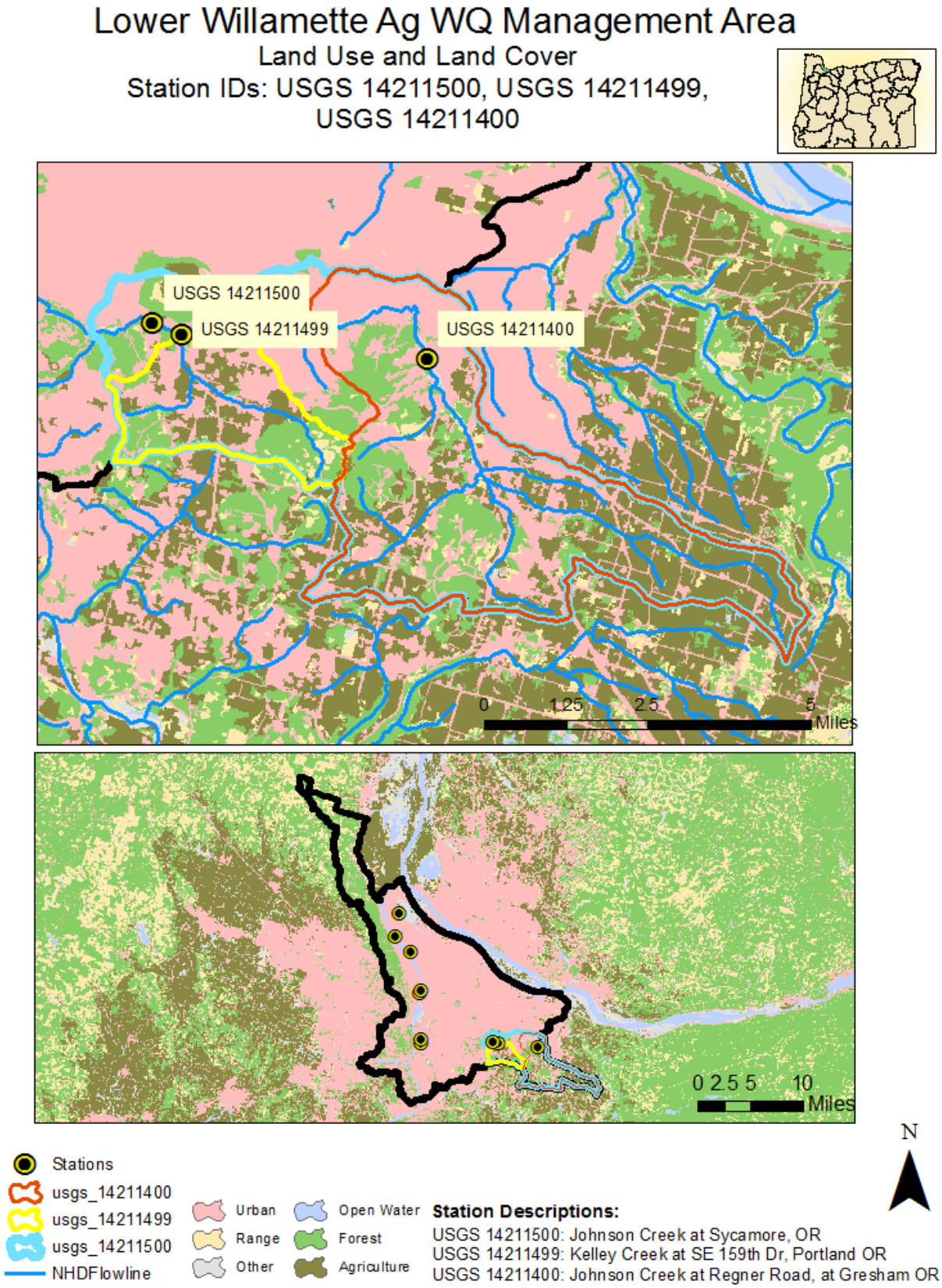

Figure 3- Land use and land cover for the catchments of USGS stations along Johnson and Kelley Creek

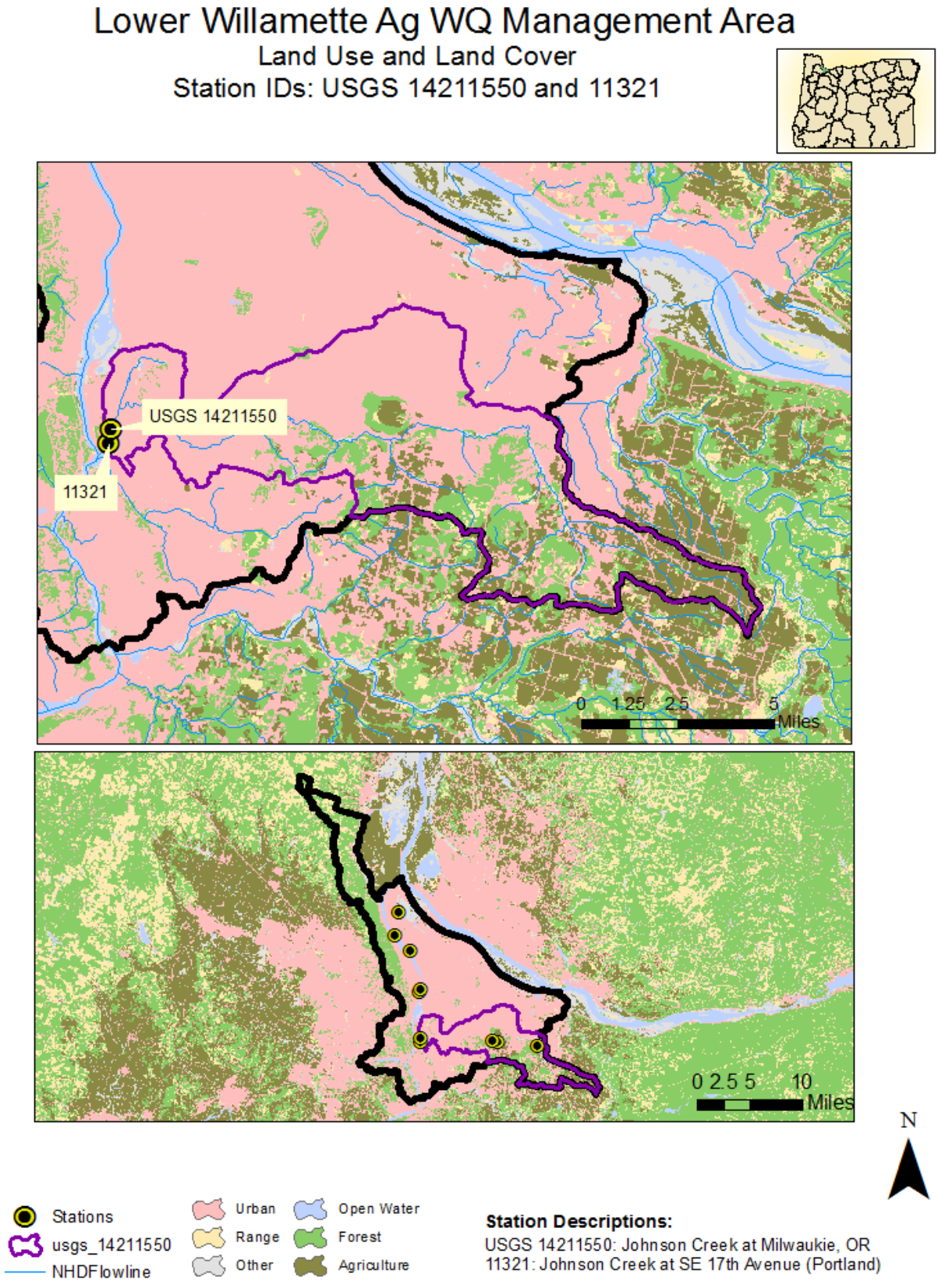

Figure 4- Land use and land cover within the catchment of Stations USGS 14211550 and 11321 along Johnson Creek

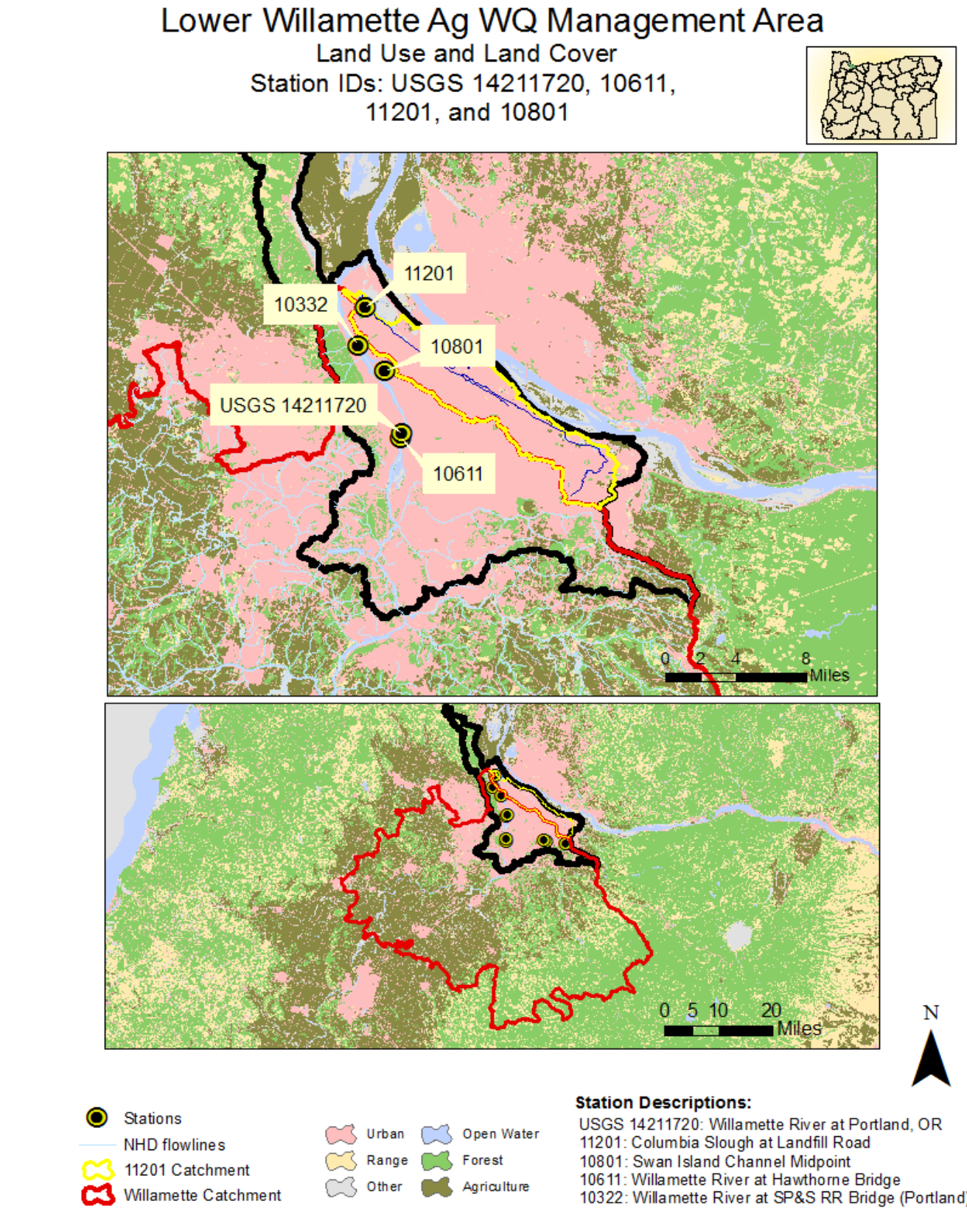

Figure 5- Land use and land cover within the catchments of stations located along the Willamette River and Columbia Slough

2.2 Water Quality Limited Stream Segments

Table 4. Summary of water quality-limited stream segments, organized by parameter. Table based on the approved (and partially disapproved) 2012 Integrated Report Listings by the EPA.

Waterbody	Miles	Pollutant	Season	Year	Criteria	Listing Status
Willamette River	0 to 24.8	Aldrin	Year Round	2002	See below	Cat 5
Johnson Creek	0 to 23.7	Aldrin	Year Round	2004	Table 20 Toxic Substances	Cat 3
Kelly Creek	0 to 3.6	Aldrin	Year Round	2004	Table 20 Toxic Substances	Cat 3
Johnson Creek	0 to 23.7	DDD 4,4	Year Round	1998	Table 20 Toxic Substances	Cat 2
Johnson Creek	0 to 23.7	DDD 4,4	Year Round	2012	Table 40	Cat 3B
Willamette River	0 to 24.8	DDD 4,4	Year Round	1998	See below	Cat 3B
Columbia Slough	0 to 8.5	DDE 4,4	Year Round	2002	See below	Cat 4A
Willamette River	0 to 24.8	DDE 4,4	Year Round	2002	See below	Cat 5
Johnson Creek	0 to 23.7	DDE 4,4	Year Round	2012	Table 40	Cat 5
Willamette River	0 to 186.4	DDE 4,4	Year Round	2012	Table 40	Cat 3
Willamette River	0 to 24.8	DDE 4,4	Year Round	1998	See below	Cat 3B
Willamette River	0 to 24.8	DDT 4,4	Year Round	2002	See below	Cat 5
Kelly Creek	0 to 3.6	DDT 4,4	Year Round	2004	Table 20 Toxic Substances	Cat 3
Willamette River	0 to 24.8	DDT 4,4	Year Round	2002	Table 20 Toxic Substances	Cat 5
Johnson Creek	0 to 23.7	DDT 4,4	Year Round	2012	Table 40	Cat 4A
Willamette River	0 to 24.8	DDT 4,4	Year Round	1998	See below	Cat 3B
Willamette River	0 to 24.8	Dieldrin	Year Round	2002	See below	Cat 5
Kelly Creek	0 to 3.6	Dieldrin	Year Round	2004	Table 20 Toxic Substances	Cat 3B
Johnson Creek	0 to 23.7	Dieldrin	Year Round	2012	Table 40	Cat 4A
Balch Canyon	0 to 3.1	Dissolved Oxygen	FallWinterSpring	1998	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 2
Cedar Creek	0 to 3.7	Dissolved Oxygen	Year Around	2004	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Dart Creek	0 to 3.4	Dissolved Oxygen	Year Around	2004	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 2
Johnson Creek	12.7 to 23.7	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 2
Miller Creek	0 to 1.8	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Milton Creek	0.1 to 19.9	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Multnomah Channel	0 to 21.7	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 2
Multnomah Channel Trib	0 to 1.5	Dissolved Oxygen	Year Around	2004	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Oswego Creek/Lake Oswego	0.5 to 3	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Saltzman Creek	0 to 2.4	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Tryon Creek	0 to 5	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 2

Waterbody	Miles	Pollutant	Season	Year	Criteria	Listing Status
Unnamed Stream	0 to 3.1	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Unnamed Stream	0 to 2.8	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 2
Unnamed Stream	0 to 2.1	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Unnamed Stream	0 to 1.4	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Unnamed Stream	0 to 1.2	Dissolved Oxygen	Year Around	2012	Cold water: Not less than 8.0 mg/l or 90% of saturation	Cat 3
Arata Creek/Blue Lake	0 to 0.9	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 5
Blue Heron Canal	0 to 1	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 3
Columbia Slough	0 to 8.5	Dissolved Oxygen	Year Around	2002	Cool water: Not less than 6.5 mg/l	Cat 4A
Columbia Slough	0 to 9.8	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 2
Johnson Creek	0 to 12.7	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 2
Kellogg Creek	0 to 5	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 2
McNulty Creek	0 to 5.8	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 3
Mitchell Creek	0 to 1.4	Dissolved Oxygen	Year Around	2004	Cool water: Not less than 6.5 mg/l	Cat 3
Osburn Creek	0 to 5.8	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 3
Oswego Canal	0 to 0.7	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 3
Oswego Creek	0 to 0.5	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 2
Scappoose Creek	0 to 5.8	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 2
South Scappoose Creek	0 to 1.9	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 3
Teal Creek	0 to 1.2	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 3
Willamette River	0 to 50.6	Dissolved Oxygen	Year Around	2012	Cool water: Not less than 6.5 mg/l	Cat 2
Arata Creek/Blue Lake	0 to 0.9	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 3
Columbia Slough	0 to 9.8	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 5
Johnson Creek	0 to 10.5	Dissolved Oxygen	October 15 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 5
Johnson Creek	10.5 to 23.7	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 2
Kellogg Creek	0 to 1	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 5
Kellogg Creek	1 to 4.5	Dissolved Oxygen	October 15 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 3
Multnomah Channel	0 to 21.7	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 5
Oswego Creek/Lake Oswego	0 to 3	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 5
Scappoose Creek	0 to 5.8	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 5
South Scappoose Creek	0 to 1.9	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 3
Tryon Creek	0 to 2.5	Dissolved	October 15 - May	2012	Spawning: Not less than 11.0 mg/L or	Cat 5

Waterbody	Miles	Pollutant	Season	Year	Criteria	Listing Status
		Oxygen	15		95% of saturation	
Unnamed Stream	0 to 3.1	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 3
Unnamed Stream	0 to 2.8	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 3
Unnamed Stream	0 to 2.1	Dissolved Oxygen	January 1 - May 15	2012	Spawning: Not less than 11.0 mg/L or 95% of saturation	Cat 3
Unnamed Stream/Bybee Lake	0.5 to 1.7	Dissolved Oxygen	Undefined	1998	--	Cat 3
Unnamed Stream/Smith Lake	1.7 to 3	Dissolved Oxygen	Undefined	1998	--	Cat 3
Columbia Slough	0 to 8.5	E. Coli	FallWinterSpring	2004	See below	Cat 3
Columbia Slough	0 to 9.8	E. Coli	FallWinterSpring	2004	See below	Cat 2
Columbia Slough	0 to 9.8	E. Coli	Summer	2004	See below	Cat 2
Fairview Creek	0 to 1.7	E. Coli	Year Round	2010	See below	Cat 4A
Johnson Creek	0 to 23.7	E. Coli	FallWinterSpring	2010	See below	Cat 4A
Johnson Creek	0 to 23.7	E. Coli	Summer	2010	See below	Cat 4A
Kellogg Creek	0 to 5	E. Coli	FallWinterSpring	2010	See below	Cat 4A
Kellogg Creek	0 to 5	E. Coli	Summer	2004	See below	Cat 3
Mitchell Creek	0 to 1.4	E. Coli	Summer	2004	See below	Cat 3
Mount Scott Creek	0 to 6.1	E. Coli	FallWinterSpring	2010	See below	Cat 4A
Mount Scott Creek	0 to 6.1	E. Coli	Summer	2010	See below	Cat 4A
Multnomah Channel	0 to 21.7	E. Coli	Summer	2004	See below	Cat 3
North Fork Johnson Creek	0 to 2.1	E. Coli	FallWinterSpring	2012	See below	Cat 4A
Oswego Creek/Lake Oswego	0 to 3	E. Coli	Summer	2004	See below	Cat 3
Phillips Creek	0 to 1.2	E. Coli	FallWinterSpring	2010	See below	Cat 4A
Phillips Creek	0 to 1.2	E. Coli	Summer	2010	See below	Cat 4A
South Columbia Slough	0 to 3.2	E. Coli	FallWinterSpring	2004	See below	Cat 3
Unnamed Stream	0 to 3.1	E. Coli	FallWinterSpring	2012	See below	Cat 4A
Willamette River	0 to 186.4	E. Coli	FallWinterSpring	2010	See below	Cat 4A
Willamette River	0 to 186.4	E. Coli	Summer	2004	See below	Cat 2
Fairview Creek	0 to 1.7	Mercury	Year Round	2012	Table 20 Toxic Substances	Cat 2
Johnson Creek	0 to 23.7	Mercury	Year Round	2012	Table 20 Toxic Substances	Cat 2
Kelly Creek	0 to 3.6	Mercury	Year Round	2012	Table 20 Toxic Substances	Cat 2
Osburn Creek	0 to 5.8	Mercury	Year Round	2012	Table 20 Toxic Substances	Cat 2
Willamette River	0 to 186.6	Mercury	Year Round	2004	Table 20 Toxic Substances	Cat 3
Multnomah Channel	0 to 21.7	Mercury	Year Round	2012	Table 40	Cat 5
Willamette River	0 to 186.6	Mercury	Year Round	2012	Table 40	Cat 5
Arata Creek/Blue Lake	0 to 0.9	pH	FallWinterSpring	2010	pH 6.5 to 8.5	Cat 5
Arata Creek/Blue Lake	0 to 0.9	pH	Summer	2012	pH 6.5 to 8.5	Inactive
Arata Creek/Blue Lake	0 to 0.9	pH	Summer	2012	pH 6.5 to 8.5	Cat 5

Waterbody	Miles	Pollutant	Season	Year	Criteria	Listing Status
Balch Canyon	0 to 3.1	pH	FallWinterSpring	1998	pH 6.5 to 8.5	Cat 2
Cedar Creek	0 to 3.7	pH	Summer	2004	pH 6.5 to 8.5	Cat 3
Columbia Slough	0 to 8.5	pH	FallWinterSpring	2004	pH 6.5 to 8.5	Cat 2
Columbia Slough	0 to 8.5	pH	Spring/Summer/Fall	2002	pH 6.5 to 8.5	Cat 4A
Columbia Slough	0 to 8.5	pH	Winter	1998	pH 6.5 to 8.5	Cat 2
Columbia Slough	0 to 9.8	pH	FallWinterSpring	2004	pH 6.5 to 8.5	Cat 2
Columbia Slough	0 to 9.8	pH	Summer	2004	pH 6.5 to 8.5	Cat 4A
Dart Creek	0 to 3.5	pH	Summer	2004	pH 6.5 to 8.5	Cat 2
Fairview Creek	0 to 1.7	pH	Spring/Summer	2004	pH 6.5 to 8.5	Cat 4A
Johnson Creek	0 to 23.7	pH	FallWinterSpring	2010	pH 6.5 to 8.5	Cat 5
Johnson Creek	0 to 23.7	pH	Summer	2004	pH 6.5 to 8.5	Cat 2
Mitchell Creek	0 to 1.4	pH	Summer	2004	pH 6.5 to 8.5	Cat 3
Multnomah Channel	0 to 21.7	pH	Summer	2004	pH 6.5 to 8.5	Cat 3
Multnomah Channel Trib	0 to 1.5	pH	Summer	2004	pH 6.5 to 8.5	Cat 3
Osburn Creek/Fairview Lake	2 to 2.8	pH	FallWinterSpring	2004	pH 6.5 to 8.5	Cat 4A
Oswego Creek/Lake Oswego	0.5 to 3	pH	FallWinterSpring	2004	pH 6.5 to 8.5	Cat 3
Oswego Creek/Lake Oswego	0.5 to 3	pH	May 1 - October 31	1998	pH 6.5 to 8.5	Cat 4A
Oswego Creek/Lake Oswego	3 to 3.1	pH	FallWinterSpring	2004	pH 6.5 to 8.5	Cat 3
Saltzman Creek	0 to 2.4	pH	Summer	2004	pH 6.5 to 8.5	Cat 3
South Columbia Slough	0 to 3.2	pH	FallWinterSpring	2004	pH 6.5 to 8.5	Cat 2
Spring Brook Creek	0 to 2.3	pH	FallWinterSpring	1998	pH 6.5 to 8.5	Cat 2
Tryon Creek	0 to 5.1	pH	Summer	2004	pH 6.5 to 8.5	Cat 3
Unnamed Stream/Bybee Lake	0.5 to 1.7	pH	Summer	1998	pH 6.5 to 8.5	Cat 5
Unnamed Stream/Smith Lake	1.7 to 3	pH	Summer	1998	pH 6.5 to 8.5	Cat 5
Willamette River	0 to 24.8	pH	FallWinterSpring	2004	pH 6.5 to 8.5	Cat 2
Willamette River	0 to 24.8	pH	Summer	2004	pH 6.5 to 8.5	Cat 2
Columbia Slough	0 to 8.5	Temperature	Spring/Summer/Fall	2010	Rearing: 17.8 C	Cat 4A
Fairview Creek	0 to 1.7	Temperature	Summer	2010	Rearing: 17.8 C	Cat 4A
Kellogg Creek	0 to 5	Temperature	Summer	2002	Rearing: 17.8 C	Cat 2
Phillips Creek	0 to 1.2	Temperature	Summer	2002	Rearing: 17.8 C	Cat 2
Tryon Creek	0 to 5	Temperature	Summer	2010	Rearing: 17.8 C	Cat 4A
Willamette River	0 to 50.6	Temperature	Year Around	2010	Salmon and steelhead migration corridors: 20.0 C 7DADM	Cat 4A
Johnson Creek	0.2 to 10.5	Temperature	October 15 - May 15	2010	Salmon and steelhead migration corridors: 20.0 C 7DADM	Cat 4A
Johnson Creek	0 to 23.7	Temperature	Year Around	2010	Salmon and trout rearing and migration: 18.0C 7DADM	Cat 4A
Multnomah Channel	0 to 21.7	Temperature	Year Around	2010	Salmon and trout rearing and migration: 18.0C 7DADM	Cat 4A
Kellogg Creek	0 to 5	Temperature	October 1 - May 31	2002	Spawning: 12.8 C	Cat 2

Waterbody	Miles	Pollutant	Season	Year	Criteria	Listing Status
Phillips Creek	0 to 1.2	Temperature	October 1 - May 31	2002	Spawning: 12.8 C	Cat 2
Crystal Springs Creek	0 to 2.2	Temperature	Undefined	1998		Cat 3
Mount Scott Creek	0 to 6.1	Temperature	Undefined	1998		Cat 3
Sturgeon Lake/Sturgeon Lake	0 to 5.4	Temperature	Undefined	1998		Cat 3

E.coli: 30-day log mean of 126 E coli organisms per 100ml OR no single sample >406 organisms per 100 ml
pH: Exceedances are values high or lower than the given range
Temperature: Year Around = non-spawning
DDD, DDE, DDT, Dieldrin, Aldrin: Toxic substances may not be introduced above natural background levels in the waters of the State in amounts, concentrations, or combinations that may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediment.Where no published EPA criteria exist for a toxic substance, public health advisories and other published scientific literature may be considered and used, if appropriate, to set guidance values.
Assessment Categories: Cat 2: Attaining some criteria/uses
Cat 3: Insufficient Data
Cat 3b: Insufficeint Data, potential concern
Cat 4A: Water quality limited, TMDL approved
Cat 5: Water quality limited, 303(d) list, TMDL needed

2.3 *E. coli*

In the Lower Willamette Subbasin, 99 stations contained monitoring data for *E. coli*, while five contained data sufficient to assess status and trends (Table 5). In addition, the City of Gresham had sufficient E.Coli data at four sites in the Johnson Creek watershed to assess status and trends. Station 11201 was the only station that had no exceedances of the water quality standard during the 16-year timeframe (Figure 9 and Table 5); however stations 10332 and 10801 had no exceedances between 2014 and 2016 (Figures 6 and 8). E.Coli exceedances are based on exceeding a single sample result of 406 organisms per 100 mL. DEQ did not have data to assess whether the 90-day geometric mean of 126 organisms per 100 mL was met.

Table 5- Number of samples and exceedances for each station that measured *E. coli* from 01/01/2000 through 12/01/2016

Station ID	Sample Type	Observations	Exceedances	%Exceedance	Slope	p-value	Sig level
10332	Single Sample	95	2	2.11	-2.22	0.001	99% Sig
10611	Single Sample	161	5	3.11	-0.62	0.032	95% Sig
10801	Single Sample	96	1	1.04	-1.31	0.008	99% Sig
11201	Single Sample	92	0	0	0.43	0.557	Not Sig
11321	Single Sample	103	45	43.69	-16.51	0.002	99% Sig

10332 -Willamette R at SP&S RR Bridge (Portland)
10611-Willamette R at Hawthorne Bridge
10801- Swan Island Channel Midpoint
11201- Columbia Slough at Landfill Road
11321- Johnson Creek at SE 17th avenue (Portland)

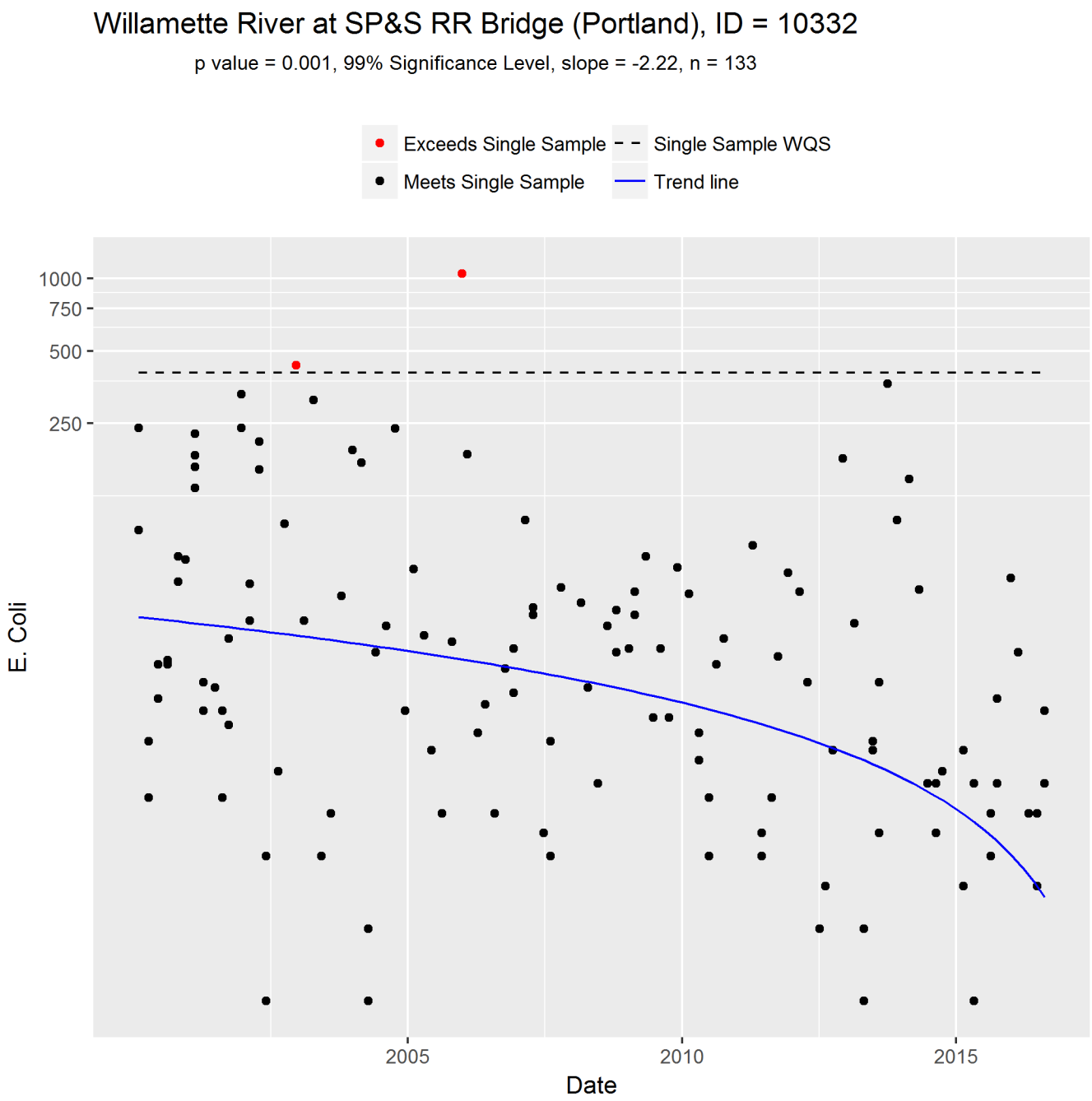

Figure 6- Trends of *E. coli* in the Willamette River at SP&S RR bridge (station 10332). Two exceedances occurred between 2000 and 2016. A decreasing trend is shown in the 16-year tim frame.

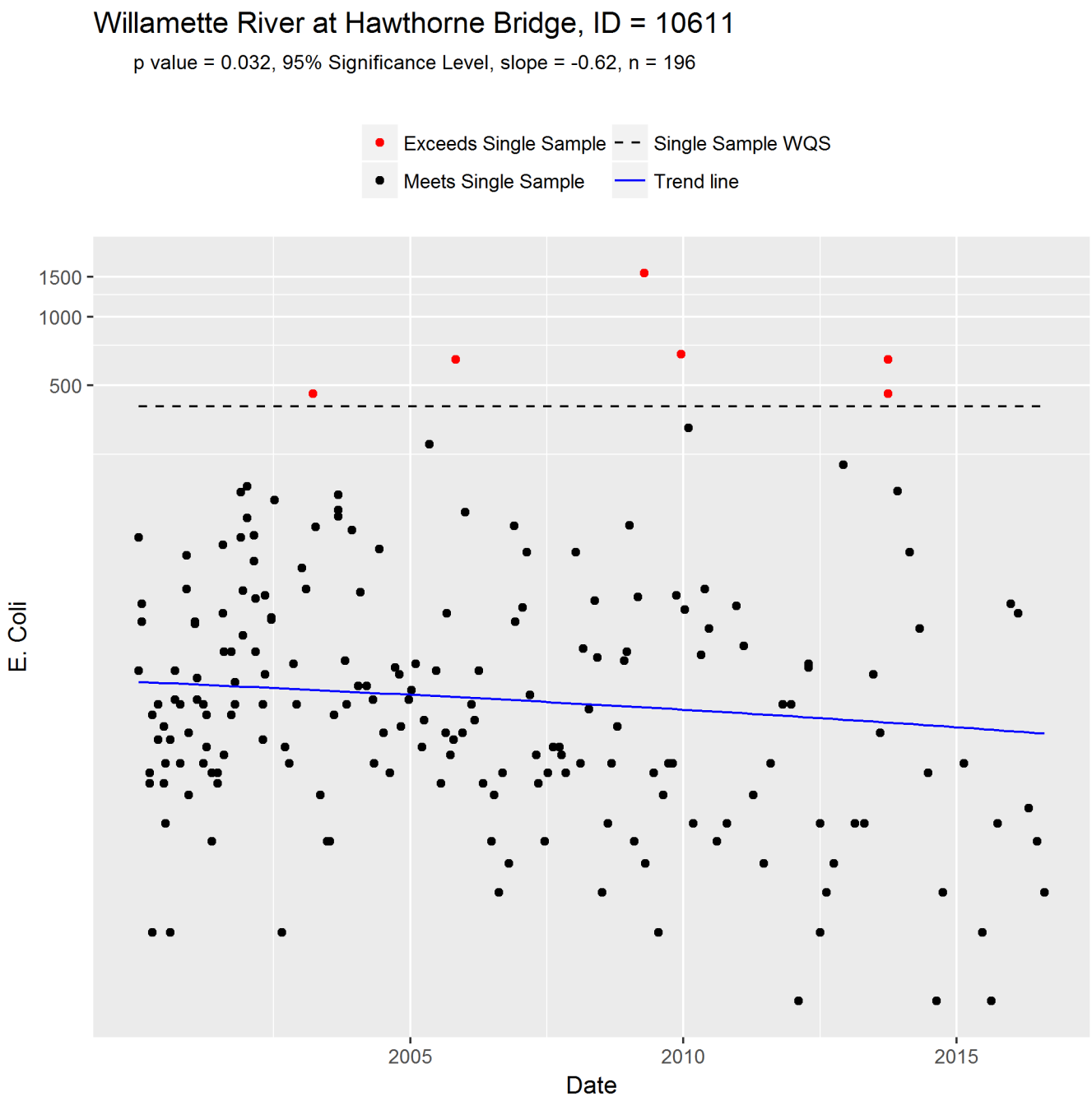

Figure 7- Trends of *E. coli* in the Willamette River at the Hawthorne Bridge (Station 10611). A decreasing trend is shown with six exceedances of the WQS occurring in the 16-year time period.

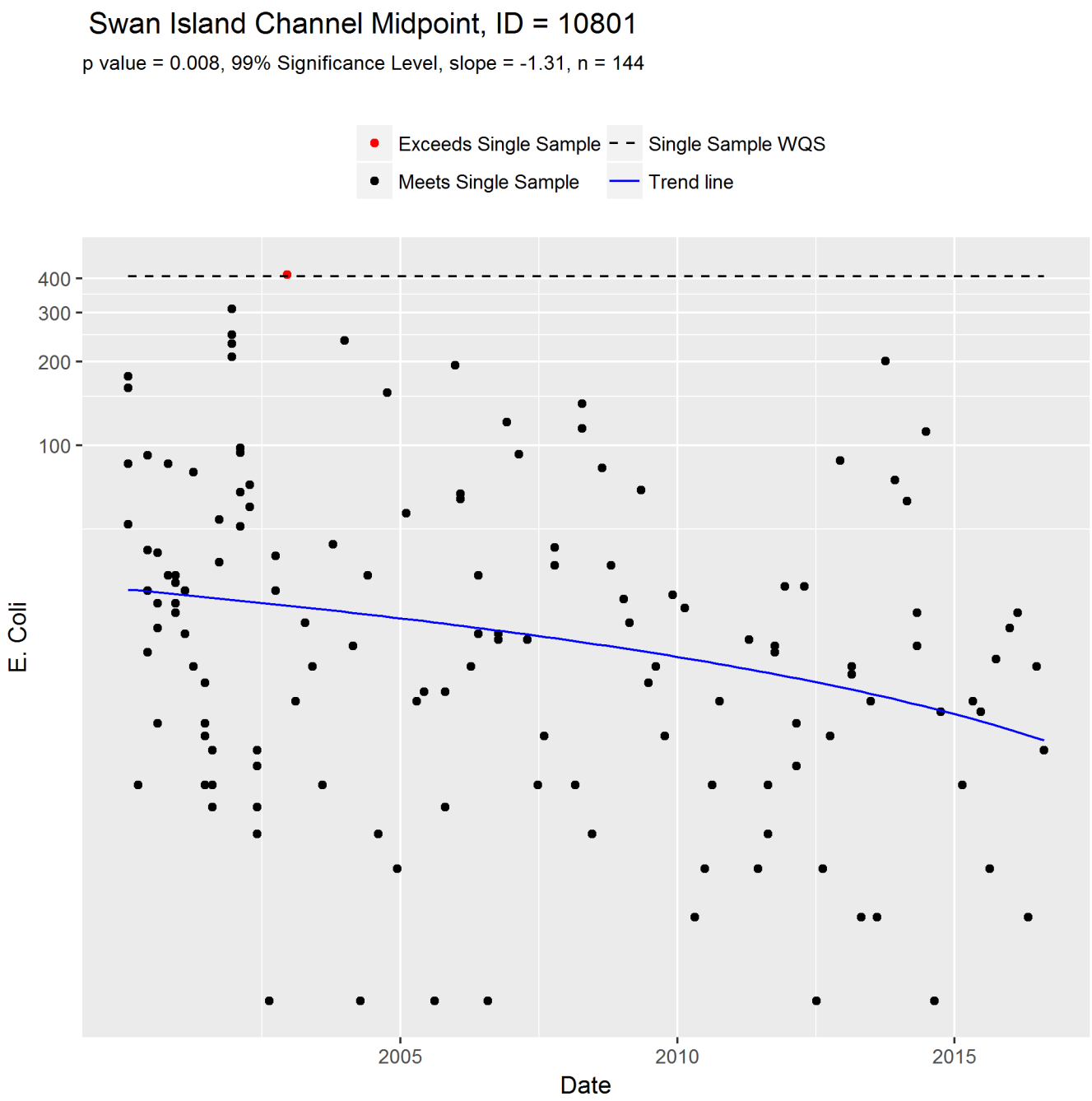

Figure 8- Trend of *E. coli* at the Swan Island Channel midpoint (Station ID 10801). A decreasing trend is represented with a single exceedance of the WQS occurring in the 16-year timeframe.

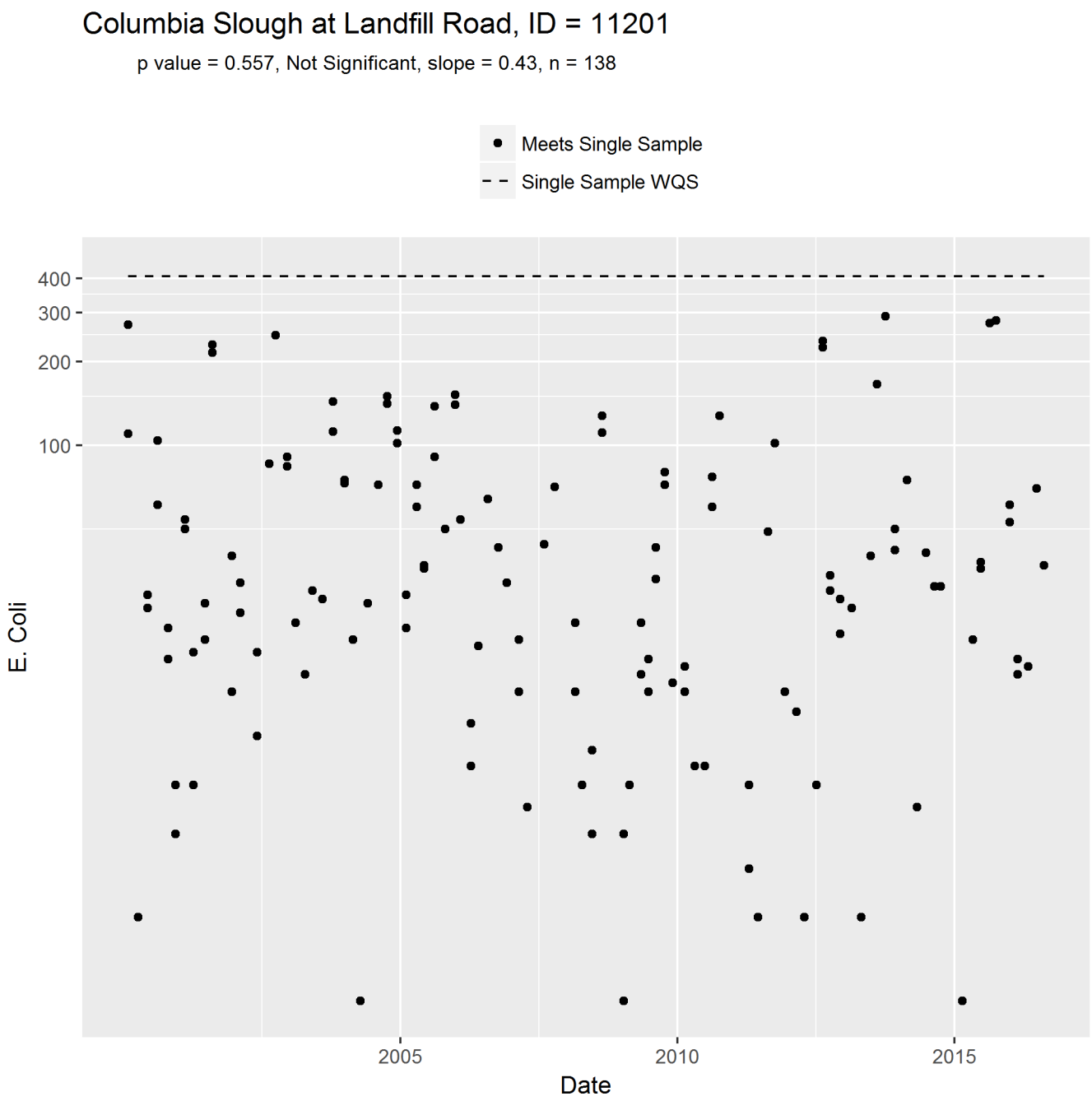

Figure 9- Trends of *E. coli* at the Columbia Slough (Station ID 11201). No exceedances of the WQS occurred during the 16-year timeframe.

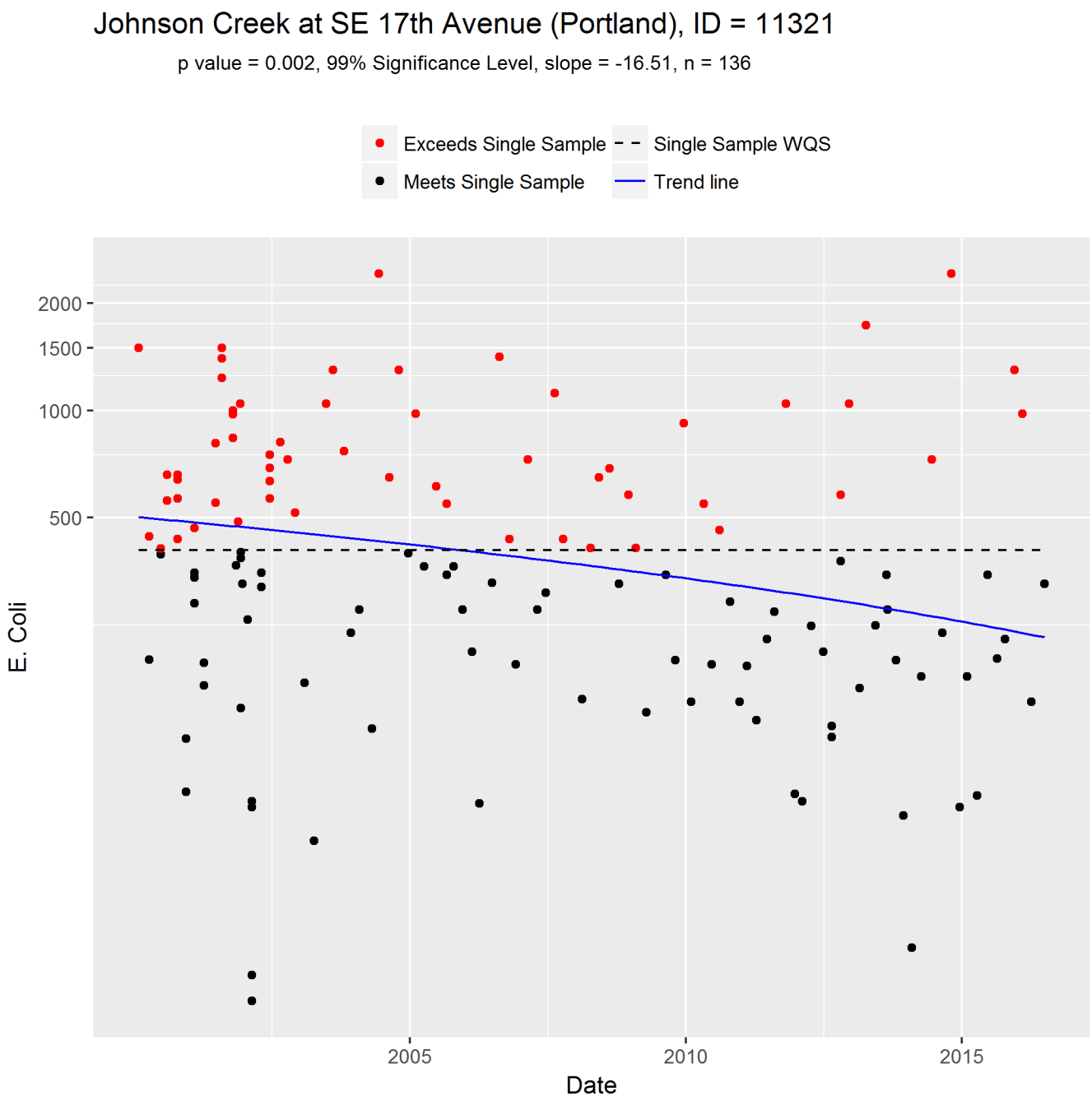

Figure 10- Trends of *E. coli* at Johnson Creek at 17th avenue (Station 11321). Many exceedances of the WQS occurred during the 16-year timeframe with a significant decreasing trend.

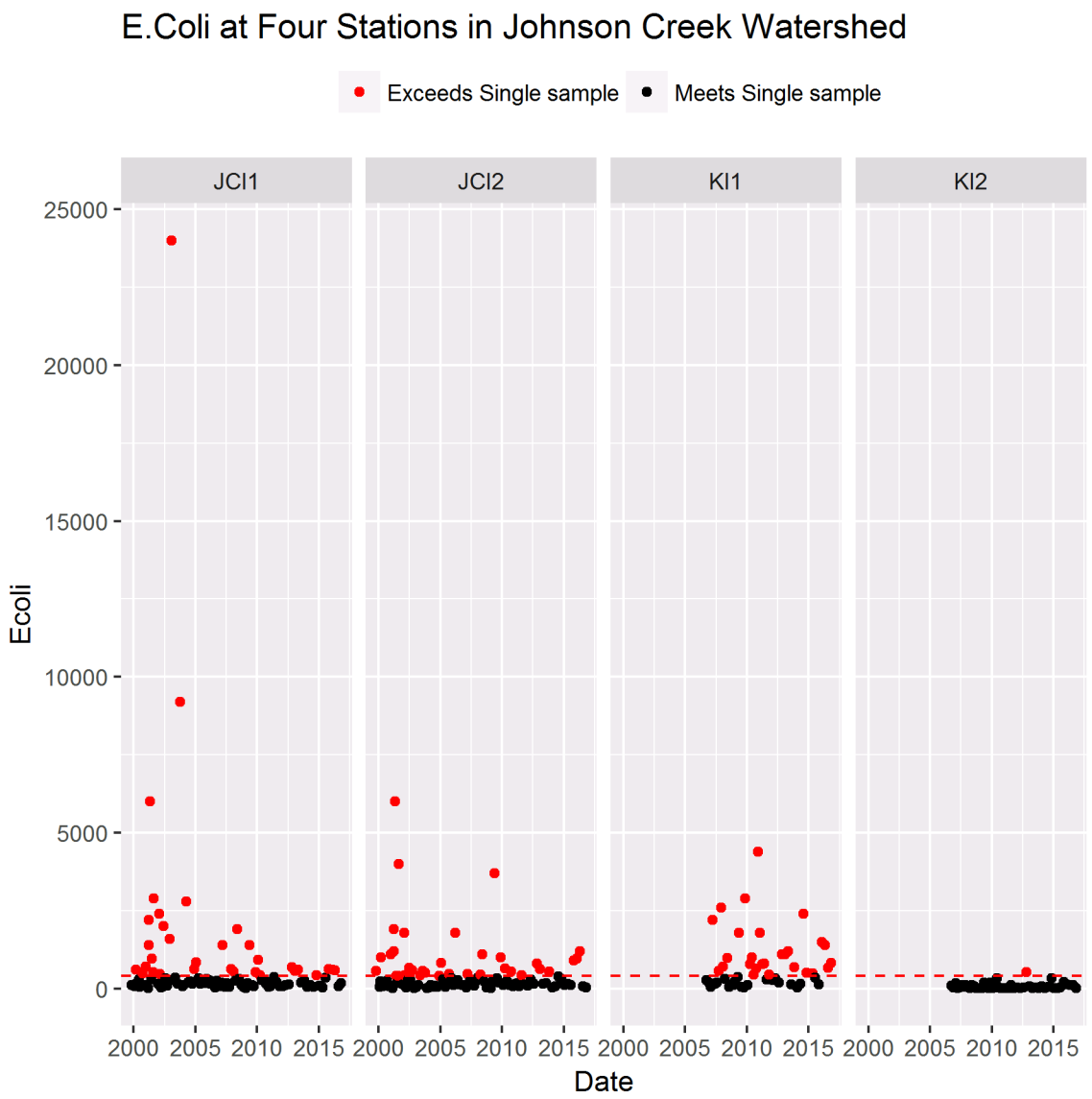

Figure 11- E. coli data in relation to the WQS at four locations, data provided by the City of Gresham. Four stations include JCI1 (Johnson Creek at 174th Ave/Jenne Rd), JCI2 (Johnson Creek at 252nd/Palmblad), KI1 (Kelley Creek at Pleasant Valley Grange), and KI2 (Kelley Creek at Rodlum Road).

2.4 pH

In the Lower Willamette Subbasin, 286 stations contained monitoring data for pH though six fit the criteria to assess status and long-term trends. All stations that fit the criteria for assessment of trends also fit the criteria for status. Stations 10332 and 10611 had no exceedances of the water quality standard during the 16-year time frame, and station 11321 had no exceedances of the water quality standard between 2014 and 2016.

Table 6- pH trends for the Lower Willamette basin

Station ID	Observations	Exceedances	%Exceedance	Slope	p-value	Sig level
10332	146	0	0	0	0.238	Not Sig.
10611	172	0	0	0.02	0	99% Sig
10801	149	18	12.1	0.01	0.066	90% Sig
11201	155	25	16.1	0	0.863	Not Sig.
11321	125	1	0.8	0	0.075	90% Sig

Station ID	Observations	Exceedances	%Exceedance	Slope	p-value	Sig level
USGS-14211720	134,341	66	0.05	0	0.1	Not Sig

10332-Willamette R at SP&S RR Bridge (Portland)
10611-Willamette R at Hawthorne Bridge
10801- Swan Island Channel Midpoint
11201- Columbia Slough at Landfill Road
11321- Johnson Creek at SE 17th avenue (Portland)
USGS- 1411720 Willamette River at Portland, OR

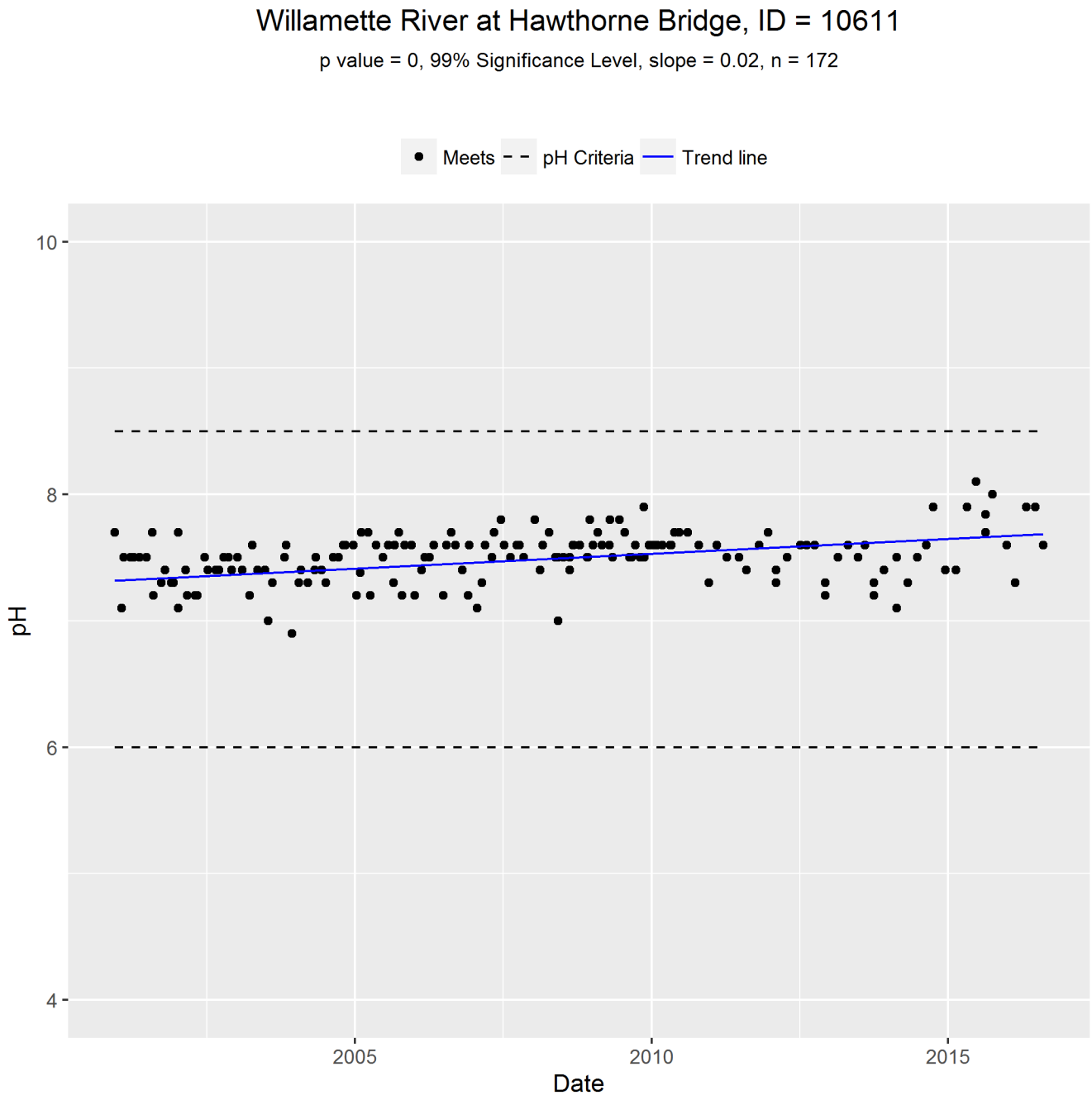

Figure 12- pH trends for Station 10611 between 2000 and 2016; a slight increasing trend is shown with no exceedances of the WQS

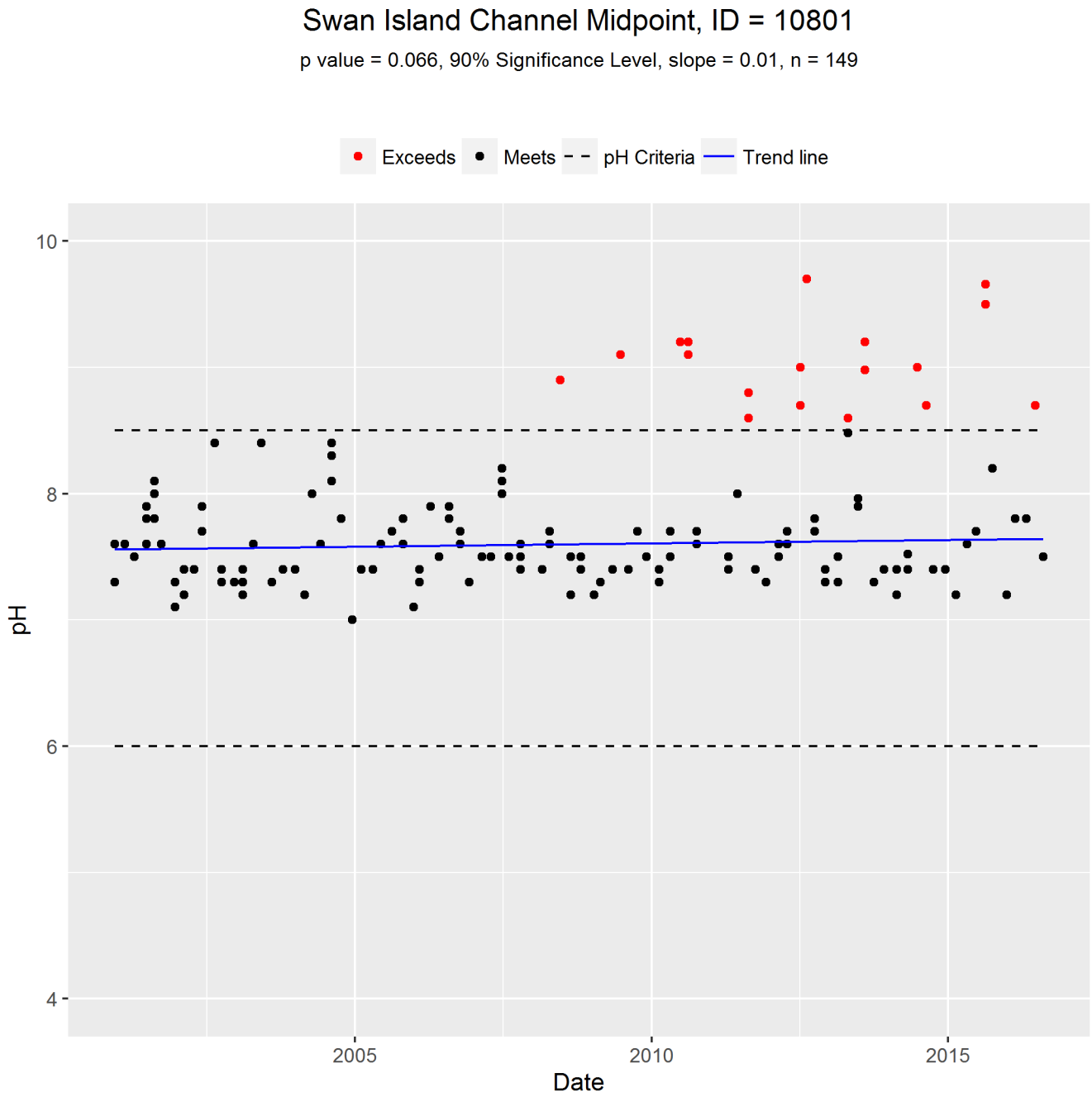

Figure 13- pH trends for Station 10801 between 2000 and 2016; exceedances of the WQS occurred between 2008 and 2016 and were all alkaline

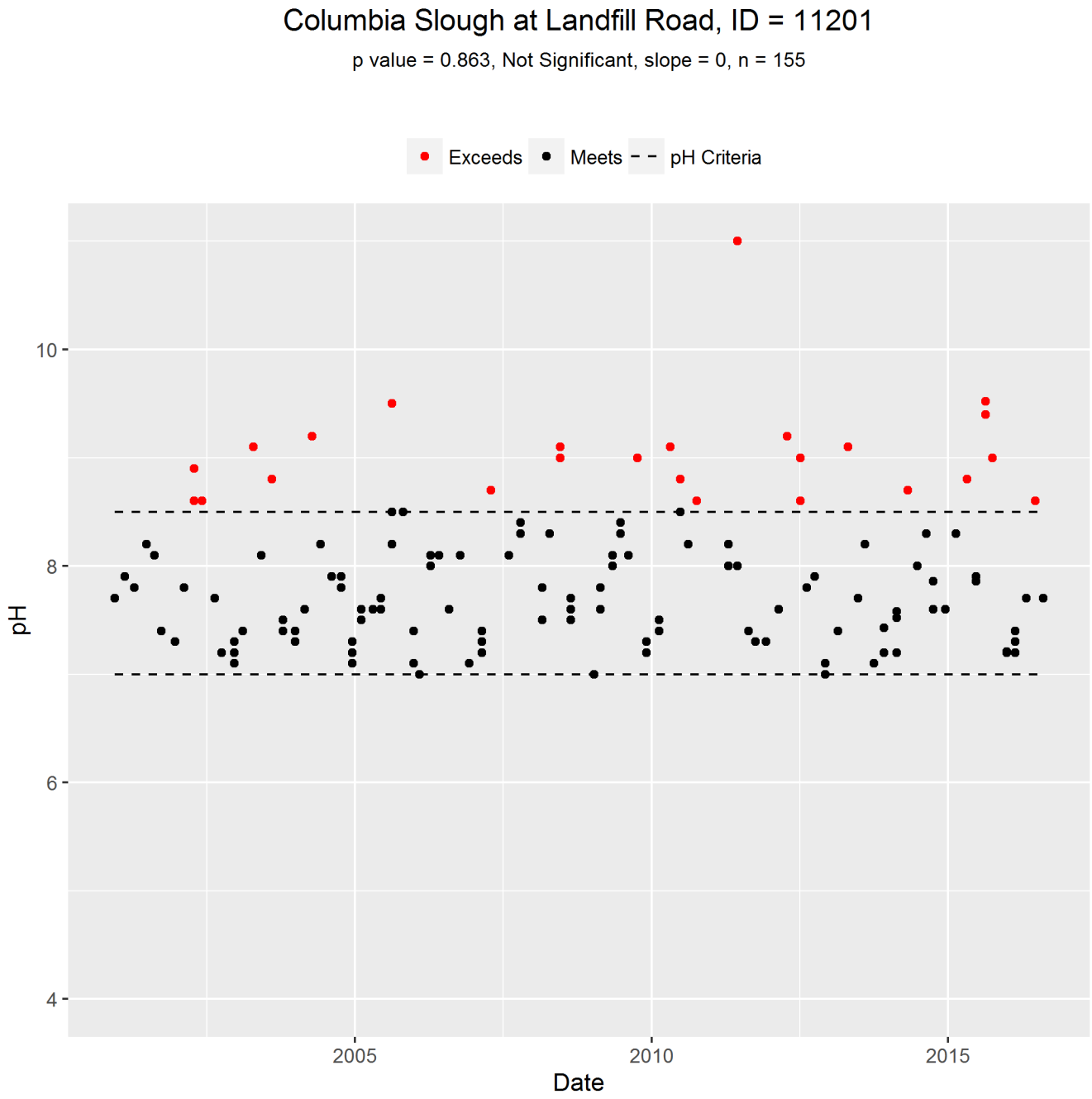

Figure 14- pH trends for Station ID 11201; exceedances of the WQS occurred between 2002 and 2016 and were all alkaline

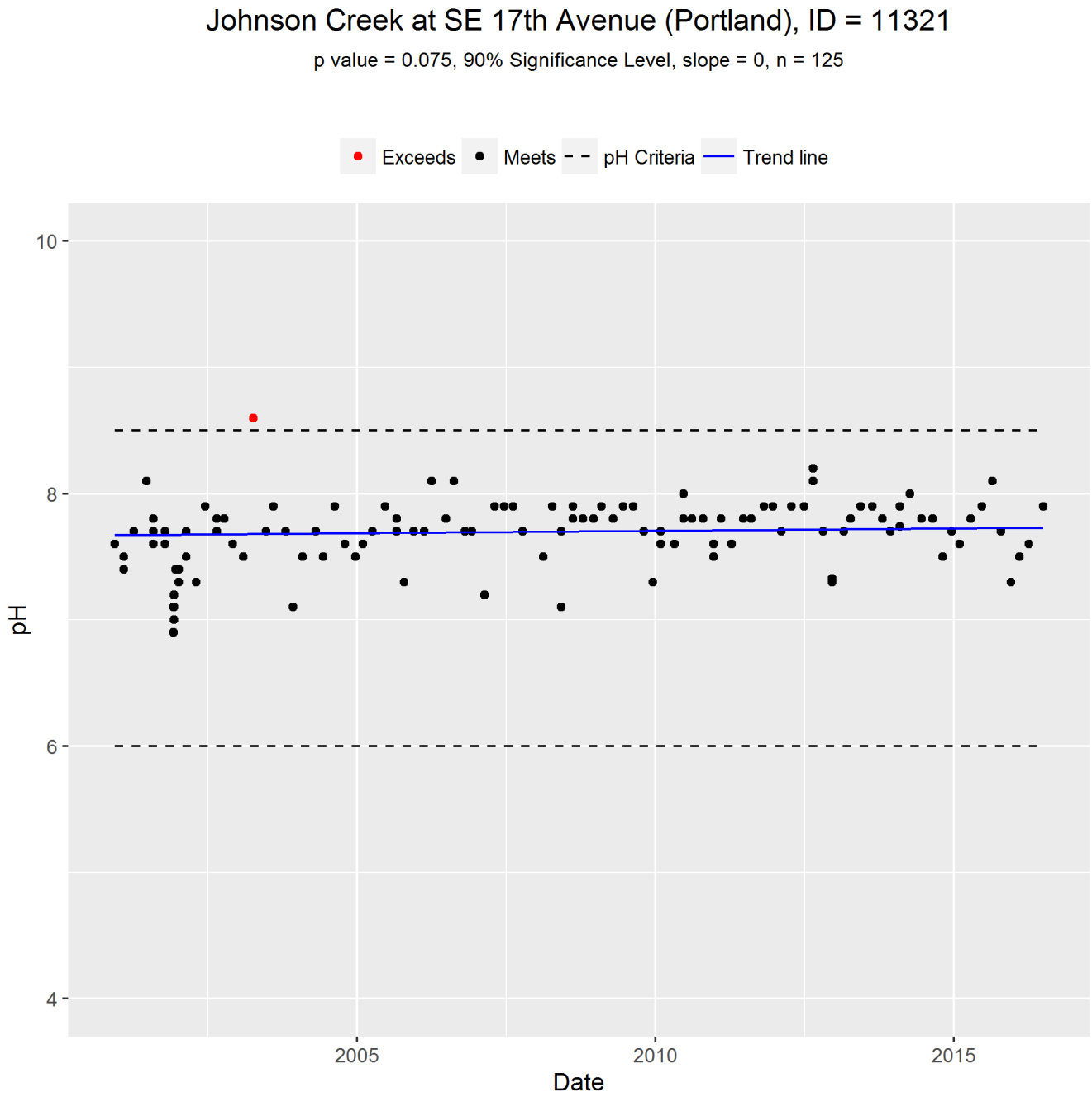

Figure 15- pH trends for Station 11321; a single exceedance of the WQS occurred in 2003 and was alkaline

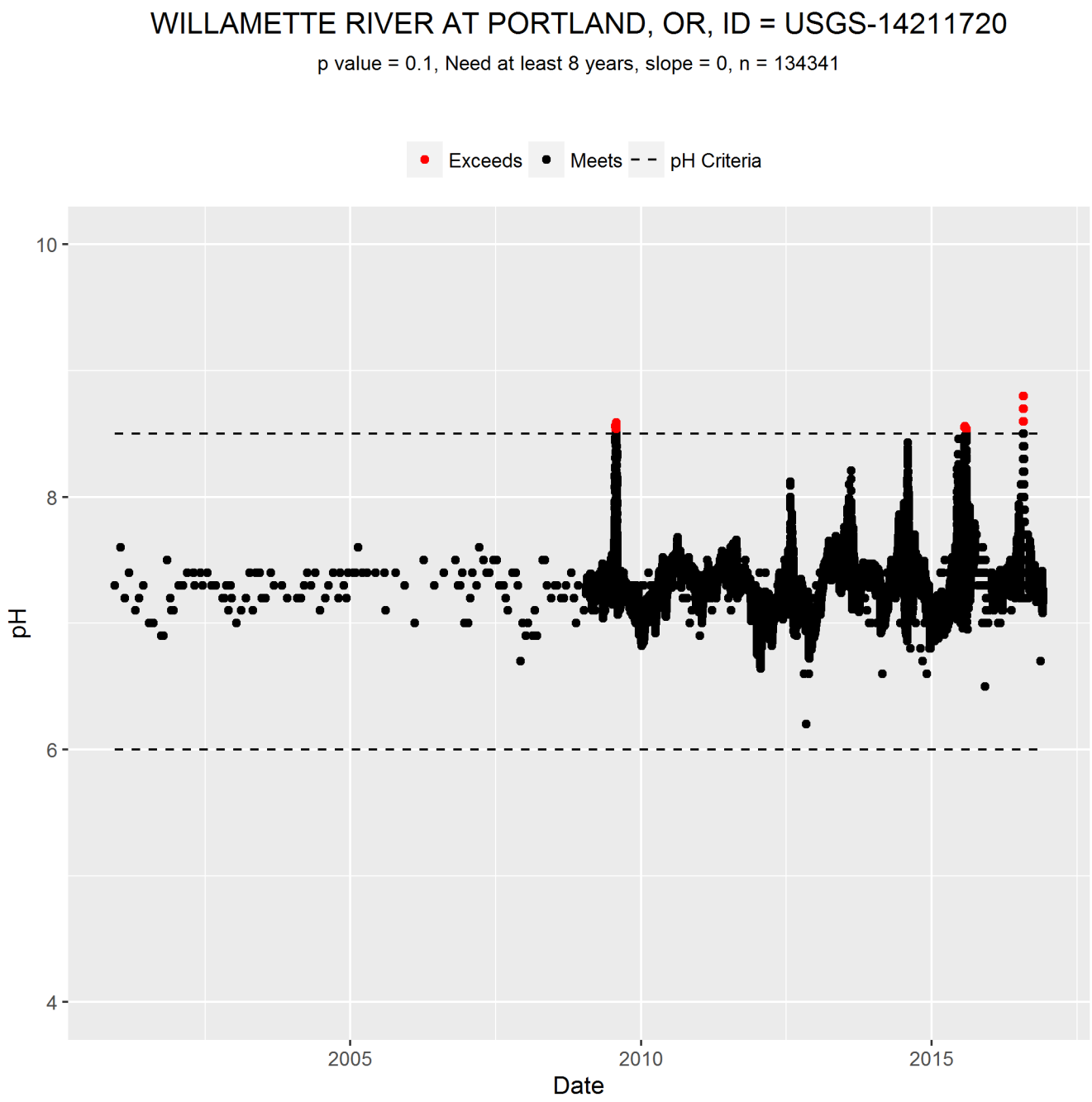

Figure 16- pH trends for Station ID USGS-14211720; continuous monitoring began in 2009 and exceedances of the WQS did not occur until 2009

2.5 Temperature

Long-term temperature data exists at five sites within the Lower Willamette at five USGS sites. Sufficient data exists to assess trends and status of temperature at all five locations, with all stations containing data from 2007-2016 with the exception of USGS 14211720 which contains data from 2000 to present. Stations provided by the Johnson Creek Watershed Council contained data for 2016 only and could only be evaluated for status (Figure 21-26).

Table 7- Temperature trends within the Lower Willamette Ag WQ management area
Note: N refers to the 7-day average daily maximum values, exceedances represent both spawning and non-spawning time periods

Station ID	Station Description	Time Period	N	Exceedances	%Exceedance
USGS 14211400	Johnson Cr at Regner Road, at Gresham, OR	2007-2016	3293	744	22.6
USGS 14211499	Kelly Creek at SE 159th Dr at Portland, OR	2007-2016	3203	461	14.4
USGS 14211500	Johnson Creek at Sycamore, OR	2007-2016	3331	855	25.7
USGS 14211550	Johnson Creek at Milwaukie, OR	2007-2016	6109	3016	49.4
USGS 14211720	Willamette R at Portland, OR	2000-2016	4180	865	20.7

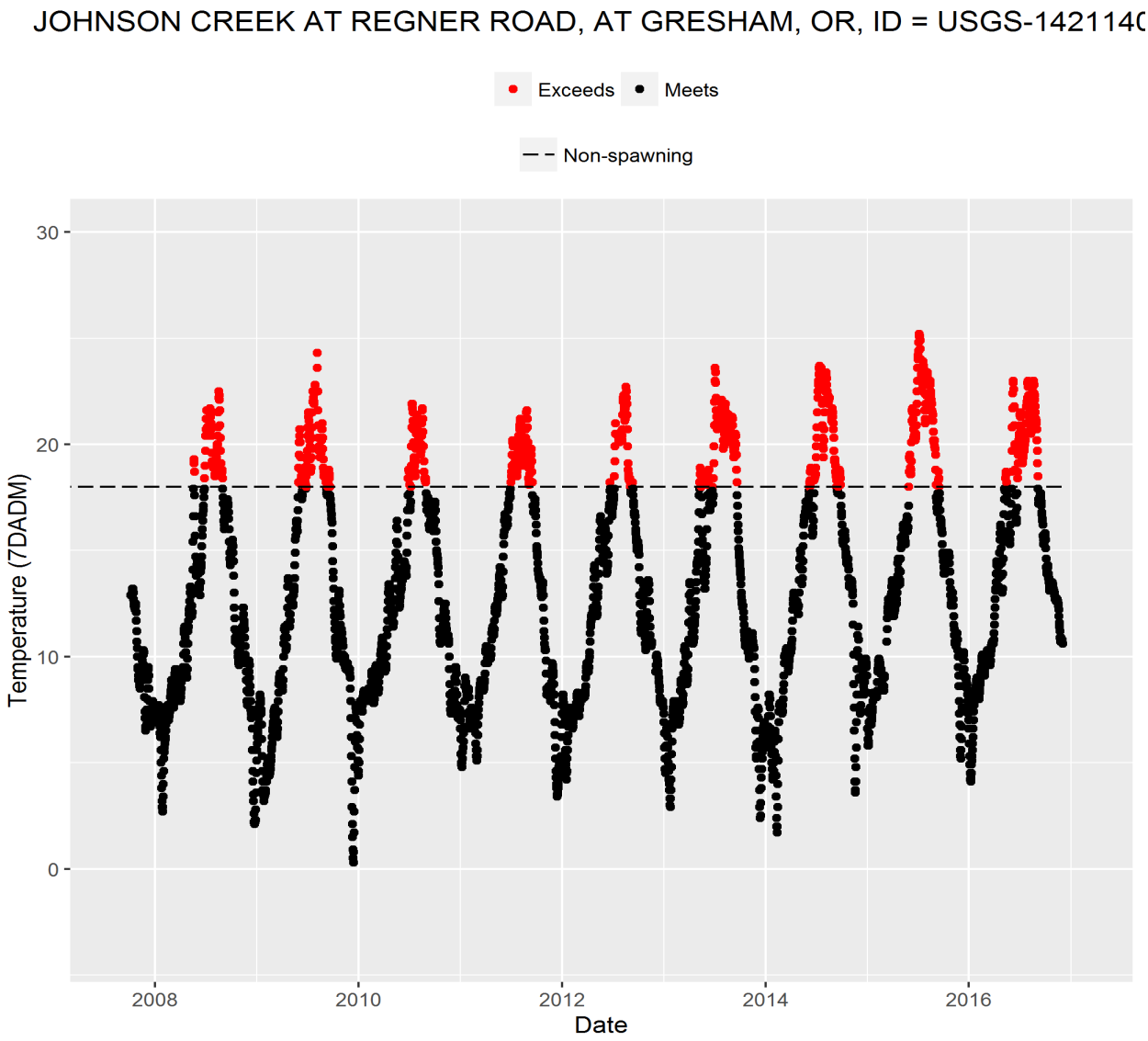

Figure 17- Temperature trends for Station ID USGS- 14211400; the WQ beneficial use is for salmon and trout rearing and migration with no spawning. Most exceedances of the WQS occur during August with a significant (p<0.05) degrading trend.

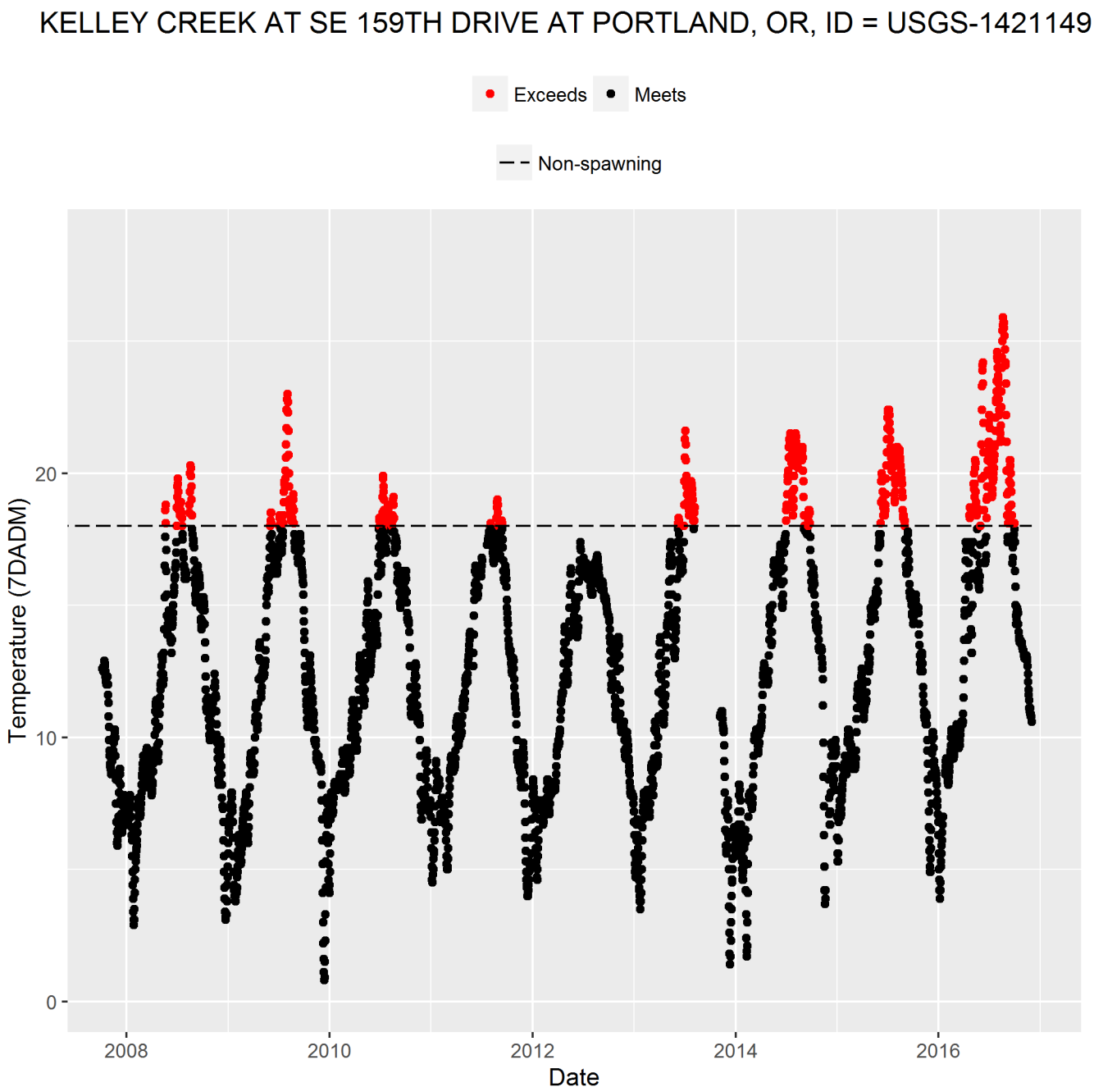

Figure 18- Temperature trends for Station ID USGS- 14211499; the WQ beneficial use is for salmon and trout rearing and migration with no spawning. Most exceedances of the WQS occur during summer months and no exceedances occurring in 2012.

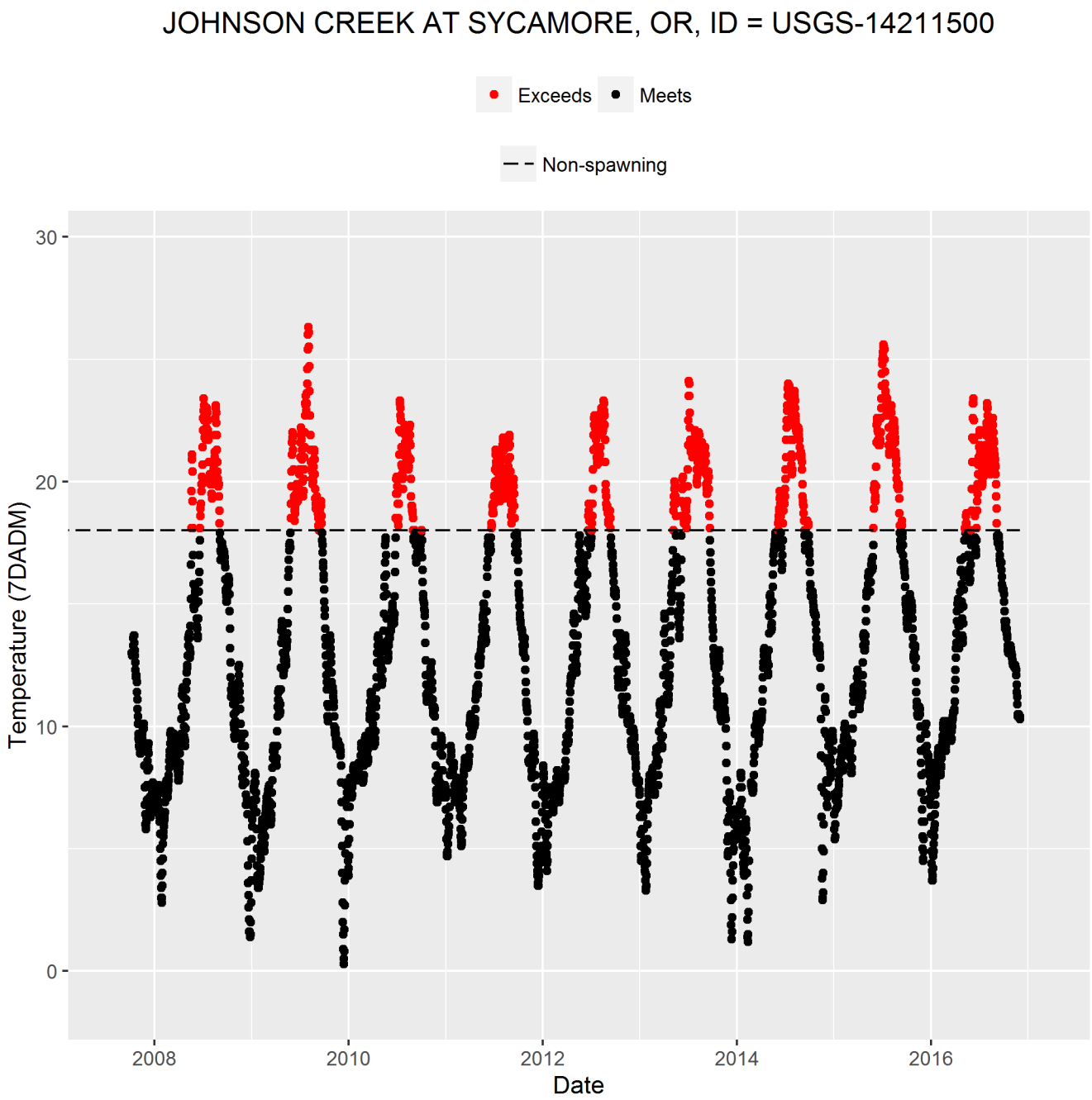

Figure 19- Temperature trends for Station ID USGS- 14211500; the WQ beneficial use is for salmon and trout rearing and migration with no spawning. Most exceedances of the WQS occur during July and August.

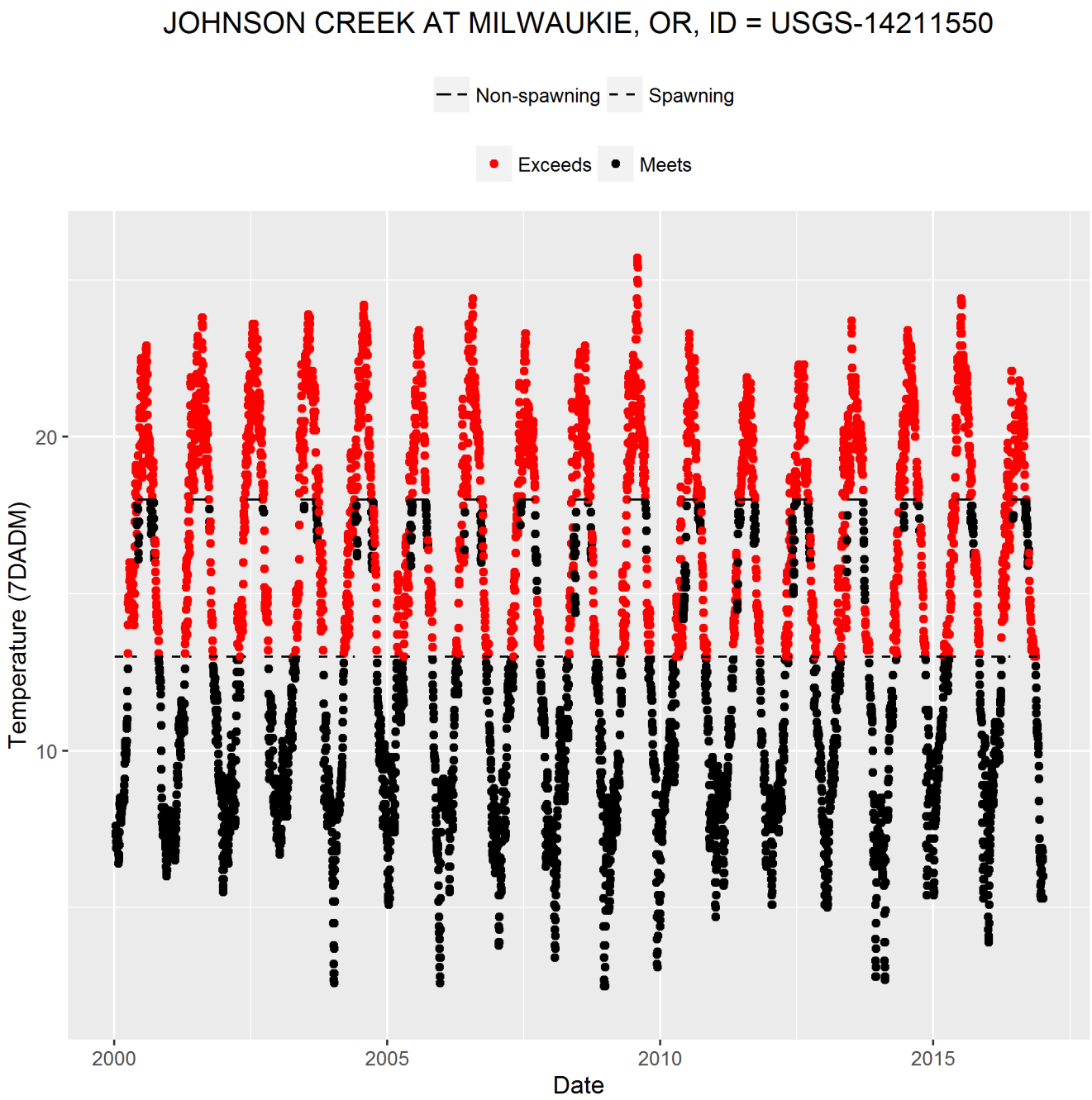

Figure 20- Temperature trends for Johnson Creek at Station USGS 14211550. Fish use designation is for salmon and trout rearing and migration with spawning occurring from Oct 15 - May 15

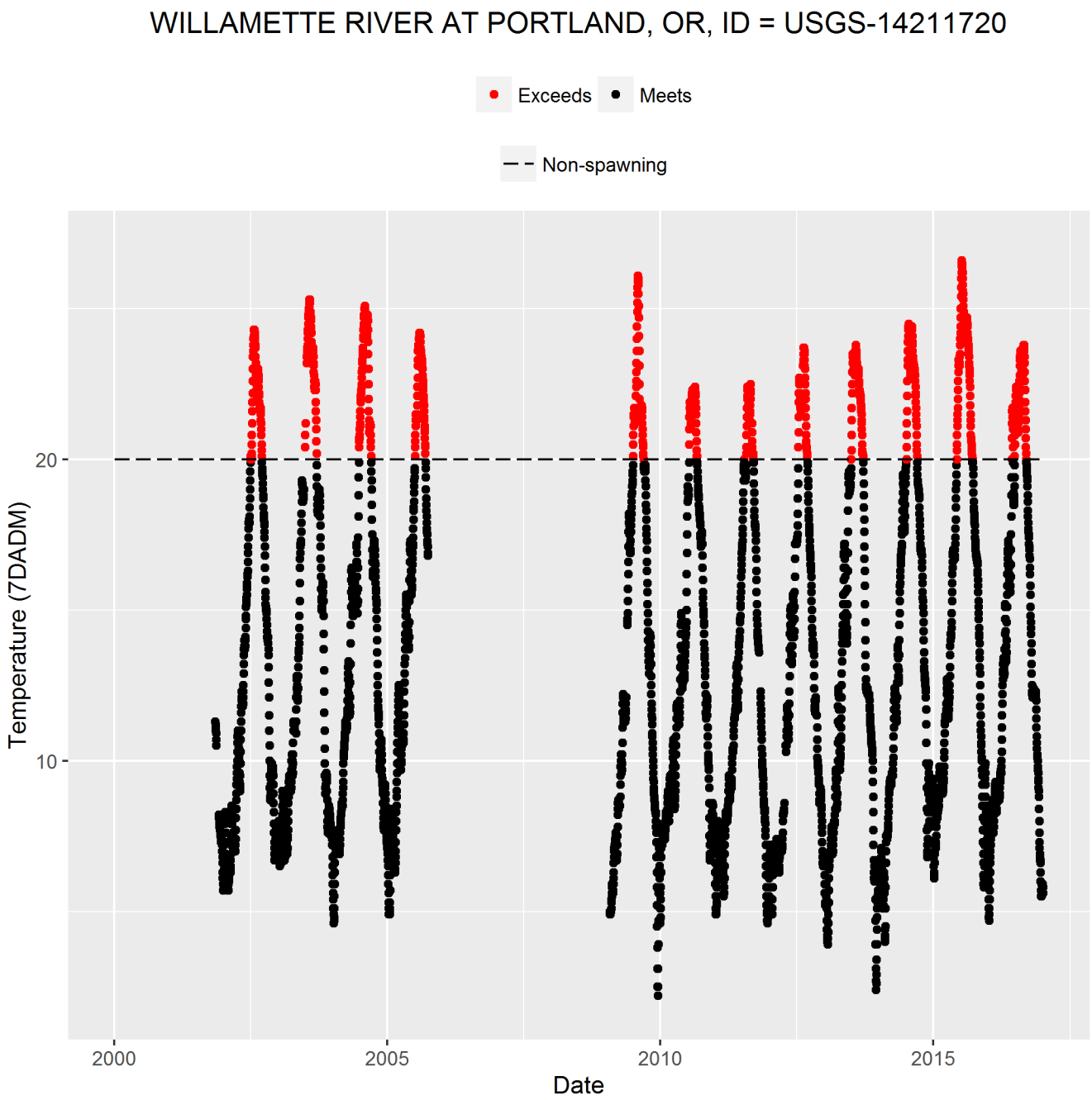

Figure 21- Temperature trends for the Willamette River at Station USGS 14211720, fish designation is for salmon and steelhead migration corridors with no spawning.

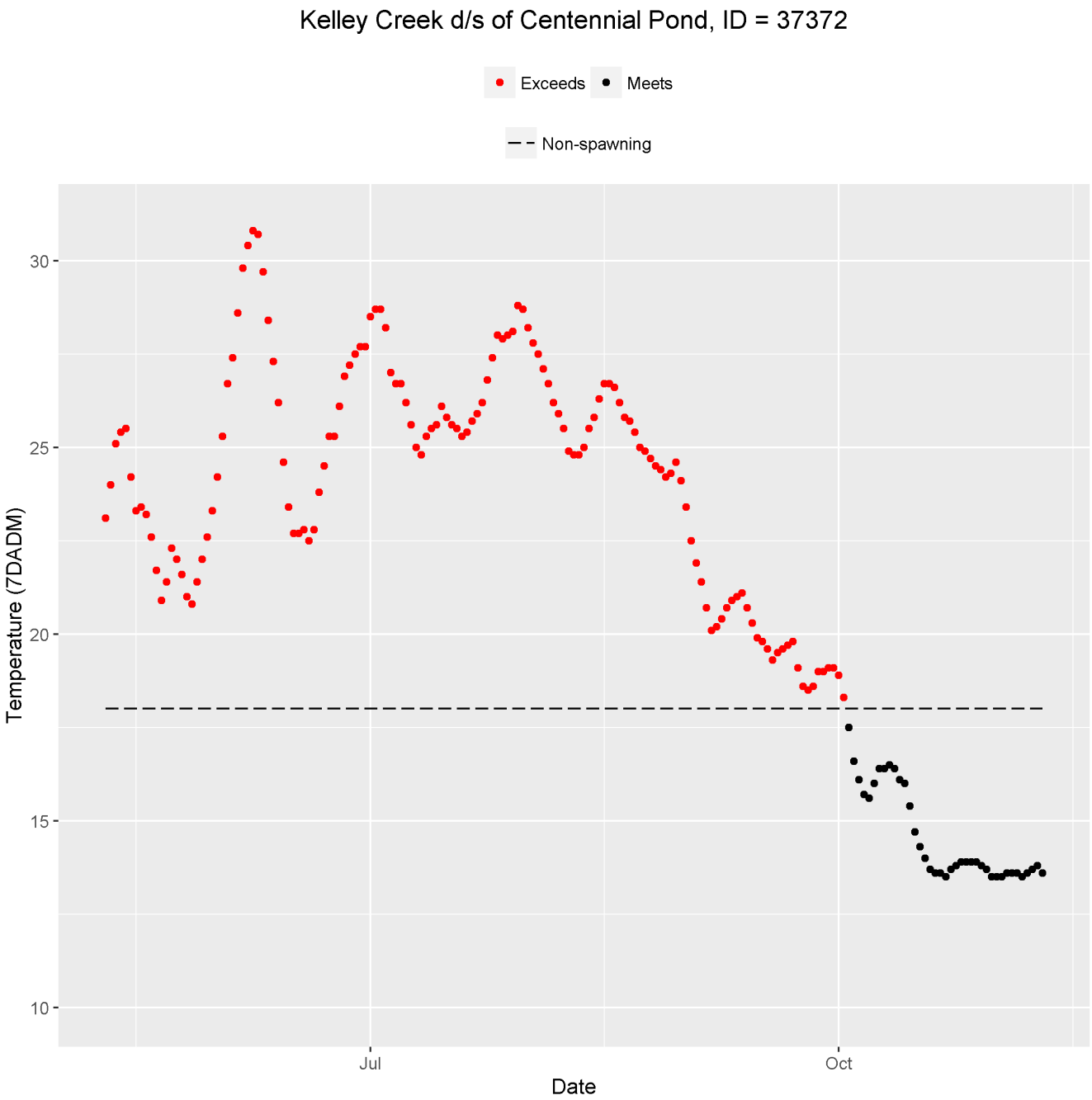

Figure 22- Temperature trends for Kelley Creek d/s of Centennial Pond (Station ID 37372), fish designation is for salmon and trout rearing and migration with no spawning.

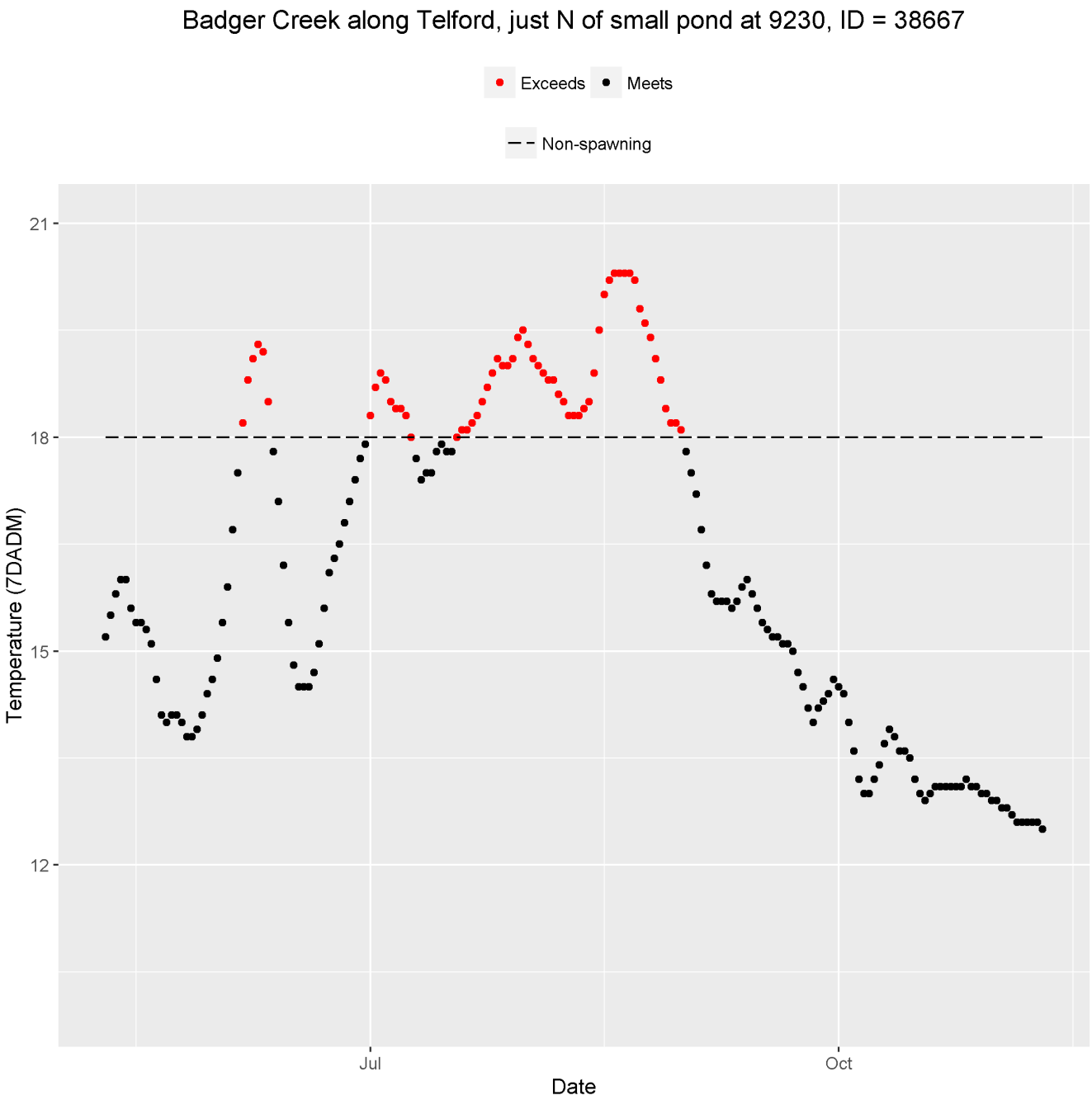

Figure 23- Temperature trends for Badger Creek along Telford, just N of small pond (Station 38667), fish designation is for salmon and trout rearing and migration with no spawning.

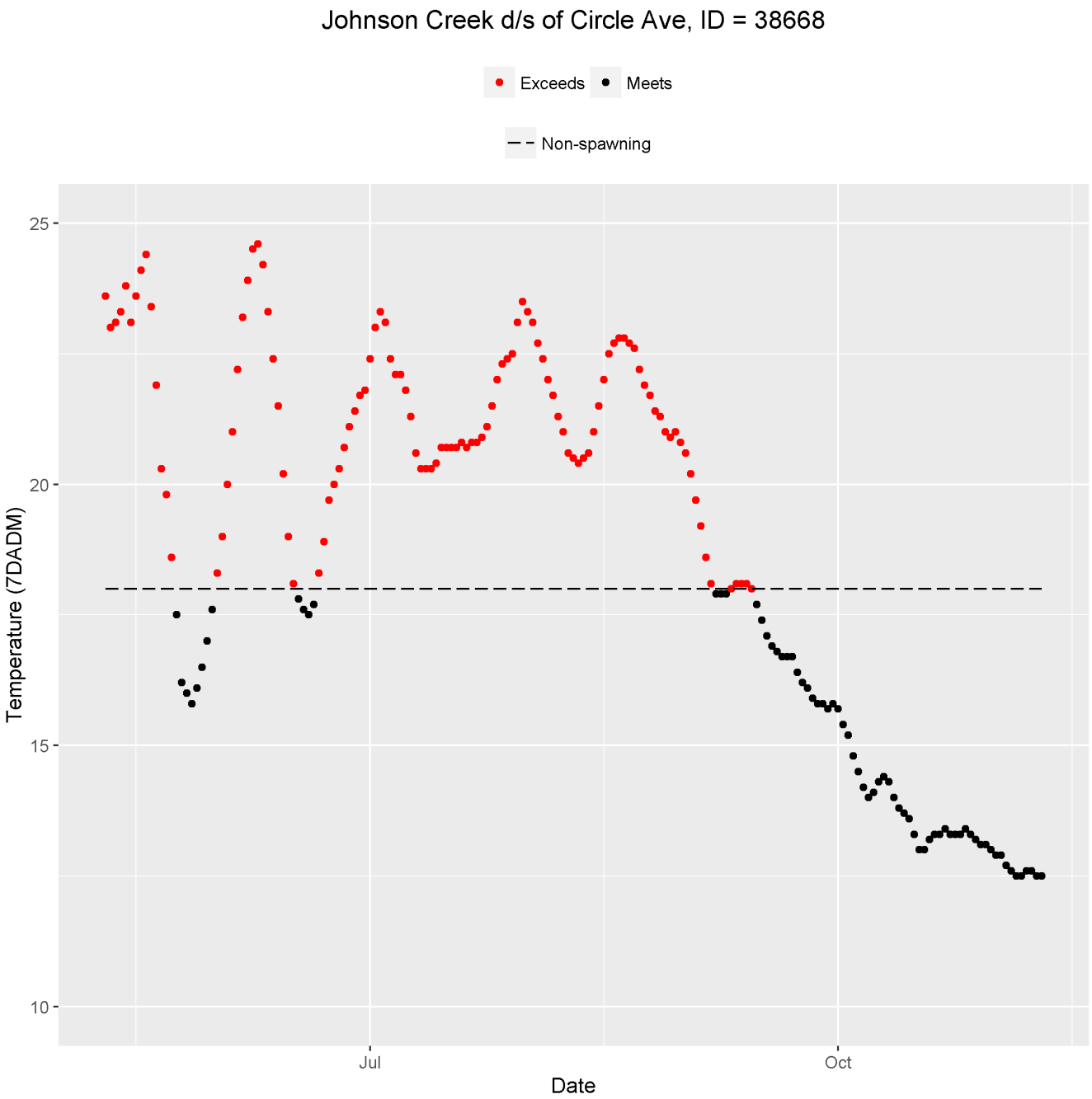

Figure 24- Temperature trends for Johnson Creek d/s of Circle Ave (Station 38668), fish designation is for salmon and trout rearing and migration with no spawning.

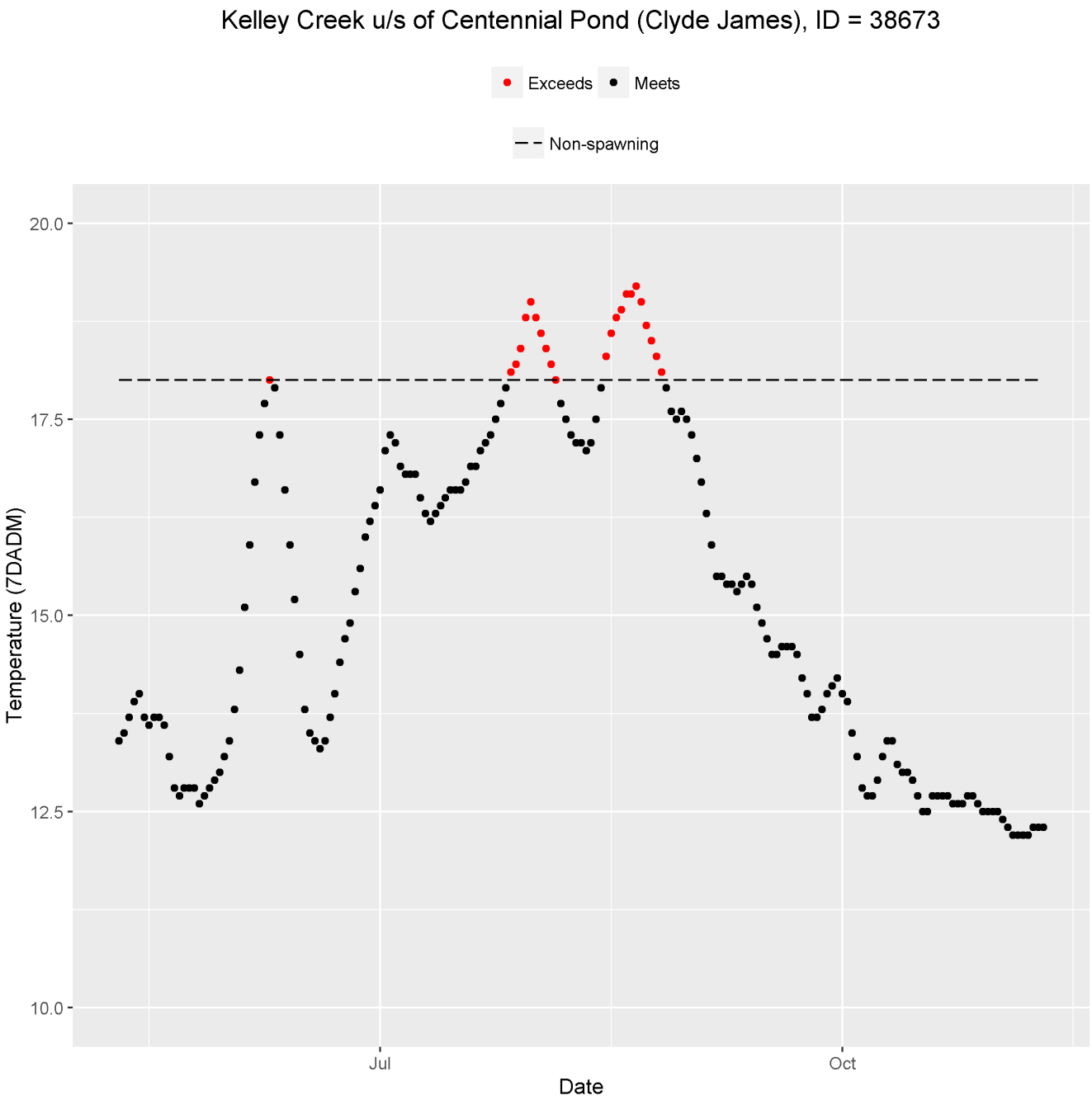

Figure 25- Temperature trends for Kelley Creek u/s of Centennial Pond (Station ID 38673), fish designation is for salmon and trout rearing and migration with no spawning.

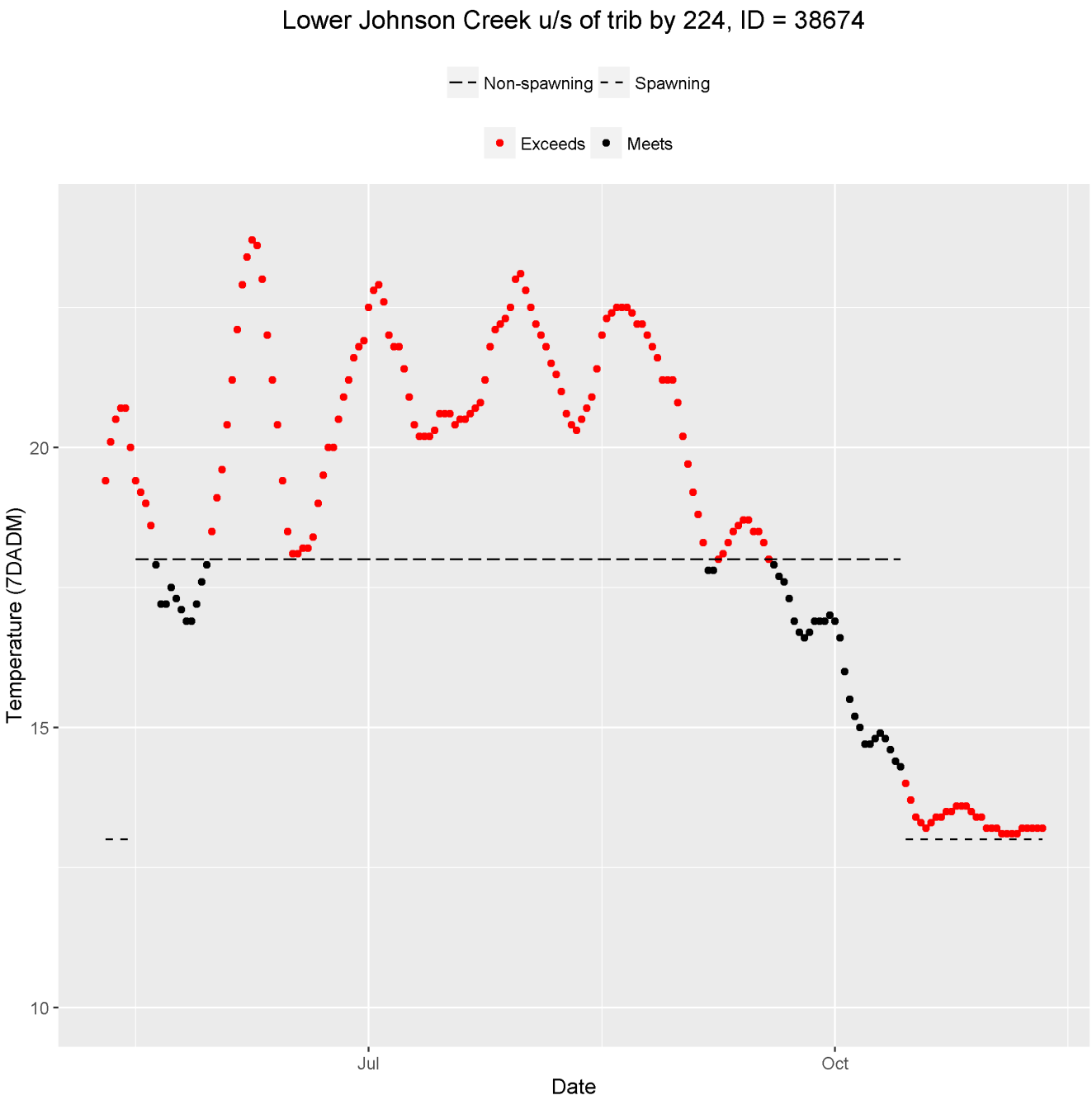

Figure 26- Temperature trends for Lower Johnson Creek (Station ID 38674), fish designation is for salmon and trout rearing and migration with spawning occurring from Oct 15 – May 15.

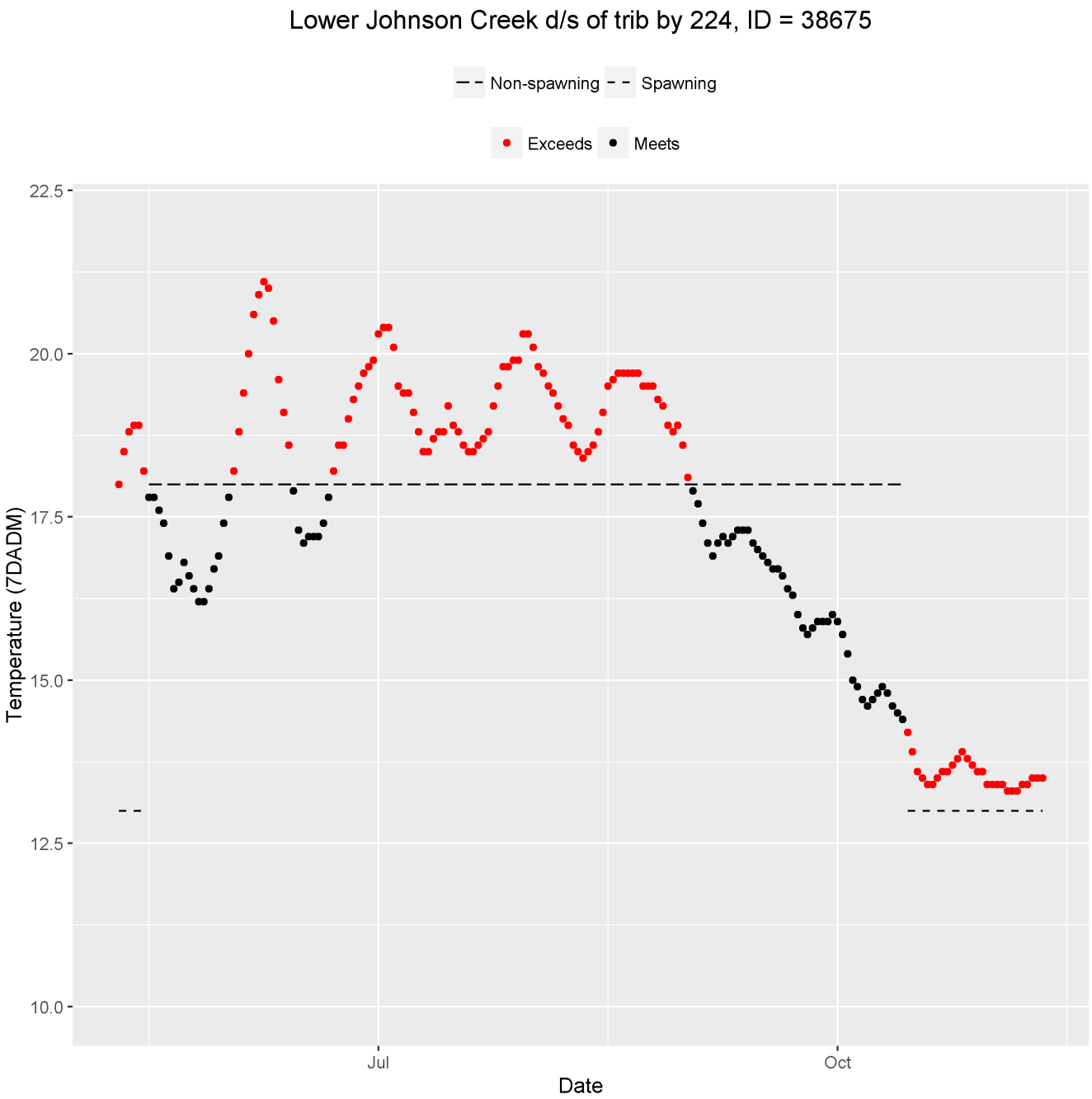

Figure 27- Temperature trends for Lower Johnson Creek (Station ID 38675), fish designation is for salmon and trout rearing and migration with spawning occurring from Oct 15 – May 15.

2.6 Dissolved Oxygen

Long-term data for dissolved oxygen concentration and saturation exists at five monitoring stations within the Lower Willamette AgWQ management area (Table 7). Most stations meet the WQS for dissolved oxygen with the exception of station 11201 which has two exceedances in 2009 (Table 7, Figure 21) and 11321 which has 15 exceedances occurring between 2000 and 2016 (Table 7, Figure 23).

Table 8- Dissolved oxygen trends for the Lower Willamette basin

Station ID	Observations	Meet b/c of DO saturation	Exceedances	%Exceedance
10332	125	0	0	0
10611	172	0	0	0
10801	122	0	1	0.81
11201	130	0	2	1.5
11321	114	4	15	13.2

10332-Willamette R at SP&S RR Bridge (Portland)
10611-Willamette R at Hawthorne Bridge
10801- Swan Island Channel Midpoint
11201- Columbia Slough at Landfill Road
11321- Johnson Creek at SE 17th avenue (Portland)

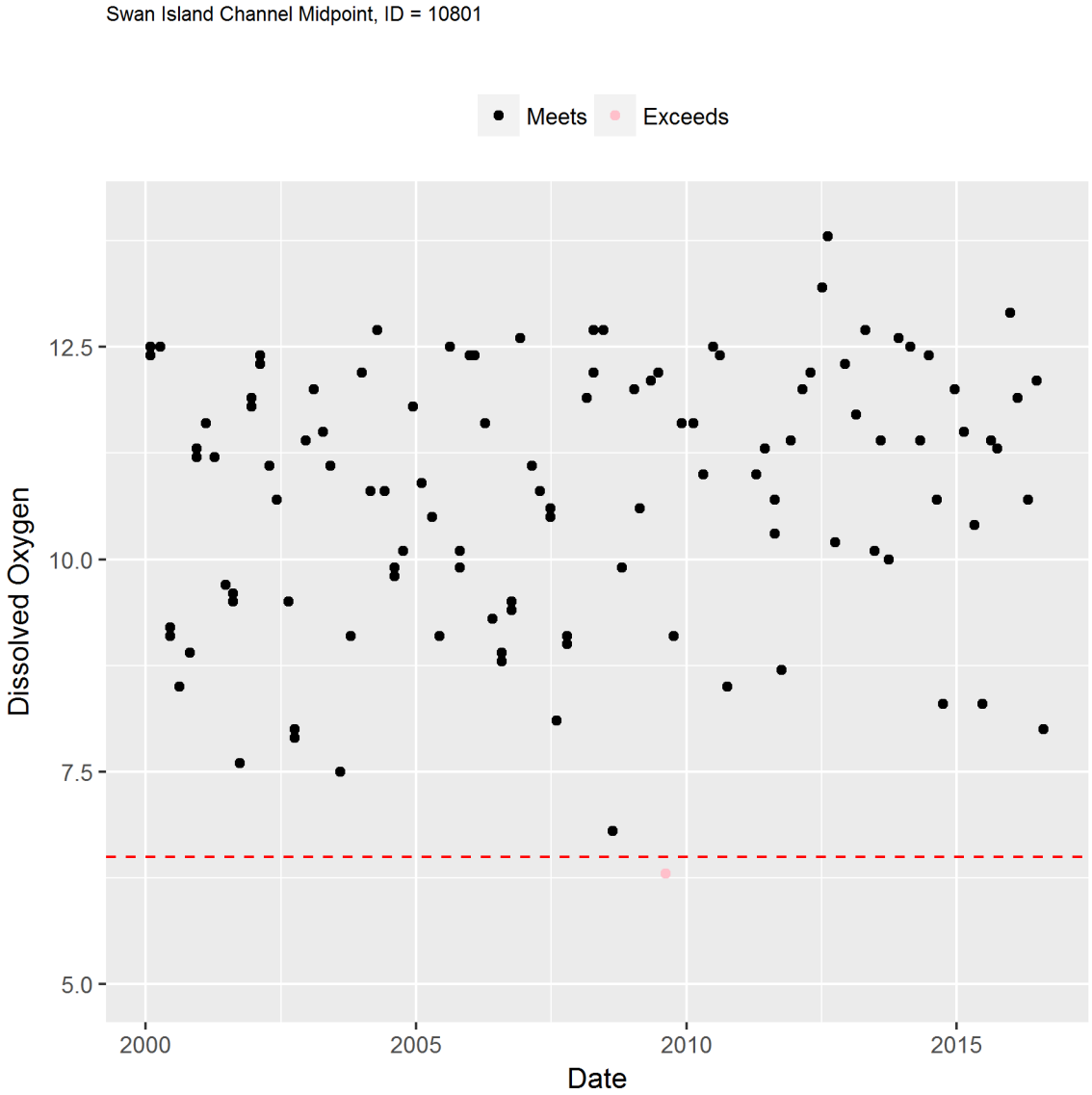

Figure 28- Salmon and Steelhead migration corridor (Cool Water Criterion); no spawning. The red-dashed line represents the dissolved oxygen concentration criteria for cool-water aquatic species.

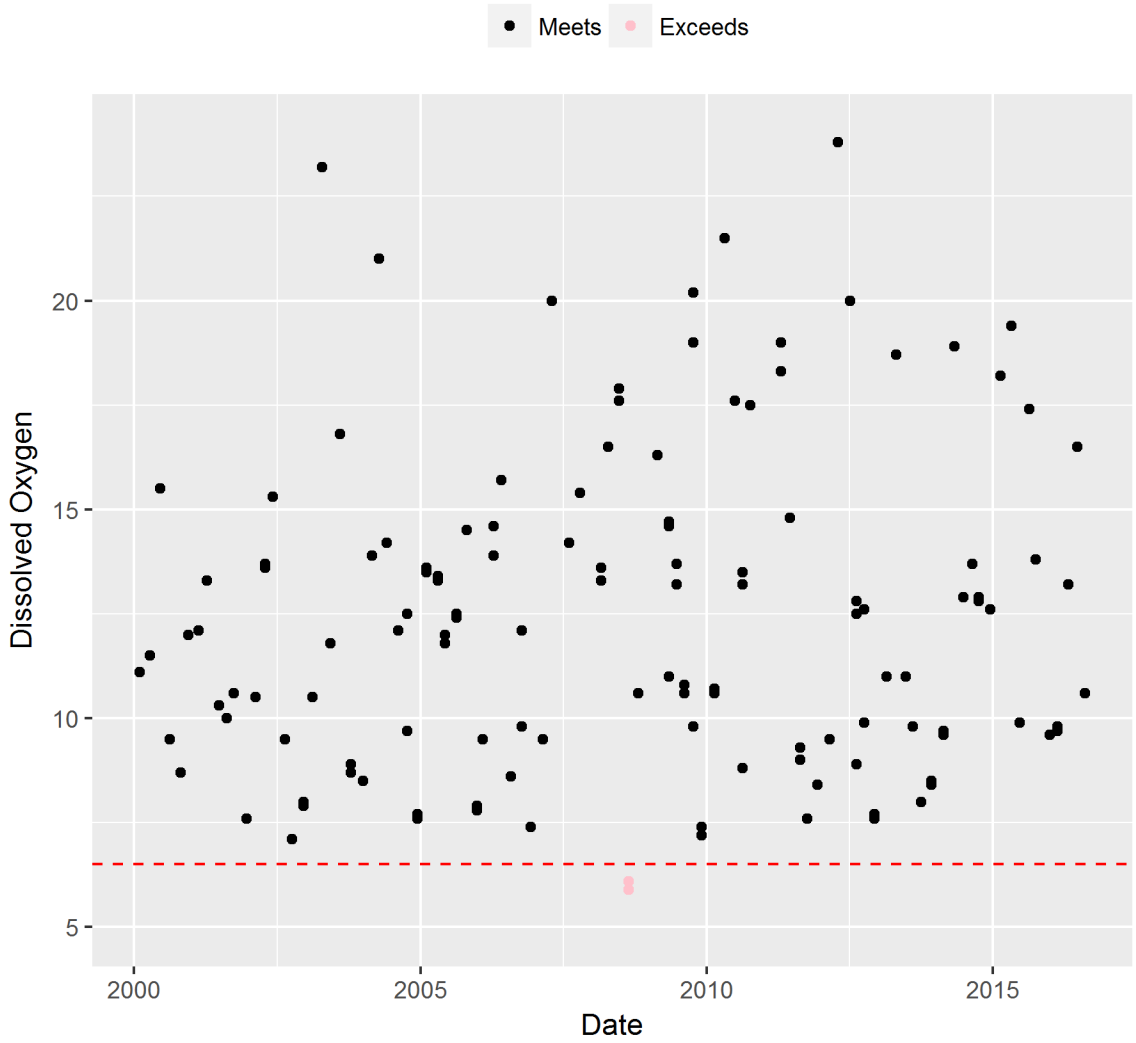

Figure 29- Salmon & Trout Rearing and Migration (Cold Water Criterion); no spawning. The red-dashed line represents the dissolved oxygen concentration criteria for cold-water aquatic species.

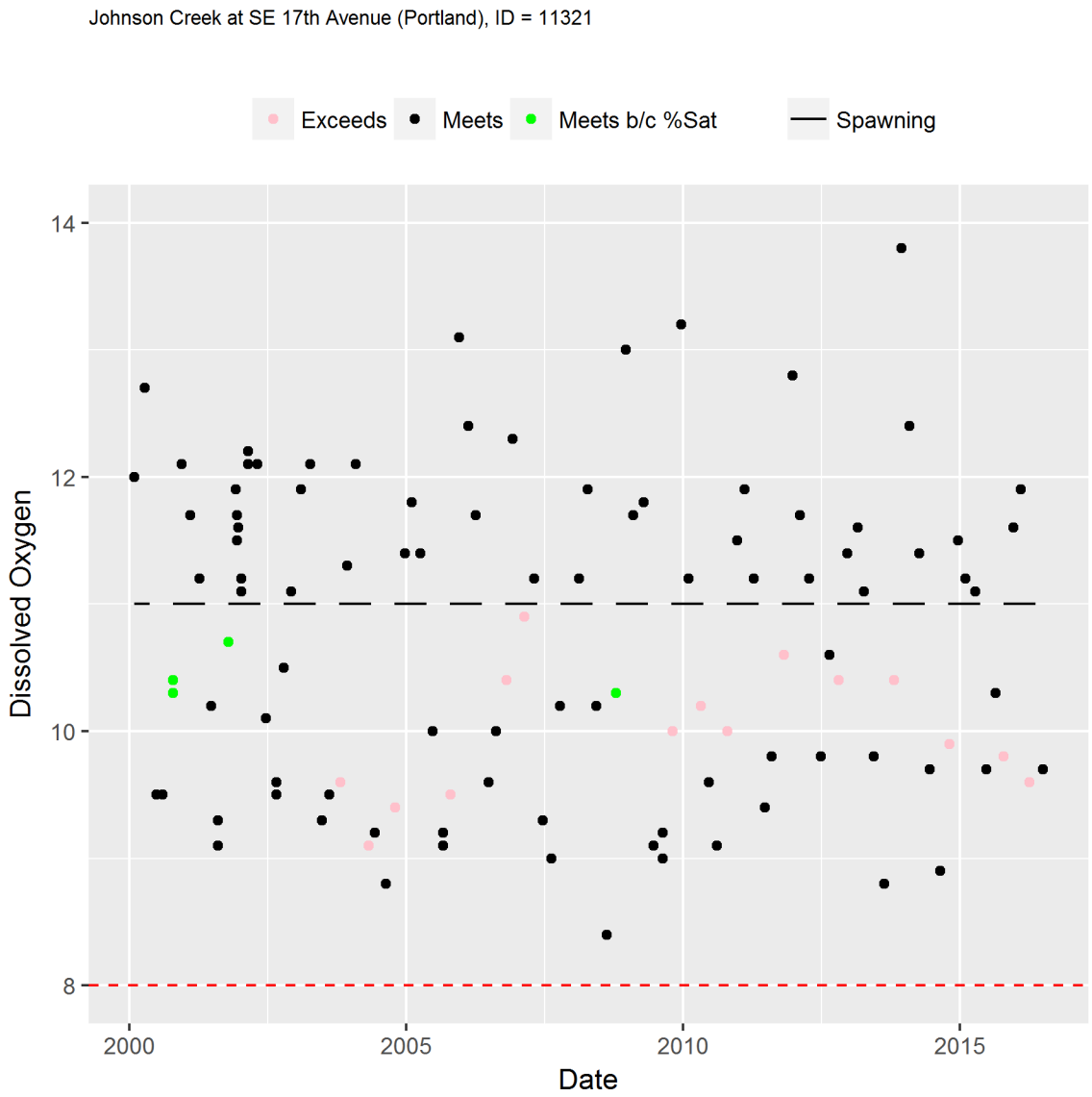

Figure 30- Salmon and trout rearing and migration (Cold-Water Criterion); spawning occurring Oct 15 – May 15. The red-dashed line represents the dissolved oxygen concentration criteria for cold-water aquatic species.

2.7 Additional Parameters included in the L. Willamette TMDL

Toxics data provided by the City of Gresham is summarized in figures 24 through 27. Four sites in the Johnson Creek watershed were sampled for a variety of parameters over two year period. Data that was less than the minimum reporting limit (<MRL) was marked as 'NA' and not included in the plots. Station descriptions are included in table 9.

Table 9- Station descriptions for City of Gresham provided data

Station ID	Station Description
JCI1	Johnson Creek at 174th Ave/Jenne Rd
JCI2	Johnson Creek at 252nd/Palmblad
KI1	Kelley Creek at Pleasant Valley Grange
KI2	Kelley Creek at Rodlun Road

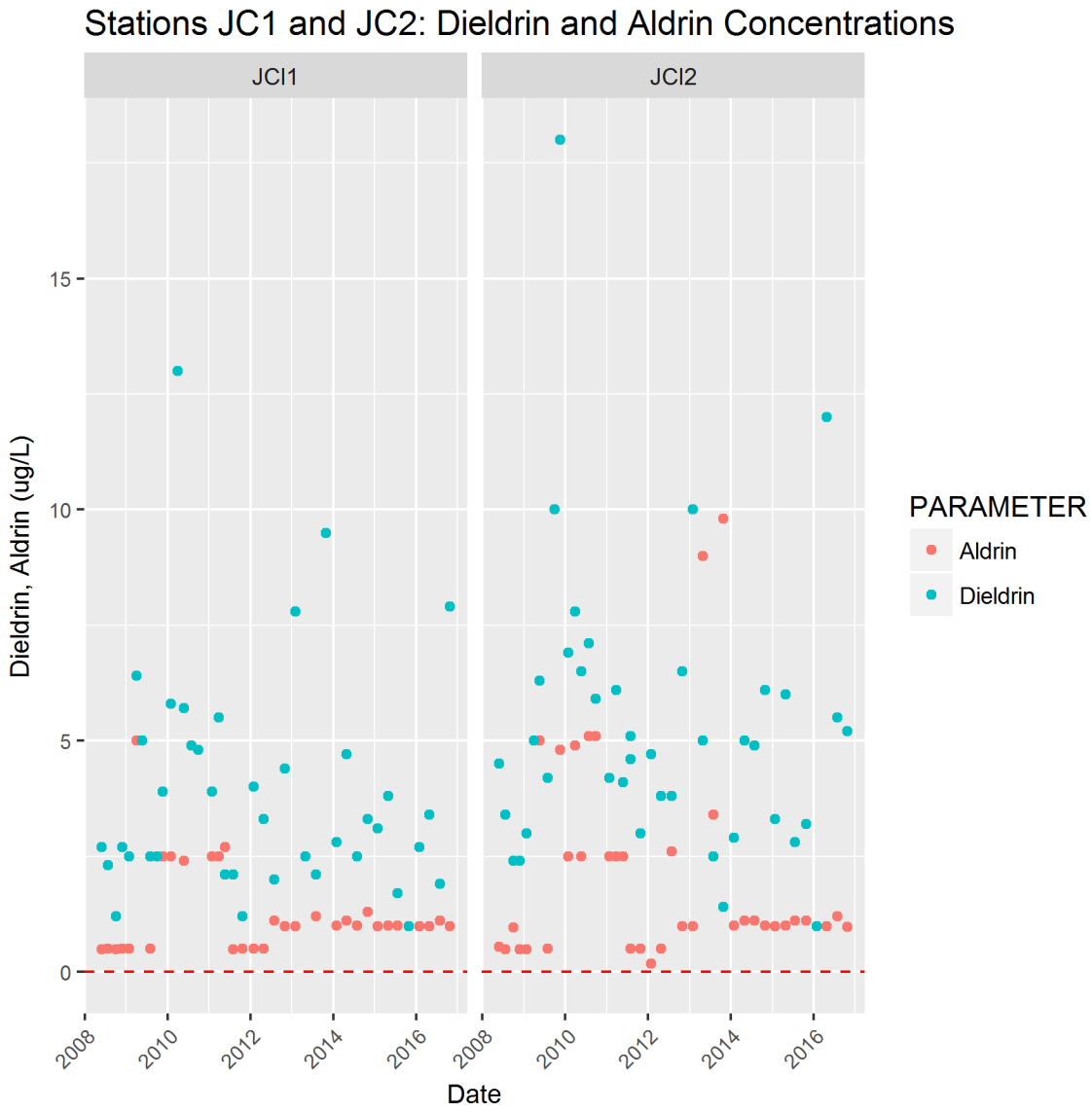

Figure 31- Dieldrin concentrations at two sites in the Johnson Creek watershed over an eight-year period, data provided by the City of Gresham. The dashed red line represents the aquatic life criterion of 0.056 ug/l, all values above 0.056 are considered exceedances. The aquatic life criterion for aldrin is 3 ug/L.

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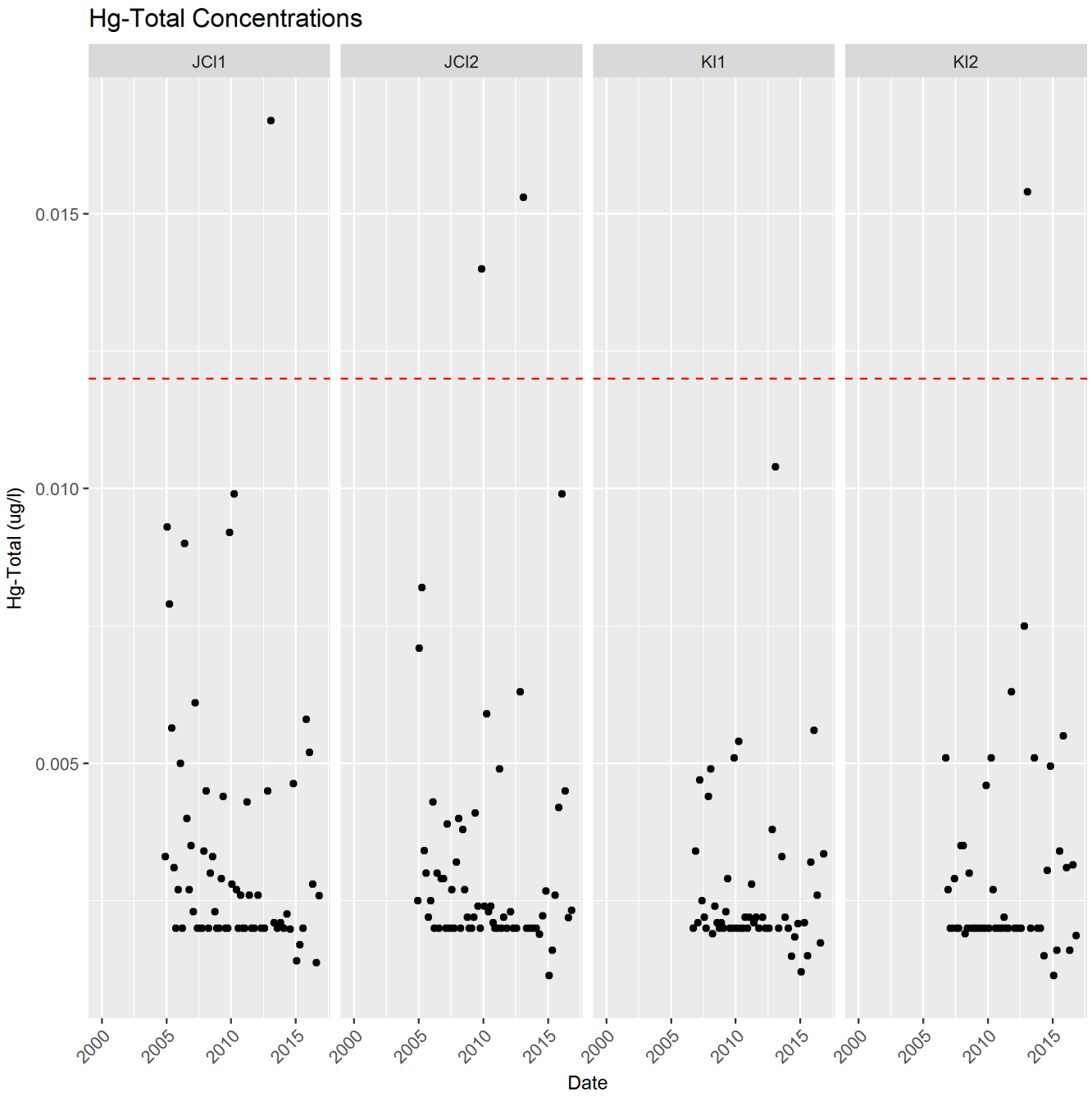

Figure 32- Mercury concentrations over an eight-year time period at four monitoring stations within the Johnson Creek watershed, provided by the City of Gresham. The dashed line represents the chronic mercury aquatic life criterion of 0.012 ug/l. Four results were above the criterion.

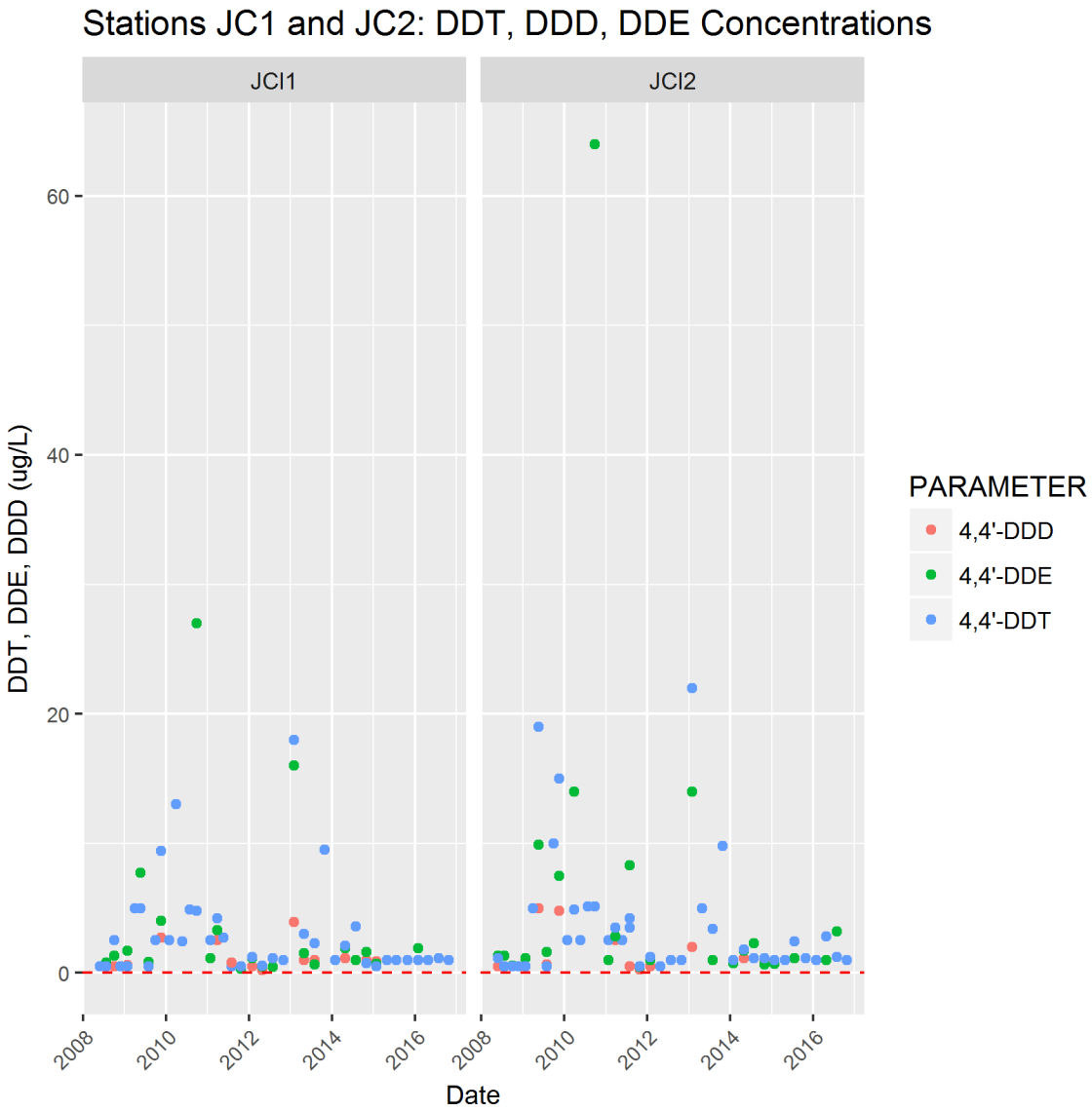

Figure 33- DDT, DDE, and DDD concentrations over an eight-year time period at two monitoring stations within the Lower Willamette Subbasin, provided by the City of Gresham. The chronic aquatic life criteria of 0.001 ug/l is represented by the dashed red line.

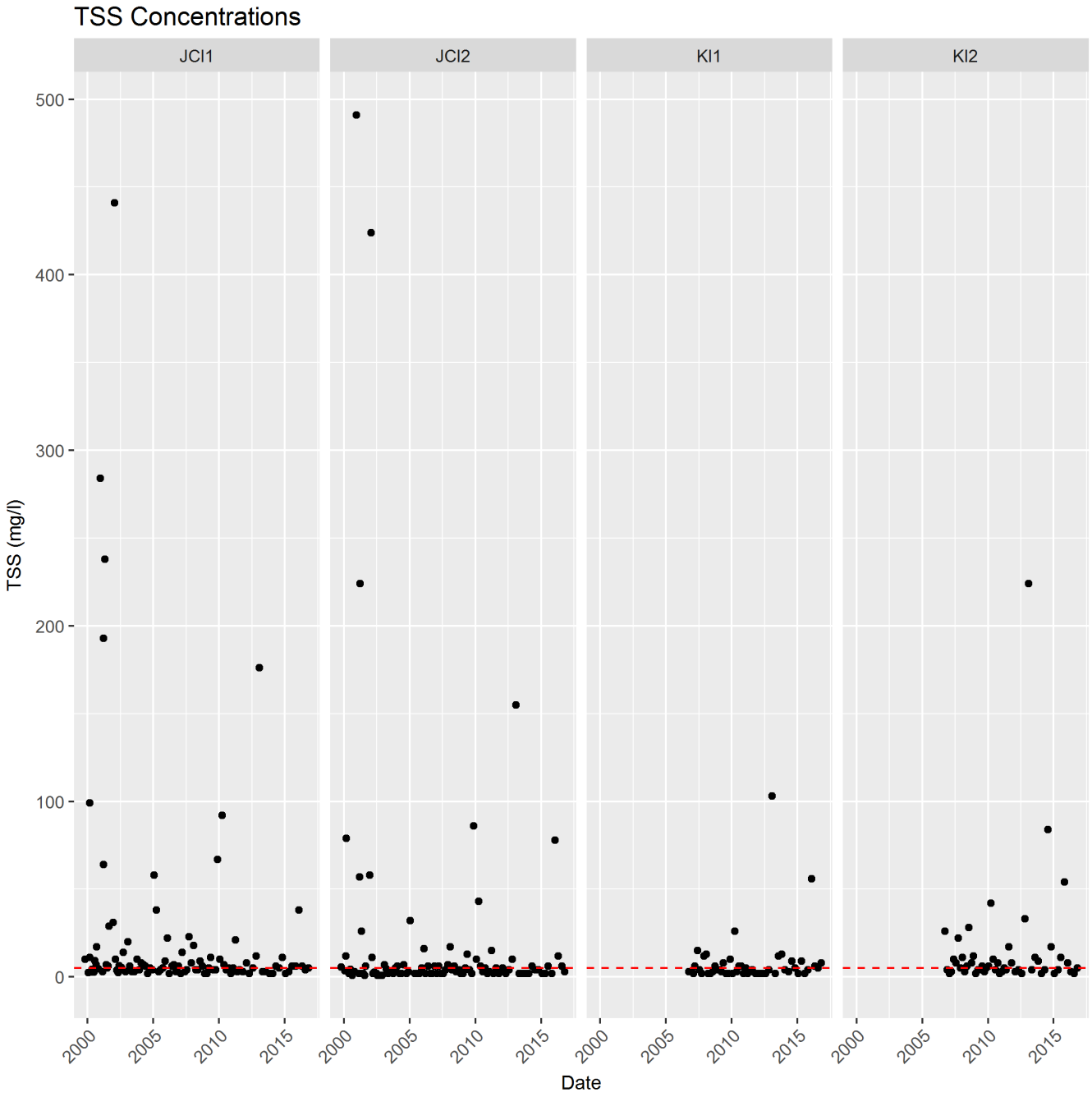

Figure 34- Total Suspended Solids (TSS) concentrations over an eight-year time period at four monitoring stations within the Johnson Creek watershed, provided by the City of Gresham. Dashed line represents the TMDL allocation for DDT and dieldrin when pollutant data is not available; exceedances are represented by data that is greater than 15 mg/l.

2.8 Parameter Summary

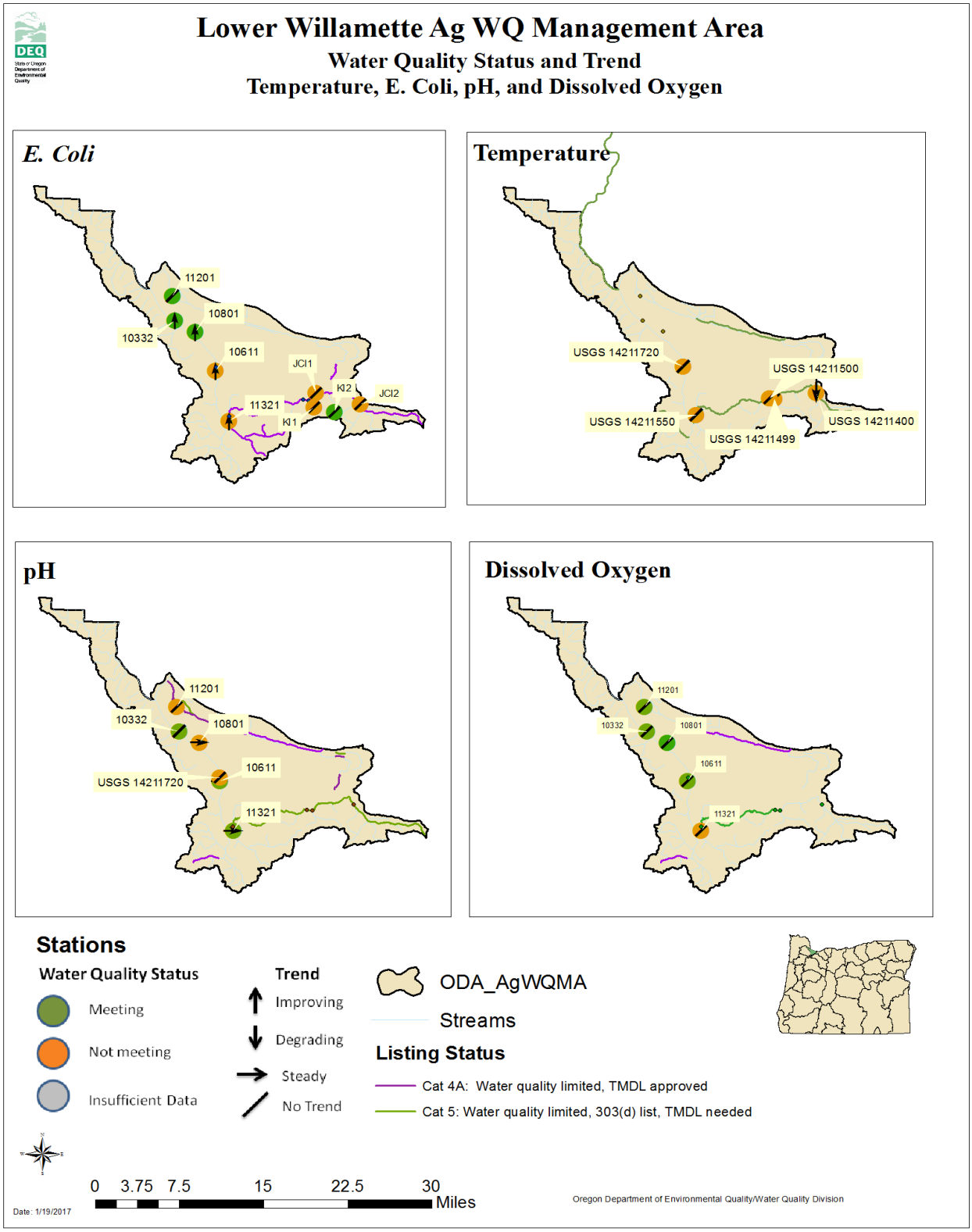

Figure 35- Summary of stations that fit the criteria for status and trends analysis. A single exceedance of the WQ standard within the last two years defined whether a station was 'Meeting' or 'Not Meeting'. Trend was determined by significant trends associated with long-term datasets. For details on when exceedances of the WQ standard occurred, see sections 2.3-2.6. Only significant trends were reported.

3. Conclusions

- **What are the overall trends?**[15]
  - *Temperature:* Five USGS stations contained sufficient data to observe long-term temperature trends within the Lower Willamette Subbasin. All stations had exceedances of the water quality standard, primarily during summer and late summer. Data provided by the Johnson Creek Watershed Council allowed for the assessment of temperature status at six locations during 2016. These stations had exceedances of the water quality standard.
  - *pH:* Stations 10332 and 10611 had no exceedances of the water quality standard during the 16-year timeframe and station 11321 was in compliance with the water quality standard when assessing water quality status. Station 10801 has an increase in exceedances of the water quality standard, beginning in 2008 and continuing through 2016.
  - *E.coli*: Improving *E.coli* trends are present in stations 10332, 10801, 10611, and 11321. Station 11201 is in compliance of the water quality standard during the 16-year timeframe, while all other stations have had some exceedances in the last 16-years. Stations 10801 and 10332 meet the water quality standard during the last two-years. All four City of Gresham monitoring stations in the Johnson Creek watershed routinely exceed the water quality standards.
  - *Dissolved Oxygen:* Stations 10611 and 10332 have no exceedances of the water quality standard during the last 16-years, while stations 11201 and 10801 have one to two exceedances occurring longer than two-years ago, meeting the criteria for status. Station 11321 has many exceedances of the water quality standard during the 16-year timeframe.
  - *Toxics:*
    - *Dieldrin and Aldrin:* data provided by the City of Gresham represents Dieldrin and Aldrin concentrations from 2008 through 2016 at two locations along Johnson Creek (JCI1 and JCI2). Every data point in the eight year time frame in exceedance of the chronic freshwater criterion for Dieldrin, (0.056 ug/l).
    - *Mercury:* Four stations contain data to assess trends of mercury from 2004 to 2016. Station KI1 had no exceedances of the chronic freshwater mercury criteria, while JCI1 and KI2 had one exceedance and JCI2 had two.
    - *DDT, DDD, DDE:* Data was available to assess trends from 2008-2016 of DDT, DDE, and DDD at two sites in Johnson Creek (JCI1 and JCI2). All results were above the chronic freshwater criteria for DDT (0.001 ug/l) at both locations.

[15] Station Descriptions:
10332 -Willamette R at SP&S RR Bridge (Portland)
10611-Willamette R at Hawthorne Bridge
10801- Swan Island Channel Midpoint
11201- Columbia Slough at Landfill Road
11321- Johnson Creek at SE 17th avenue (Portland)
USGS- 1411720 Willamette River at Portland, OR
USGS- 14211400 Johnson Creek at Regner Road at Gresham OR
USGS- 14211499 Kelly Creek at SE 159th Dr at Portland OR
USGS- 14211500 Johnson Creek at Sycamore OR
USGS 14211550 Johnson Creek at Milwaukie OR
KI1- Kelley Creek at Pleasant Valley Grange
KI2- Kelley Creek at Rodlun Road
JCI1- Johnson Creek at 174th Ave/Jenne Rd
JCI2- Johnson Creek at 252nd/Palmblad

- *Total Suspended Solids (TSS):* TSS is used as a surrogate measure for DDT in the Lower Willamette TMDL with values greater than 15 mg/l identified as exceeding the TMDL load allocation. Two sites contain data to assess TSS trends from 2000 to 2016 (JCI1 and JCI2) and two sites have data from 2006 – 2016 (KI1 and KI2). Each of the four stations have many exceedances of the TMDL allocation.

- **Is the monitoring data adequate to address status and trends in relation to WQ standards and TMDL load allocations?**
  - E. coli data in Johnson Creek is only available through DEQ at the mouth (Station 11321 – Johnson Creek at SE 17th Ave), the station has 15% of its upstream area with agricultural land use, and shows consistent exceedance of the water quality standard. However, the station has a declining trend of about 16 MPN/100mL per year. The City of Gresham has provided E. coli data at two additional sites on Johnson Creek (JCI1 and JCI2) which also have consistent exceedances of the water quality standard. Two stations on Kelley Creek also contain data for E. coli, provided by the City of Gresham. Kelley Creek at Pleasant Valley Grange (KI1) has consistent exceedances of the water quality standard, while Kelley Creek at Rodlum Road (KI2) has few exceedances.
  - This report did not analyze nutrients data but pH data in the lower Columbia Slough (Station 11201) indicates that there is an increase in the number of exceedances of the pH water quality standard there.
  - In order to address the status and trend of nutrient concentrations in relation to the Columbia Slough TMDL load allocations additional monitoring is needed in areas more immediately downstream of agricultural lands.
  - Temperature data analyzed at stations in the upper portion of Johnson Creek where higher percentages of agricultural land are present are consistently not meeting the temperature water quality standard. The sampling station on Johnson Creek at Regner Road in Gresham (USGS-14211400) has 32% agricultural land use in its upstream area and shows an increase in the mean August seven day average daily maximums.
  - All stations within the Lower Willamette AgWQ management area are represented by varied land uses, mostly dominated by urban, agriculture and forest. Additional data is needed to evaluate site potential vegetation on the agricultural land, which would require remote sensing data to determine tree heights and calculate effective shade.
  - Dissolved oxygen data is not available in upper Johnson Creek but at the mouth there are consistent exceedances of the water quality standard during the spawning time period.
  - In order to address the status and trend of dissolved oxygen in relation to the water quality standard near agricultural land additional monitoring is needed in areas more immediately downstream of agricultural lands.
  - Data provided by the City of Gresham was adequate to address the status of DDT, Dieldrin water quality standards and TSS TMDL load allocations and showed consistent exceedance of those criteria.

Appendix A

Pages A-1 through A-X

Revision	Date	Changes	Editor

Table A- 1- Stations that have eight or more years of consecutive data; values represent amount of data points in each given year.

Station ID	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Analyte
10332	1	8	8	8	8	6	8	10	7	12	8	8	9	9	11	15	10	pH
10611	1	12	13	11	12	14	12	12	16	15	10	6	13	7	7	7	4	pH
10801	3	12	12	8	8	8	14	10	9	7	9	8	11	10	9	7	4	pH
11201	1	6	10	10	10	16	8	7	10	14	8	7	12	8	11	11	6	pH
11321	1	17	15	6	6	8	6	5	8	6	9	7	9	6	7	6	3	pH
USGS-14211720	1	14	16	14	15	10	9	19	18	15,996	16,145	17,201	17,346	16,562	17,523	17,506	15,946	pH
10332	1	7	8	9	7	6	7	7	6	7	8	6	6	9	8	10	7	Temp
10611	1	12	12	11	12	13	12	11	14	15	10	6	8	7	6	6	4	Temp
10801	2	9	9	7	7	7	10	7	6	6	5	7	7	7	7	6	4	Temp
11201	1	3,204	4,305	8	8	11	7	5	7	11	7	6	9	7	8	8	5	Temp
11321	1	15	4,950	6	6	7	6	5	6	6	6	6	8	7	6	6	3	Temp
USGS-14211400	NA	NA	NA	NA	NA	NA	NA	8,832	35,031	34,632	34,936	35,001	34,166	35,028	34,331	34,073	32,186	Temp
USGS-14211499	NA	NA	NA	NA	NA	NA	NA	8,835	34,750	35,040	35,254	41,303	20,141	26,817	34,605	35,410	32,141	Temp
USGS-14211500	NA	NA	NA	NA	NA	NA	NA	4,417	17,518	17,442	24,421	35,034	35,134	35,040	34,668	34,943	32,248	Temp
USGS-14211550	NA	NA	1	NA	NA	NA	NA	4,418	17,520	17,519	21,938	34,559	32,684	28,083	34,148	34,840	32,148	Temp
USGS-14211720	1	14	16	14	15	10	9	19	18	16,100	17,106	17,299	17,346	17,482	17,533	17,520	16,119	Temp
10332	1	14	9	6	7	6	7	7	6	8	8	6	6	9	7	9	7	E. coli
10611	2	24	18	14	12	13	12	11	12	12	9	6	8	7	5	5	4	E. coli
10801	4	18	14	7	6	7	10	7	6	7	5	7	7	7	6	6	4	E. coli
11201	2	10	8	8	8	11	7	5	7	13	7	6	9	7	7	8	5	E. coli
11321	2	24	15	6	6	7	6	5	6	5	6	6	8	7	6	6	3	E. coli

Table A- 2- Stations that have sufficient data to assess status (or calculate 7DADM for temperature); values represent amount of data points in each given year

Station ID	2014	2015	2016	Total Data Points	Analyte
10332	11	15	10	36	pH
10611	7	7	4	18	pH
10801	9	7	4	20	pH
11201	11	11	6	28	pH
11321	7	6	3	16	pH
USGS-14211720	17,523	17,506	15,946	50,975	pH
10332	7	9	7	23	E. coli
10611	5	5	4	14	E. coli
10801	6	6	4	16	E. coli
11201	7	8	5	20	E. coli
11321	6	6	3	15	E. coli
10332	8	10	7	25	Temperature
10611	6	6	4	16	Temperature
10801	7	6	4	17	Temperature
11201	8	8	5	21	Temperature
11321	6	6	3	15	Temperature
USGS-14211400	34,331	34,073	32,186	100,590	Temperature
USGS-14211499	34,605	35,410	32,141	102,156	Temperature
USGS-14211500	34,668	34,943	32,248	101,859	Temperature
USGS-14211550	34,148	34,840	32,148	101,136	Temperature
USGS-14211720	17,533	17,520	16,119	51,172	Temperature

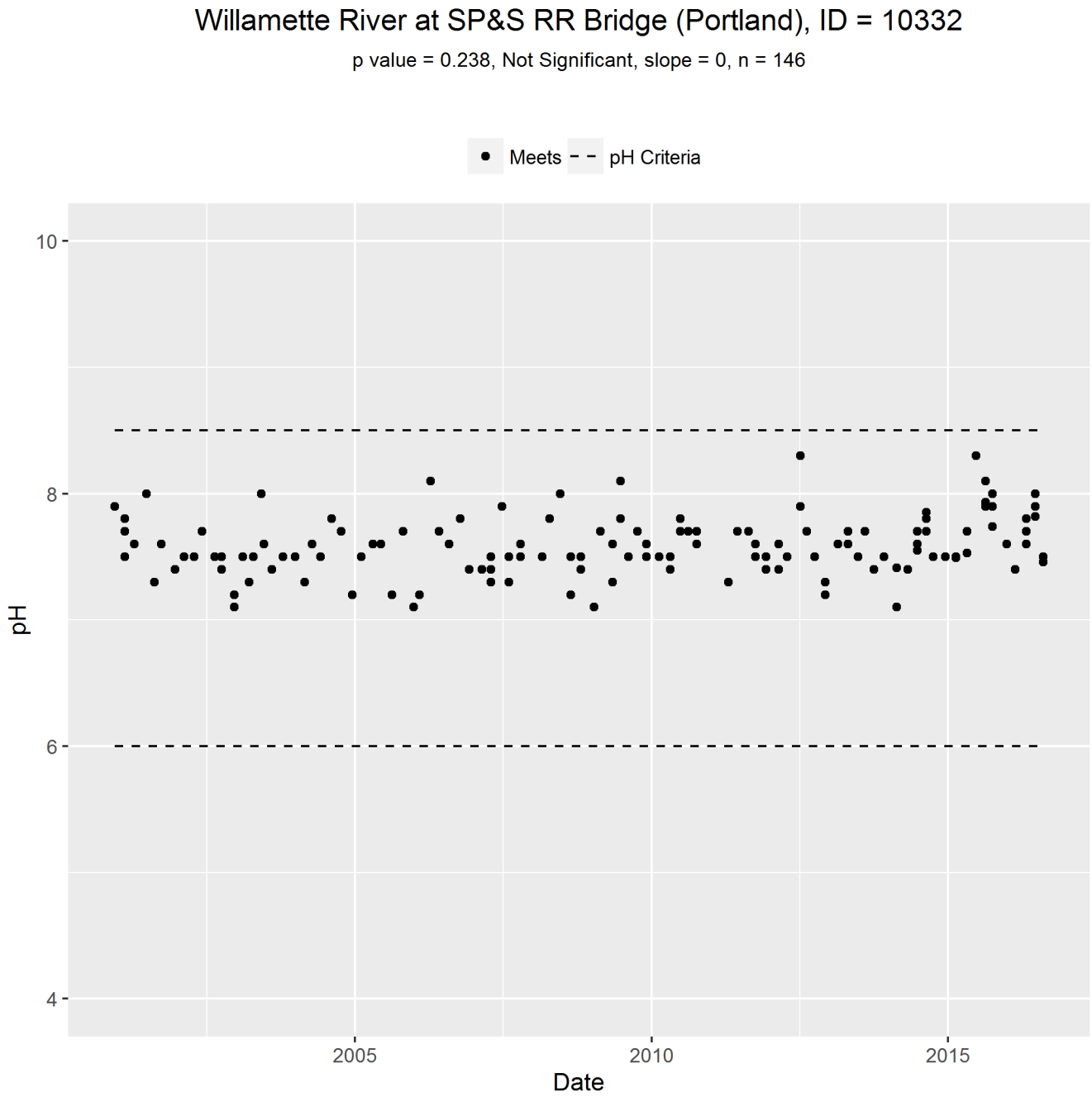

Figure A- 1- pH trends for Station 10332, no exceedances of the WQS occurred between 2000 and 2016

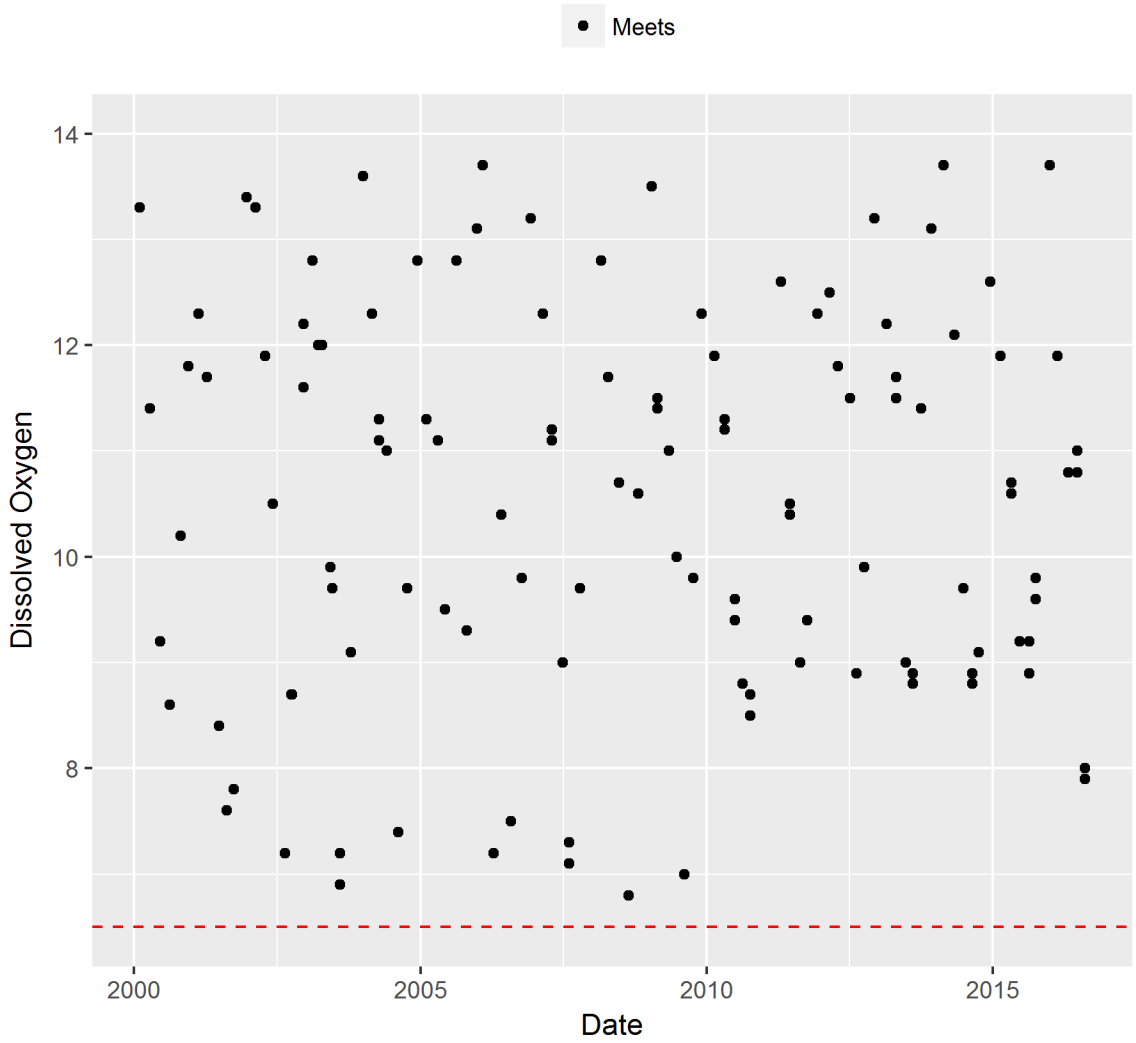

Figure A- 2- Dissolved oxygen status and trends at Station 10332. The aquatic beneficial use is for salmon and steelhead migration corridor (Cool Water Criterion) with no spawning.

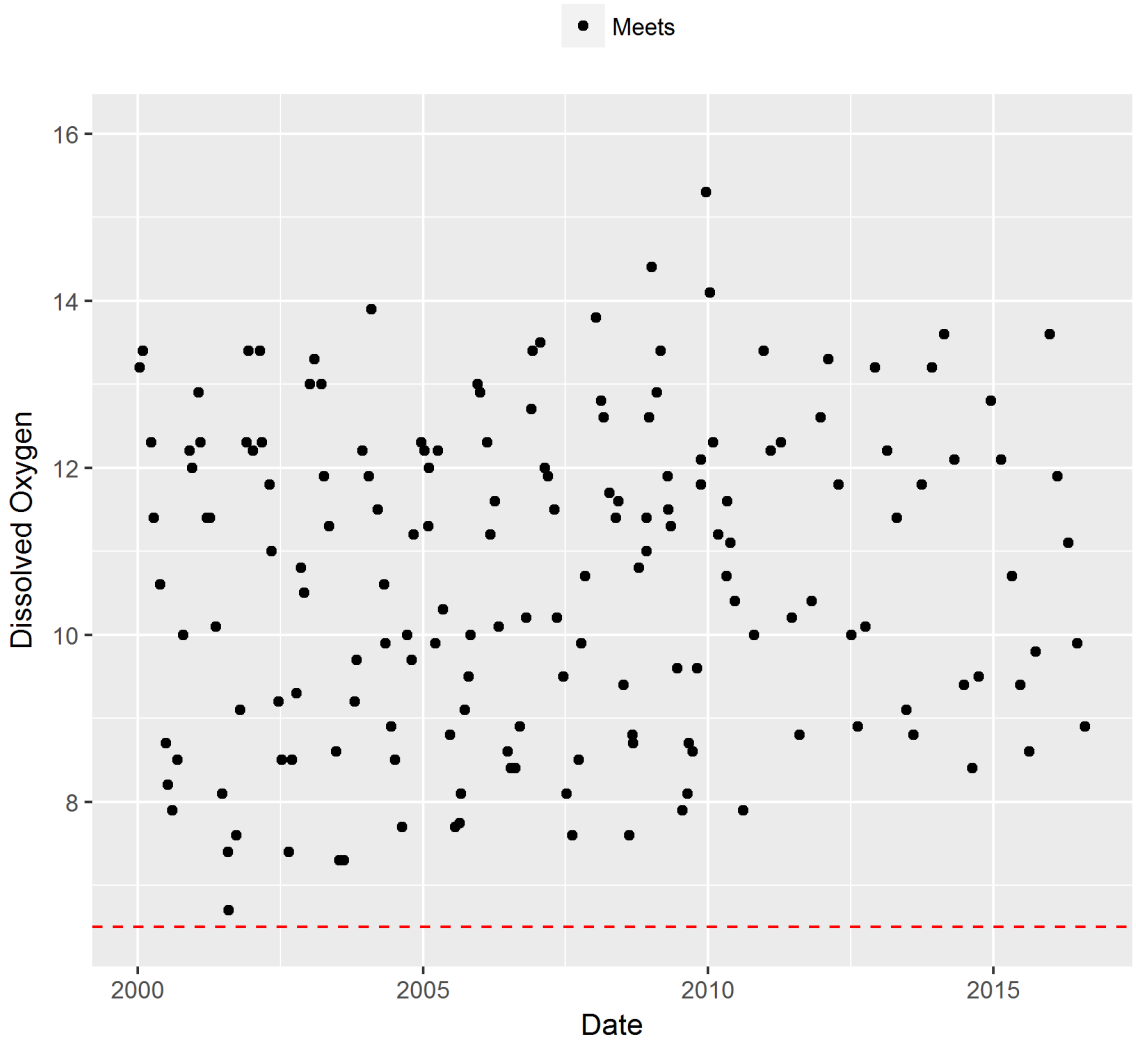

Figure A- 3- Salmon and Steelhead migration corridor (Cool Water Criterion); no spawning

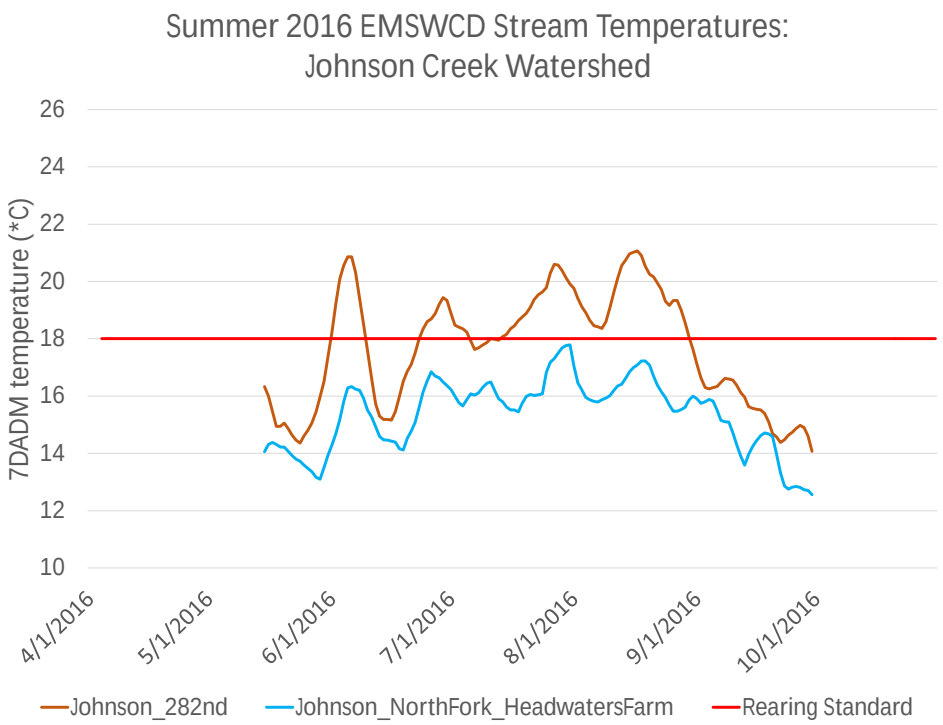

Figure A- 4- Summer stream temperatures during 2016, provided by the East Multnomah Soil Water and Conservation District

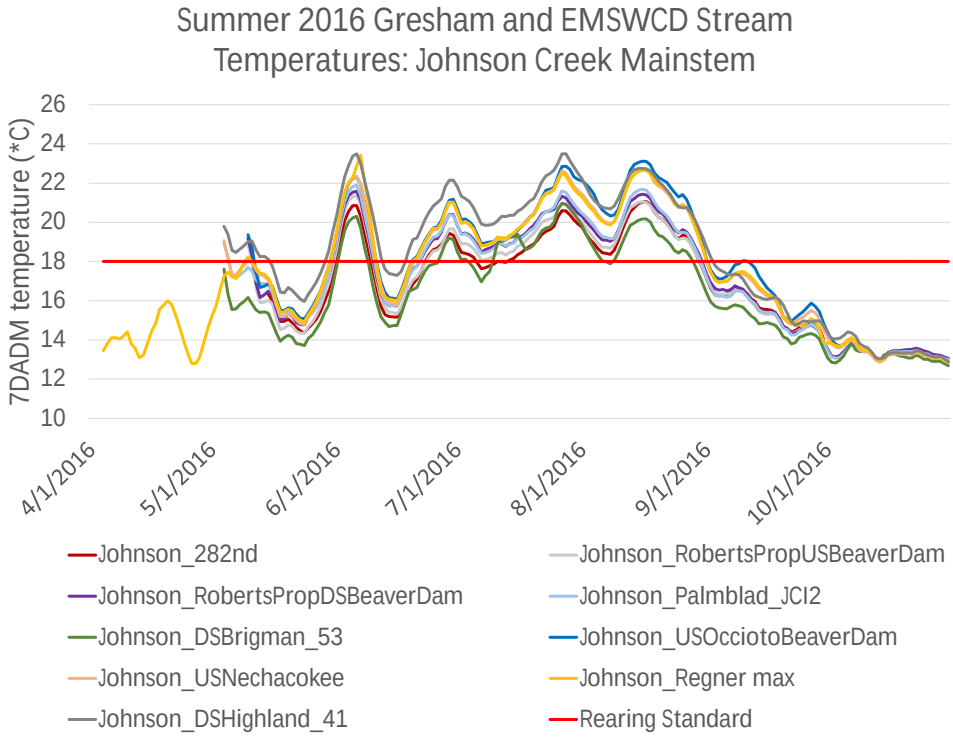

Figure A- 5- Johnson Creek temperature at various sites in Gresham, provided by the East Multnomah Soil Water and Conservation District

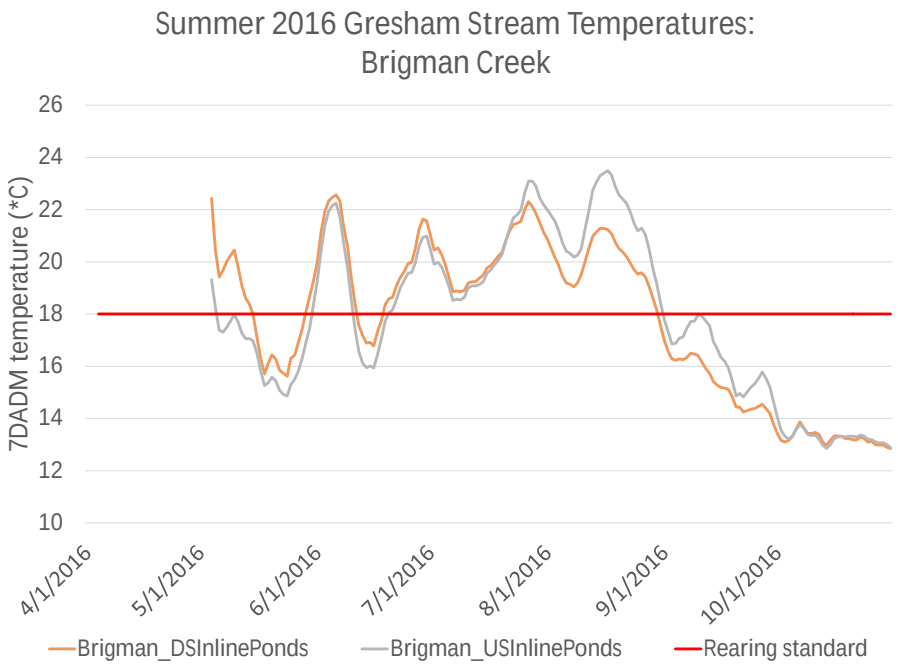

Figure A- 6- Brigham Creek temperature, provided by the East Multnomah Soil Water and Conservation District

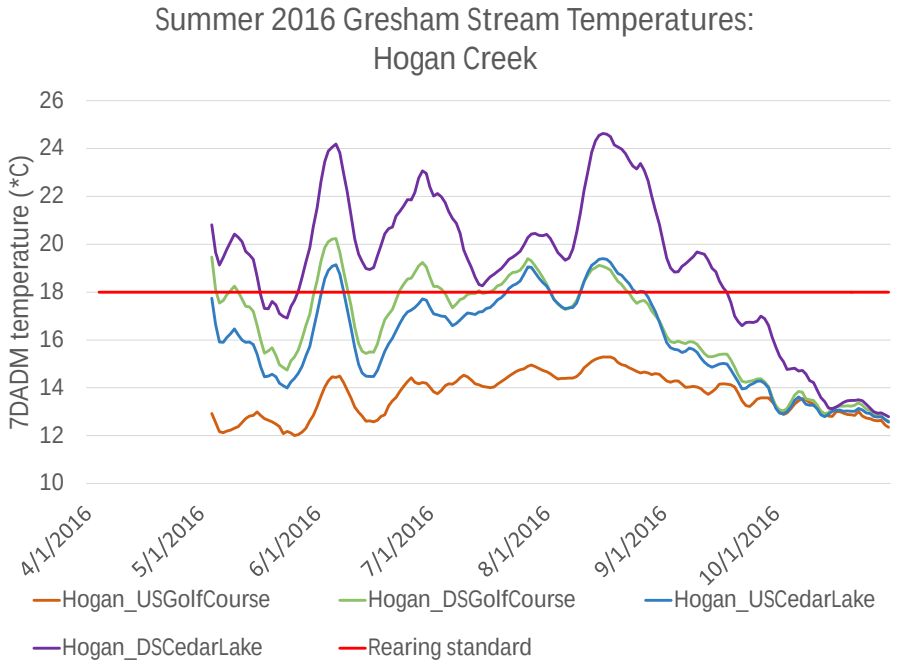

Figure A- 7- Hogan Creek temperature, provided by the East Multnomah Soil Water and Conservation District

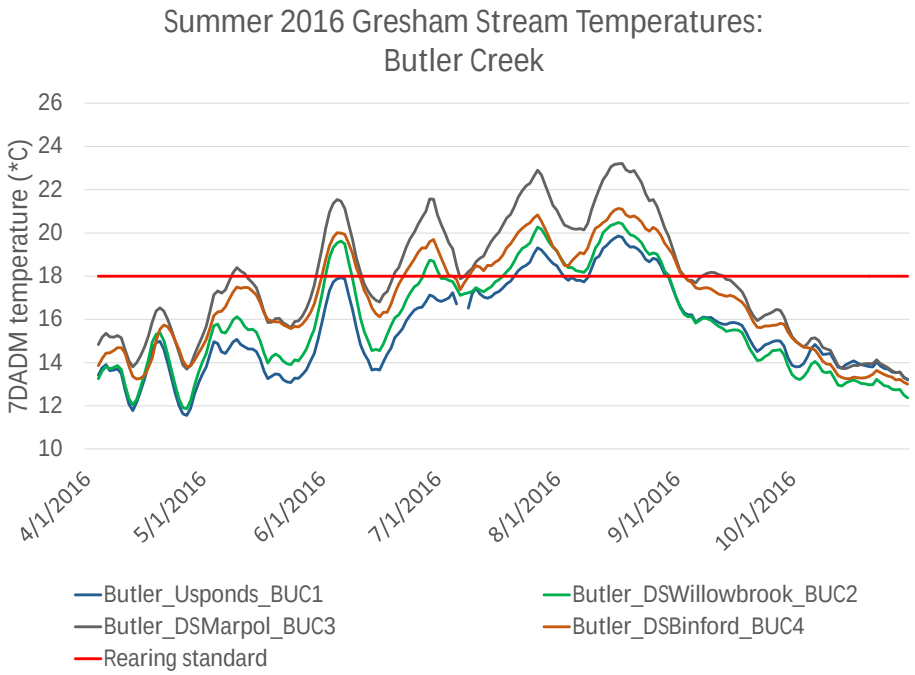

Figure A- 8- Butler Creek temperature, provided by the East Multnomah Soil Water and Conservation District

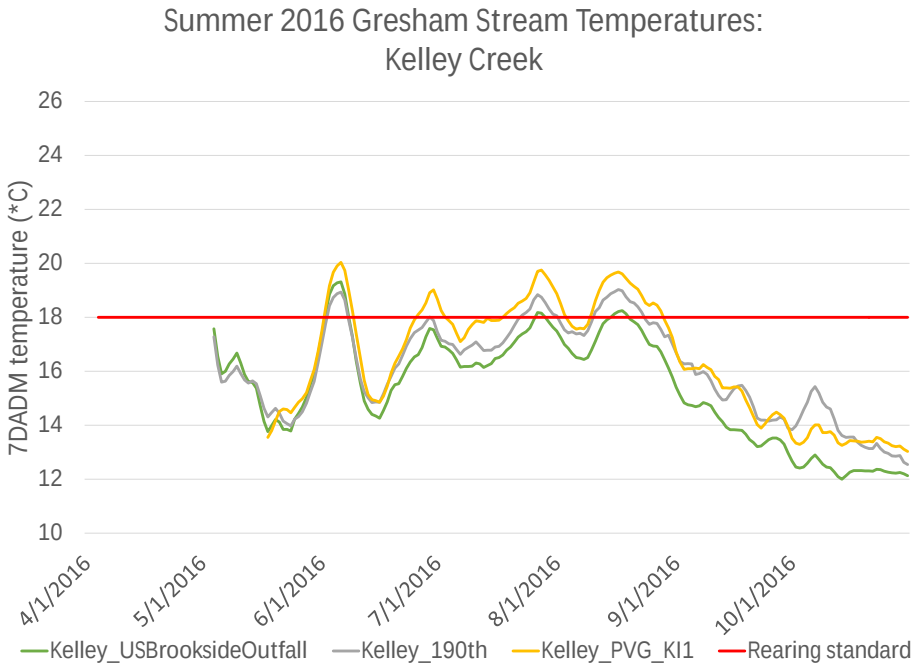

Figure A- 9- Kelley Creek temperature, provided by the East Multnomah Soil Water and Conservation District