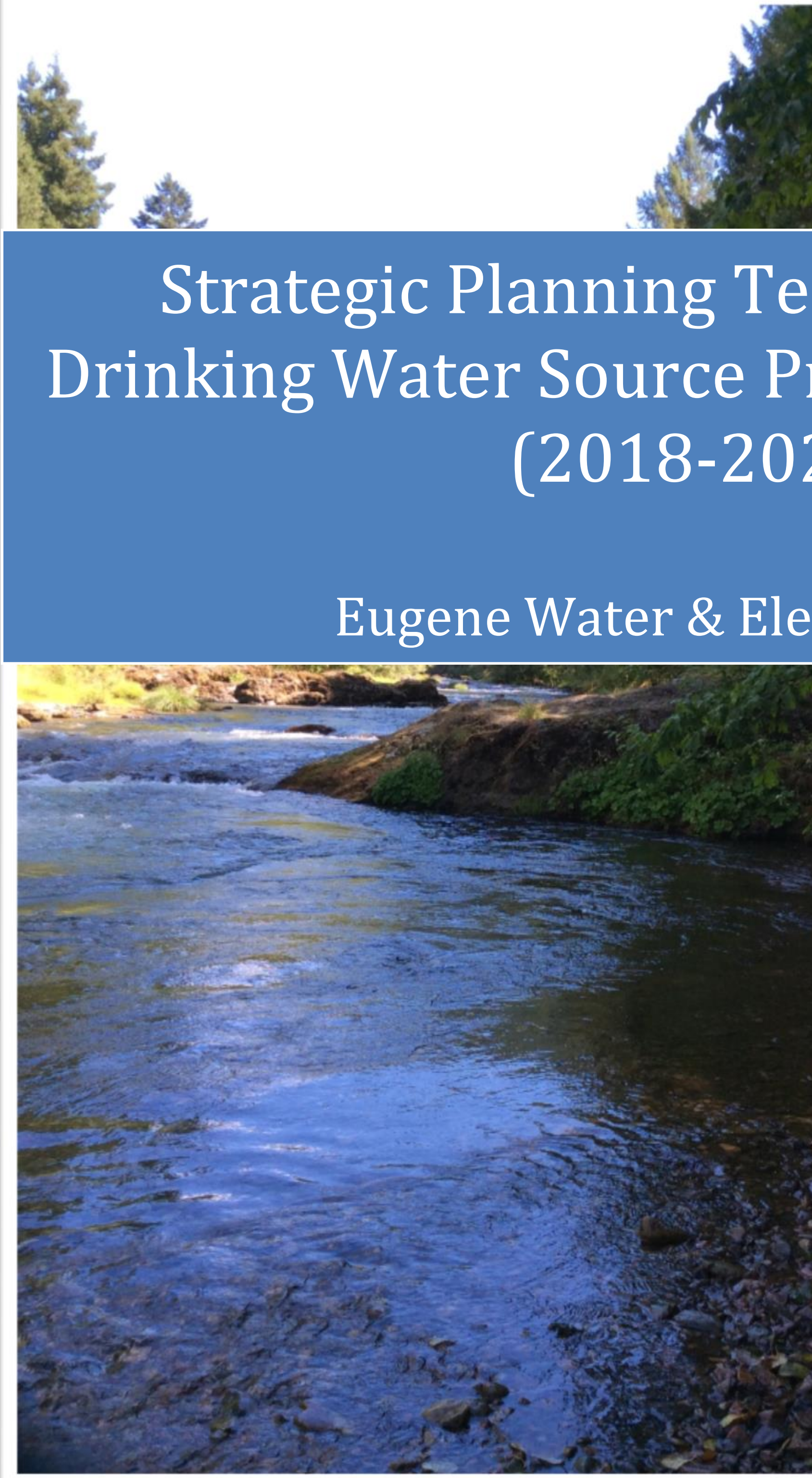
2017

Strategic Planning Technical Report Drinking Water Source Protection Program (2018-2028)

Eugene Water & Electric Board



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1.0 INTRODUCTION

"Protection and management of source waters are critical to the mission of any drinking water utility and the communities it serves."

John Donahue, former president AWWA and Chief Executive Officer North Park Public Water District Machesney Park, Illinois in testimony to Congressional House Subcommittee on the Environment, March 16 2017.

In 2000, The Eugene Water & Electric Board (EWEB) prepared a Drinking Water Source Protection Plan in order to meet the requirements of the 1996 Safe Drinking Water Act Amendments. That plan included a risk assessment of all potential threats to Eugene's drinking water (EWEB, 2000). EWEB began implementing the Board-approved Drinking Water Source Protection Plan in May 2001 to protect the McKenzie River as the sole source of drinking water for nearly 200,000 people in the Eugene, Oregon area (Figure 1-1). The goal of EWEB's Drinking Water Source Protection (DWSP) program is to measure the balance between watershed health and human use over time and implement actions that maintain exceptional water quality for current and future generations. To accomplish this, the program has two primary objectives: the first is to prevent, minimize and mitigate activities that have known or potentially harmful impacts on source water quality; and the second is to promote public awareness and stewardship of a healthy watershed in partnership with others (EWEB, 2001).

Although EWEB depends on the McKenzie watershed to supply clean and safe drinking water for the City of Eugene, EWEB owns very little land in the watershed and does not have any jurisdictional authority over other landowners. In this context, EWEB has pursued a variety of partnerships with local, state, and federal agencies and organizations in order to protect water quality and the overall health of the watershed.

Since May 2001, EWEB has invested approximately $7.5 million in the drinking water source protection program and has received nearly $3 million in grant funds and partner contributions. Based on years of research and analysis, the highest priority threats to water quality in the McKenzie Watershed are:

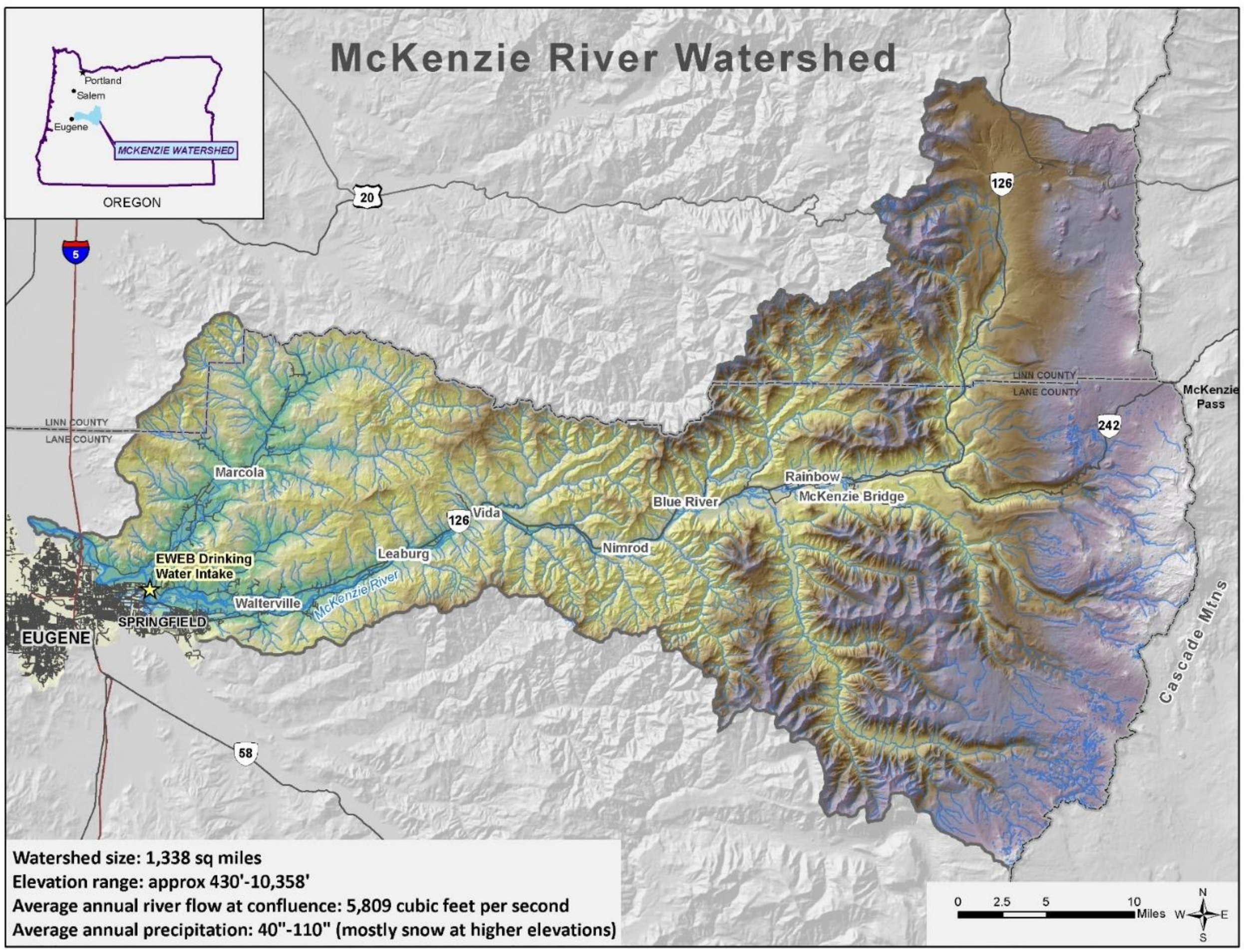
- Hazardous material spills from transportation accidents and releases from commercial and industrial facilities.
- Pollution runoff from east Springfield's urban stormwater system, which has five outfalls immediately upstream of EWEB's Hayden Bridge intake.
- Cumulative impacts associated with development along the river (septic systems, chemical use, vegetation removal in riparian areas, and loss of agricultural and forest lands to future development).
- Agricultural impacts associated with pesticide and fertilizer use, livestock access to waterways, and vegetation removal in riparian areas.
- Climate change impacts that may result in larger and more frequent flooding events, longer dry seasons, more frequent and severe wildfires, and increasingly volatile weather

patterns.

Over the last 15 years, EWEB has invested in developing risk-based watershed protection programs that: a) are collaborative and build lasting relationships with partners, stakeholders, landowners and communities; b) leverage outside funding and resources; c) are based on best available science; d) address multiple economic, social and environmental issues; e) are sustainable over the long term; and, f) are monitored for effectiveness.

The American Water Works Association (AWWA) produces and maintains voluntary standards for the drinking water industry. The AWWA has a specific standard for source water protection (G300), which we have followed during the course of program implementation. EWEB won the AWWA Exemplary Source Water Protection Award for large water systems in 2015, which was presented at the AWWA Annual Conference & Exposition. EWEB continues to follow the G300 guidelines in its source protection approach and implementation.

Figure 1-1: The McKenzie River Watershed



This technical report supports the strategic planning effort and outlines the programs and actions EWEB will continue to support in close collaboration with partners in the McKenzie Watershed, as well as estimating the level of investment needed to sustain these efforts over the next ten years. The technical report also assesses logical funding mechanisms that, when combined with partner contributions, will provide adequate funding and resources to protect these critical sources of clean and abundant drinking water for long-term community health, resiliency, and economic prosperity.

2.0 VALUE OF WATERSHED PROTECTION

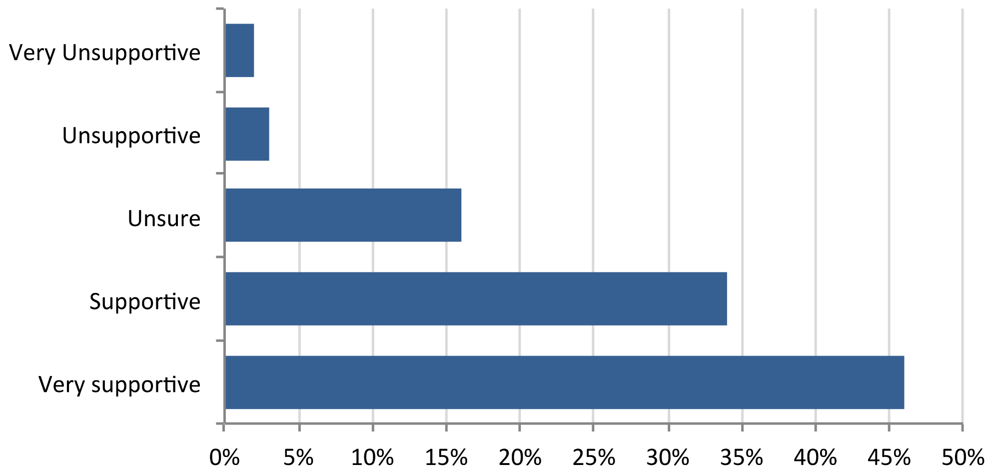
The rationale for watershed protection is rooted in the concept of cost avoidance. In short, maintaining healthy natural systems reduces the costs for water treatment and needs for additional treatment, which reduces the capital and operations and maintenance costs associated with water treatment facilities. Healthy watersheds and riparian forests provide a wealth of ecosystem services that directly benefit water quality and the communities that rely on these resources. Protecting healthy watersheds:

- Lowers drinking water treatment costs;
- Avoids expensive restoration activities;
- Sustains revenue-generating recreation and tourism opportunities;
- Minimizes vulnerability and damage from natural disasters;
- Provides critical ecosystem services at a fraction of the cost for engineered services;
- Increases property values;
- Supports jobs and economic growth; and,
- Ensures we leave a foundation for a vibrant economy for generations to come (EPA, 2012).

EWEB staff worked with University of Oregon School of Business to conduct a cost avoidance analysis that modeled how changes in water quality would impact chemical treatment costs. The results indicate a nearly doubling of daily chemical treatment costs when turbidity levels in the river exceed approximately 20 NTU (Skov et al., 2013). EWEB assessments and other research indicates that other costs avoided through investments in watershed protection include the costs associated with the need for additional physical treatment, regulatory triggers and costs (disinfection byproduct formation, plant effluent NPDES, raw and finished water quality, ESA species), restoration costs (riparian forest and wetland restoration), and reduced revenue from loss of public trust in its drinking water quality (WRI, 2013; EPA, 2012; Earth Economics, 2012).

Based on a number of customer surveys done over the last few years, EWEB's rate payers clearly understand the value of protecting their source of drinking water. In 2012, 411 EWEB ratepayers living in Eugene completed a survey about their perception of the McKenzie River Watershed. Respondents described their knowledge of water quality, their understanding of risks to water quality, and how much money they would be willing to pay for source water protection. Surveyed ratepayers showed a high level of support for programs to improve and/or maintain water quality in the McKenzie River Watershed. Among other things, the survey asked "In general, how supportive or unsupportive would you be of establishing programs or activities to maintain the environmental benefits provided by the McKenzie River Watershed?" Figure 2-1 shows that 80% of survey respondents indicated that they were supportive or very supportive.

Figure 2-1: EWEB Residential Ratepayer Support for Watershed Protection Programs



Source: University of Oregon and Oregon State University, 2013.

Ratepayers were also asked to indicate how much they would be willing to pay per month to fund water quality improvement projects. Ratepayers showed a high level of support for fees up to $1/month. Ratepayer support drops off at a $3/month fee (U of O/OSU, 2012). Table 2-1 shows EWEB ratepayers willingness to pay for water quality improvement projects.

Table 2-1: EWEB Residential Ratepayer Willingness to Pay for Water Quality Source Protection

Question	Definitely Yes	Probably Yes	Unsure	Probably No	Definitely No
50 cents per month	**55%**	17%	10%	3%	15%
$1 per month	**43%**	21%	12%	5%	20%
$3 per month	18%	21%	19%	14%	**28%**
$5 per month	9%	12%	18%	21%	**40%**
$10 per month	3%	6%	14%	23%	**54%**

2.1 Value and Return on Investment

In 2012, EWEB commissioned an economic study that used conventional economic evaluations (e.g., replacement costs, market pricing, hedonic pricing, avoided costs, etc.) to estimate the value of the various goods and services provided by the McKenzie Watershed that benefit our community, region, and society (Earth Economics, 2012). The total estimated value of the ecosystem services provided by the McKenzie Watershed ranges from $248 million to $2.4 billion annually. This estimate assumes that the land cover that is providing these ecosystem services is healthy and fully functioning (see Table 2-2). The actual value considering the degradation of the watershed from human activities over time is likely much lower.

Table 2-2: Comparison of Natural Asset Values

Land Cover Type (Generalized)	Highest Natural Asset Value ($/acre/year)
Wetlands	$34,888
Lakes and Rivers	$3,041
Riparian Buffer	$6,717
Forest	$3,677
Shrub and Scrub	$2,710
Grassland	$695
Agricultural Lands	$644

As discussed in Section 7.3, EWEB has been developing and piloting a program, called the Pure Water Partners (PWP) program, which aligns resources from multiple partners to protect and restore riparian and floodplain forests. Grant funding allowed EWEB to conduct a follow-up economic study to calculate the return on EWEB's future investment (ROI) in the PWP program for protecting healthy riparian forests. To accurately develop the ROI, the only benefits from protecting an acre of healthy riparian forest that could be modeled were avoided sediment and nutrient inputs, sediment and nutrient removal, and carbon sequestration (see Table 2-3). Over 20 years, the net present value of

Table 2-3: Summary of Average Ecosystem Service Benefits from Protecting Riparian Forests

Benefit Category	Value	Unit
Avoided Sediment	3.22	$/acre/year
Avoided Nitrogen	20.19	$/acre/year
Nitrogen Interception & Removal	148.83	$/acre/year
Sediment Interception & Removal	3.24	$/acre/year
Carbon Sequestration & Storage	262.34	$/acre/year

Total	437.83	$/acre/year

(Earth Economics, 2017)

EWEB's future costs for protecting riparian forests under the PWP program is $1,980 for a given acre, while the net present value of benefits is $7,131 per acre. This represents a return of approximately $2.60 for every $1 EWEB invested over a 20 year period (or a 260% ROI) (Earth Economics, 2017).

Table 2-4: Per-Acre Costs and Benefits of Protecting Riparian Forest in the PWP

Year	Cumulative Benefits	Cumulative Costs	Return-on-Investment
1	$429	$832	-48%
2	$850	$904	-6%
3	$1,262	$975	29%
4	$1,665	$1,044	59%
5	$2,061	$1,112	85%
6	$2,449	$1,178	108%
7	$2,829	$1,244	128%
8	$3,202	$1,307	145%
9	$3,567	$1,370	160%
10	$3,924	$1,431	174%
11	$4,275	$1,491	187%
12	$4,619	$1,550	198%
13	$4,955	$1,608	208%
14	$5,285	$1,664	218%
15	$5,609	$1,720	226%
16	$5,926	$1,774	234%
17	$6,236	$1,827	241%
18	$6,540	$1,879	248%
19	$6,839	$1,930	254%
20	$7,131	$1,980	260%

(Earth Economics, 2017)

The calculated ROI for EWEB costs is very conservative given the many benefits that could not be quantified (as indicated in Table 2-5). What is not included in Table 2-5 is that protecting and restoring watersheds on a scale that is meaningful can help reduce or avoid the regulatory burden that may fall on EWEB ratepayers and Lane County taxpayers in the future. A few examples include:

- Developing a Total Maximum Daily Load (TMDL) for a watershed can cost millions of dollars. The cost to achieve the TMDL is even higher.

- Salmon habitat restoration to comply with the Endangered Species Act can require communities and utilities to spend large sums of money on watershed planning, fish passage, habitat restoration, and ongoing monitoring.

- The costs associated with drinking water treatment infrastructure to comply with new drinking water regulations could reach into the millions of dollars.

- FEMA also rewards communities that implement better floodplain management, providing flood insurance discounts through the Community Rating System.

Table 2-5 Non-Quantified Ecosystem Services of Riparian Forests.

Ecosystem Service	Description
Habitat	Depending on the width of a buffer, riparian forest may provide habitat for a variety of species. These species include frogs, salamanders, deer, beaver and various birds.
Disaster Risk Reduction	If a river floods over its banks, riparian forests have a much greater capacity to absorb water than bare earth or developed land. If enough water is absorbed by the forest damages from floods can be reduced or wholly mitigated.
Aesthetic Information	The presence of riparian forests adds a certain picturesque quality to a river. Nearby property owners may prefer this and property value may decline if the aesthetic value of riparian forests is lost.
Recreation and Tourism	The McKenzie River is a world renowned fly fishing river and a kayaking and rafting destination. Maintaining riparian forests enhances these and other outdoor recreation experiences and supports this important economic draw to our region.
Cultural Value	Based on the U of O 2012 customer surveys, a large percentage of EWEB customers have a close cultural connection with the McKenzie River and natural landscapes. Maintaining riparian forests as a natural landscape helps to preserve this cultural connection.
Water Temperature	Water temperature is important to fish species for enabling a habitat where they can grow and reproduce. Cooler stream temperatures also benefit water quality by reduce algal blooms.

(Earth Economics, 2017)

3.0 SUBBASIN OVERVIEW

3.1 Physical Geography

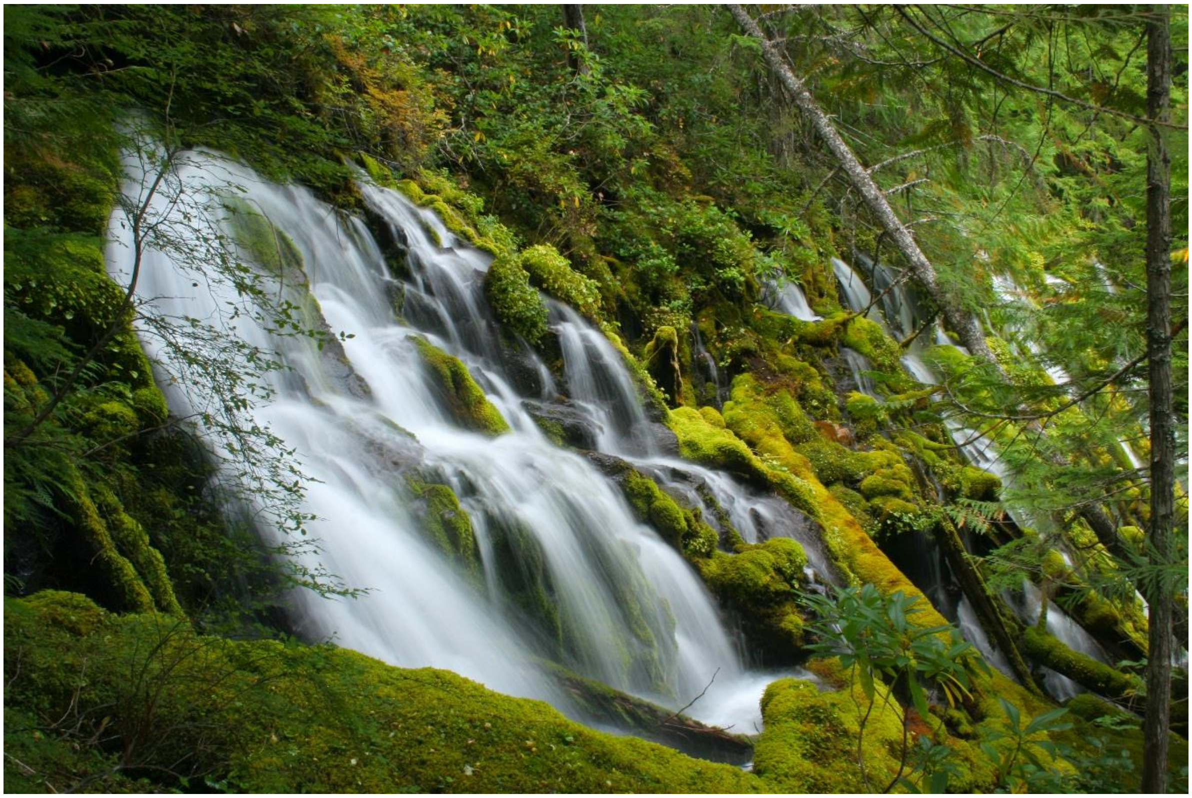
The McKenzie River subbasin is located in the Upper Willamette Basin ten miles downstream from the confluence of the Middle Fork and Coast Fork Willamette Rivers, the McKenzie River merges with the Willamette River, effectively doubling the size of the river.

The McKenzie subbasin covers 1,338 square miles, with elevations ranging from 10,358 at the South Sister summit to 358 feet at the confluence with the Willamette River.

The headwaters for the McKenzie subbasin originate in the High Cascades province along the crest of the Cascade Range. This area is characterized by highly porous, younger volcanic rocks, including lava flows, pyroclastic deposits and glacial deposits. The High Cascades province accounts for roughly 42% of the McKenzie subbasin (see Table 3-1).

Table 3-1: McKenzie Physical Characteristics

Physical Characteristics[1]	McKenzie River	Middle Fork River	Coast Fork River
Basin Size (square miles)	1,338	1,355	666
Basin Size (acres)	856,466	867,110	426,238
Maximum Elevation (feet)	10,358	8,744	5,982
Minimum Elevation (feet)	258	450	450
High Cascades Geology (%)	42%	25%	0%

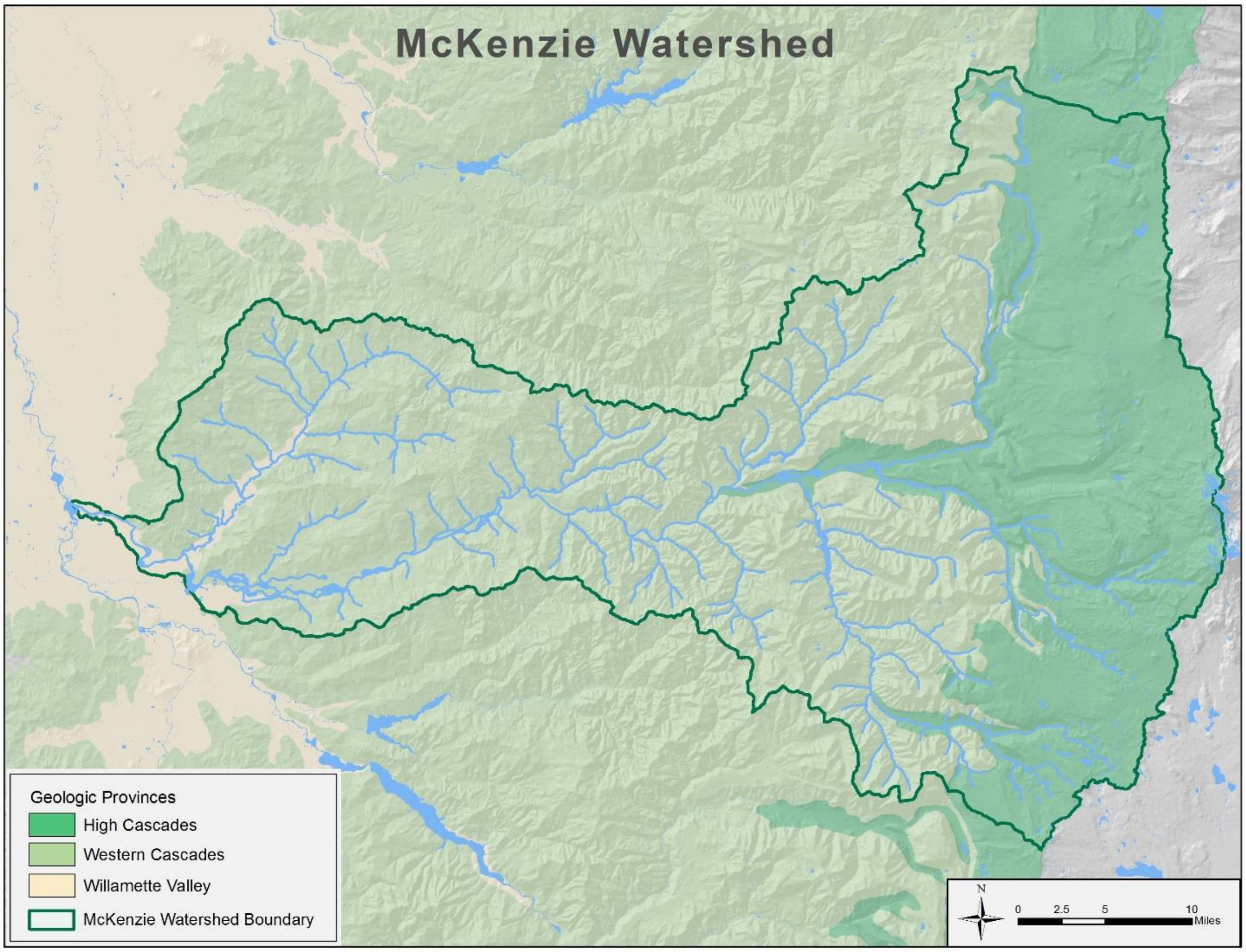


Roaring Springs, Upper McKenzie

Moving west, the McKenzie enters the less permeable Western Cascades province. This region contains older volcanic complexes that have undergone significantly longer periods of glaciation and erosion. Consequently, the terrain is marked by steep valleys and high gradient streams.

The lowest portion of the subbasin generally contains shallow alluvial deposits underlain by sedimentary rock and occasional sequences of older igneous rock. Stream gradients are lower in this region as topography begins to smooth out and conform to the Willamette Valley province.

Figure 3-1: Geology of the McKenzie Watershed



3.2 Climate and Hydrology

Hydrology of the Willamette basin is largely driven by a variety of seasonal weather patterns typical of mid-latitude marine climates, although heavily influenced by orographic features. Winters are typically cool and wet and summers are often dry and warm. Most precipitation generally falls between October and March, with very little falling from July to August. The close proximity of the Basin to the Pacific Ocean, along with the Coast Range Mountains to the west and the Cascade Mountains to the east, translates into highly variable rainfall totals across the region. Annual rainfall totals range from 40 inches in the Willamette Valley up to 130 inches along the crest of the Cascades. Precipitation in the higher elevations generally falls as snow throughout the winter, especially above 5,000 feet.

Earlier research conducted by Anne Jefferson, Gordon Grant and others at Oregon State University (OSU) found that the High Cascades geology in the McKenzie subbasin is a critical feature to the hydrology of the river and the Willamette basin as a whole. The High Cascades geology consists of recent lava flows (approximately 3,000 years ago) that appear today as large basalt boulder fields with few, if any streams or other surface runoff features on the landscape. Precipitation as snow or rain infiltrates directly into this coarse and highly porous geologic material and emerges in a system of large springs approximately 7 years later on average (Tague and Grant, 2004; Jefferson, A., G. Grant, and T. Rose, 2006; Tague, C., and G. E. Grant, 2009). Spanning the upper reaches of both the McKenzie and Middle Fork subbasins, this huge natural reservoir is responsible for the clear and cold water emerging from large springs at relatively constant flows throughout the year. This unique hydrology provides resiliency during low flow regimes. In fact, large springs account for over 80% of the flow in the McKenzie River during late summer low flow condition (Tague and Grant, 2004; Jefferson, A., G. Grant, and T. Rose, 2006). The McKenzie River in turn provides up to 25% of the flow in the Willamette River near Portland during low flow conditions (PNWERC, 2002)

The Western Cascades are generally lower in elevation and heavily forested, with streamflow determined more by rainfall runoff than snowmelt or groundwater. Following normal rainfall patterns, highest discharges occur in the winter with low flows in the dry summer and fall.

Flows in the McKenzie River are generally elevated throughout the winter with peak flows coinciding with significant storm events. Flows are typically lowest during the late summer months. Annual average discharge in the McKenzie River at 5,905 cubic feet per second (cfs). Minimum flows are influenced by reservoir discharges and prolonged dry periods. The McKenzie generally sees much higher minimum flows during prolonged dry periods, owing largely to significant groundwater reserves in the High Cascades and abundant reservoir storage capacity in the subbasin.

Table 3-2: McKenzie River Hydrologic Characteristics

Parameter*	McKenzie River
Average Discharge (cfs)	5,905
Max Discharge (cfs)	88,200 (1945)
Min Discharge (cfs)	1,080 (1966)
Recent Max Discharge (cfs)	35,400 (2013)
Recent Min Discharge (cfs)	1,970 (2013)

*USGS Gage Network, reported values associated with lowest main stem gaging station in each sub-basin

Dams

Dams are located throughout the upper Willamette basin and were built to provide flood control, generate hydroelectric power, supply irrigation water throughout the summer and enhance navigation for recreational purposes. A total of 6 dams in the McKenzie are either operated by the U.S. Army Corps of Engineers (USACE) or EWEB and were built between 1929 and 1969 (Table 3-3).

Table 3-3: Dam and Reservoir Information

Location	Subbasin	River (river mile)	Operator	Year Built	Purpose[1]	Capacity[2]
Carmen Dam	McKenzie	McKenzie River (87.5)	EWEB	1963	P	261
Smith Dam	McKenzie	Smith River (2)	EWEB	1963	P	15,050
Trail Bridge Dam	McKenzie	McKenzie River (82)	EWEB	1963	P	2,060
Cougar Dam	McKenzie	South Fork McKenzie (4.4)	USACE	1963	FC/P/N/I	153,500
Blue River Dam	McKenzie	Blue River (1.4)	USACE	1969	FC/N/I	82,800
Leaburg Dam	McKenzie	McKenzie River (38.8)	EWEB	1929	P	40

[1]Authorized Purpose Includes: Flood Control (FC), Power (P), Navigation (N), Irrigation (I)

[2]Usable Storage in Acre-Feet, Source: www.nwd-wc.usace.army.mil/nwp/wm

In the upper portion of the McKenzie subbasin, EWEB operates the Carmen-Smith River Hydroelectric Project, which includes Carmen Diversion Reservoir, Smith River Reservoir and Trail Bridge Reservoir. Carmen Diversion Reservoir, with a total storage capacity of 261 acre-feet, diverts McKenzie River flow through a 2 mile-long tunnel to Smith Reservoir. Smith Reservoir has a capacity of 14,600 acre-feet and diverts the combined flows from Smith River and McKenzie River down a second tunnel to the Carmen Power Plant (104.5 megawatts (MW)) before discharging into Trail Bridge Reservoir. Water then passes through a second powerhouse (10 MW) at Trail Bridge Dam before returning to the McKenzie River. Trail Bridge Reservoir, which only has a capacity of 2,060 acre-feet, is a re-regulating reservoir, meaning the reservoir is designed to keep flow levels below Trail Bridge Dam as natural as possible.

Two large reservoirs operated by USACE, primarily for flood control and irrigation storage, are located further downstream. Cougar Dam is situated on the South Fork McKenzie River and also serves to provide power generation (25 MW). Cougar Reservoir has a catchment area of 210 square miles and a total storage capacity of 153,500 acre-feet, making it the largest reservoir in the McKenzie subbasin. Blue River Dam, located on Blue River, has a catchment area of 88 square miles (USGS, 2010) and a storage capacity of 82,800 acre-feet. Cougar Reservoir was drained from 2002-2004 in order to modify the withdrawal structure to allow multilevel withdrawals for enhanced temperature control for fish in the released water. The primary inflow to Cougar Reservoir is the South Fork McKenzie River, which has headwaters in both the High Cascade and Western Cascade geologic provinces. Inflows to Blue River Reservoir are entirely from Western Cascade streams. Aside from the upper McKenzie River springs, withdrawals from these two reservoirs are the largest source of water to the McKenzie River during low flows in summer and fall.

Downstream of the South Fork McKenzie and Blue River, the hydrology and landscape become increasingly engineered. Two major water diversions operated by EWEB put up to 60% of summer flows into large canals for hydroelectric power production. The first diversion is Leaburg Dam, which diverts water down the Leaburg Canal and to the Leaburg Power Plant, before discharging back to the mainstem at river mile 34.2. The resulting lake created behind Leaburg Dam is relatively small at 40 acre feet. Further downstream, a set of chevrons diverts water into the Walterville Canal and to the Walterville Power Plant before discharging back at river mile 24. Instream discharges remaining in the McKenzie River are reduced to 1,050 cfs to comply with minimum flow requirements, until the return flows from the Walterville Canal enter the river at RM 17.1. Additional inflows in the reaches between the Walterville Canal and EWEB's intake include relatively small tributaries with runoff from agricultural and urban areas.

3.3 Land Use and Population

Land use within the McKenzie is dominated by forestry practices, with 89% of land use (Table 3-4). A majority of the forested lands in the McKenzie subbasin (64.2%) are publically owned, and almost entirely under federal management.

Agricultural lands (primarily orchards, nurseries, row crops, and pastureland) are predominantly located in the lower section of each subbasin, usually within the floodplain or in slightly higher alluvial deposits. The McKenzie subbasin has 76.3 square miles of agricultural land.

Urban areas, which include low to high density spaces as well as open spaces, represent an even smaller amount of land in the McKenzie, at 69.6 square miles. The total amount of urban area in each subbasin, which includes low to high density spaces as well as open spaces, was reported at 69.6 square miles in the McKenzie subbasin,

Table 3-4: Land Use Types and Population

Land Use Types[1]	McKenzie River	
	% Cover	sq mi
Agriculture (Total)	**5.7**	**76.3**
Cultivated Crops	2.9	38.8
Pasture/Hay	2.9	38.8
Forest (Total)	**89**	**1190.8**
Public	64.2	859.0
Private	24.8	331.8
Industrial	20.1	268.9
Non-Industrial	4.7	62.9
Urban (Total)	**5.2**	**69.6**
High/Medium Density	0.1	1.3
Low Density	0.2	2.7
Open Space	5	66.9
Population (Estimate)[2]	**36,047**	

[1]Willamette Basin Rivers and Streams Assessment, 2009, Oregon DEQ

[2]Oregon Explorer, Natural Resources Digital Library, www.oregonexplorer.info, accessed on 1/13/2017

The estimated population for the McKenzie subbasin is approximately 36,000, with most residents occupying the communities of Springfield, Cedar Flat, Walterville, Leaburg, Vida, Nimrod, Blue River, Rainbow and McKenzie Bridge.

4.0 THREATS

This section outlines the broad categories of threats to water quality in the McKenzie Watershed. Threats are based on an initial risk assessment completed back in 2000 (EWEB, 2000), a nonpoint source pollution assessment completed in 2006 (EWEB, 2006), investigation of septic system impacts (EWEB, 2009), University of Oregon studies completed in 2009 (U of O, 2009a (development code analysis); U of O, 2009 (risk atlas)), analysis of future development pressures (LCOG, 2010), a number of water quality studies done with the USGS (USGS, 2012 (storm event); USGS, 2009, 2014 (passive sampling results)), and analysis of water quality monitoring data from 2001-2009 (EWEB, 2011 (baseline), http://reach.northjacksonco.com/EWEB/)).

4.1 Agriculture

In the McKenzie watershed most agricultural land is located along the valley floor in close proximity to the river (Figure 4-1). Numerous studies have been conducted in the Willamette River Basin that looked at impacts of agricultural activities on streams, rivers and drinking water supplies (USGS 2001, USGS 1998, USGS 1997, USGS 1996). These studies show that pesticides and nutrients occurred more frequently and at higher concentrations at monitoring sites located in agricultural areas.

Some widely used pesticides, such as simazine, metolachlor, desethylatrazine and atrazine, were found in over 70% of the over 280 water samples collected in the Willamette Basin studies (USGS, 1996; USGS, 1997). Diuron and diazinon were found in over 50% of the water samples collected as part of the USGS study.

EWEB's DWSP program has been collecting samples from the McKenzie River system since 2001 (see Section 5.0). This data indicates that many commonly-used pesticides are frequently found in surface water samples throughout the watershed. Collectively, pesticides such as 2,4-D, Carbaryl and Diuron have been found in over 50% of more than 200 samples collected in the McKenzie Watershed (see Table 4-1). 2,4-D alone has been found in over 25% of all samples analyzed for this compound.

Based on the nonpoint source assessment from 2006, the crops with the highest usage (lbs active ingredient per acre) are hazelnut orchards, nursery operations, vegetables and blueberries as indicated below:

- Hazelnuts = 4.03 lbs chemicals applied/acre
- Nursery = 3.94 lbs chemicals applied/acre
- Blueberries = 3.79 lbs chemicals applied/acre
- Vegetable (annual rotation) = 3.44 lbs chemicals applied/acre
- Hay = 1.2 lbs chemicals applied/acre
- Christmas Trees = 0.47 lbs chemicals applied/acre
- Pasture = 0.13 lbs chemicals applied/acre

The assessment also identified areas that have a higher relative threat of potential chemical runoff from storm events impacting nearby waterways.

Table 4-1: Pesticides Detected in Water Samples from Multiple Land-use Types (2002 – 2016)

Pesticide	Application	Analyzed	Detected	Max Value (ug/L)	Occurrence
2,4-D	Herbicide	199	51	1.65	26%
Carbaryl	Insecticide	186	45	1.3	24%
Diuron	Herbicide	119	28	12.18	24%
Hexazinone	Herbicide	87	18	0.097	21%
Prometon	Herbicide	145	27	0.057	19%
Sulfometuron-methyl	Herbicide	122	22	2.22	18%
Atrazine	Herbicide	252	37	0.171	15%
Diazinon	Insecticide	160	23	0.12	14%
Triclopyr	Herbicide	115	15	3.10	13%
2,4-DB	Herbicide	154	15	0.0998	10%

EWEB worked with the USGS to conduct a multi-year study monitoring pesticides in runoff from urban, agriculture and forestry sites. Results indicated that urban and agricultural runoff were more significant sources of chemical runoff than forestry (USGS, 2012). That being said, it is harder to gain access to collect water samples on private agricultural land, so the amount of monitoring data we have for this land use type is significantly less than for urban and forestry.

Water quality data from EWEB/USGS monitoring efforts (see Section 5) in creeks that had predominately agricultural activity upstream yielded a number of pesticides typically associated with such activities. These pesticides included Diuron, Atrazine and 2,4-D.

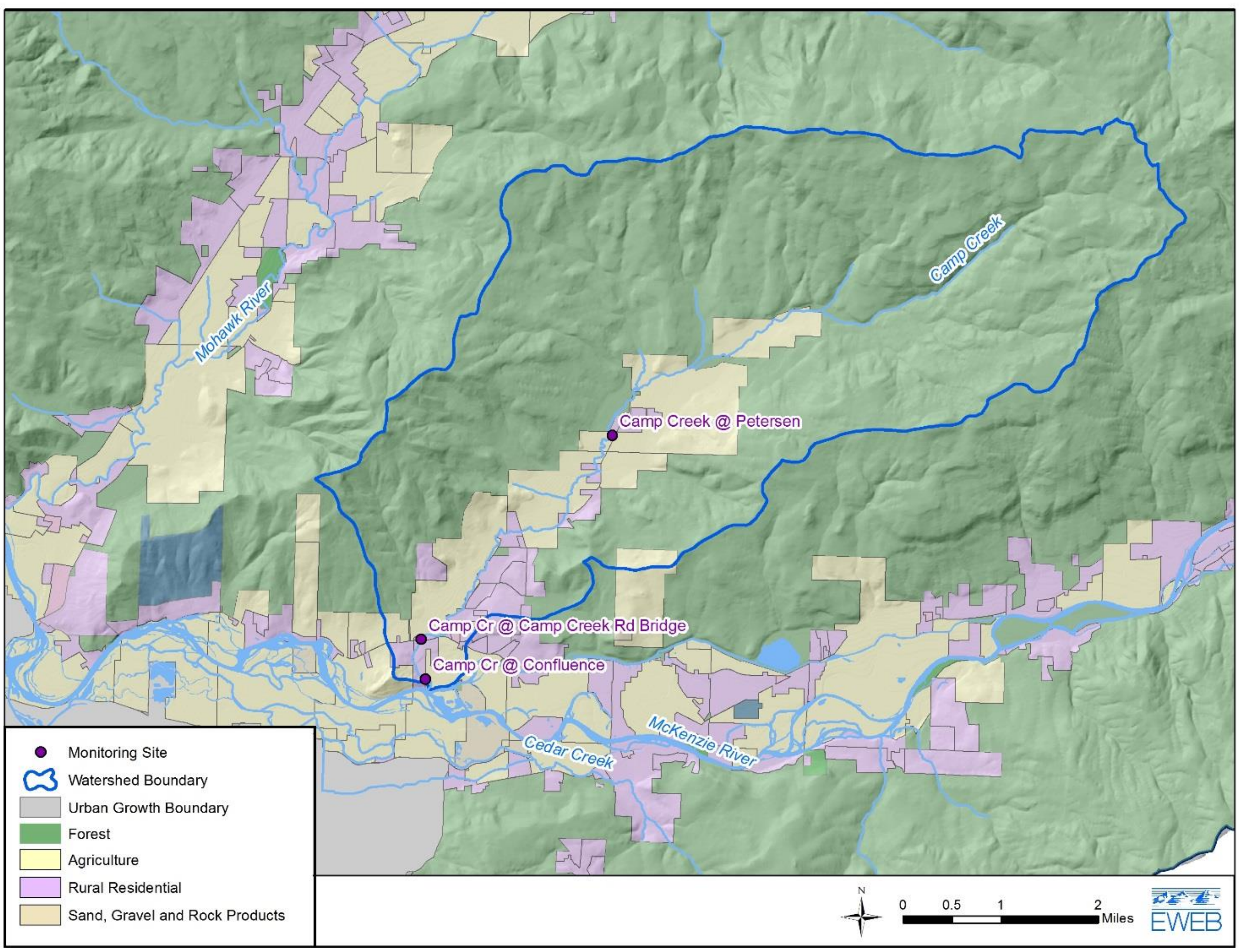
The Camp Creek basin is located approximately 20 miles upstream of EWEB's intake and drains 22 square miles. Annual flows can vary significantly depending on time of year and storm-related conditions, such as frequency, duration and intensity. For example, during the 2013 water year flows ranged from 2 cubic feet per second (cfs) during the summer to 1,400 cfs during the winter after a series of large storm events rolled in off the Pacific. The Camp Creek basin has a wide valley with significant agricultural activity, but also includes increasing residential development and industrial forestry operations in the upland forests (see Figure 4-1). Although this basin includes multiple potential sources of pesticides, bacteria, and nutrients, the data shows impacts that could be associated with agricultural activity. Table 4-2 summarizes organic compounds detected in Camp Creek from 2001 to 2016.

As indicated in Table 4-2, Deethylatrazine, Hexazinone and Triclopyr were detected in over 40% of the water samples collected. A total of 15 different pesticides and pesticide degradates have been detected in the lower portion of Camp Creek since 2002.

Table 4-2: Compounds Detected in Water Samples from Camp Creek (2002 – 2016)

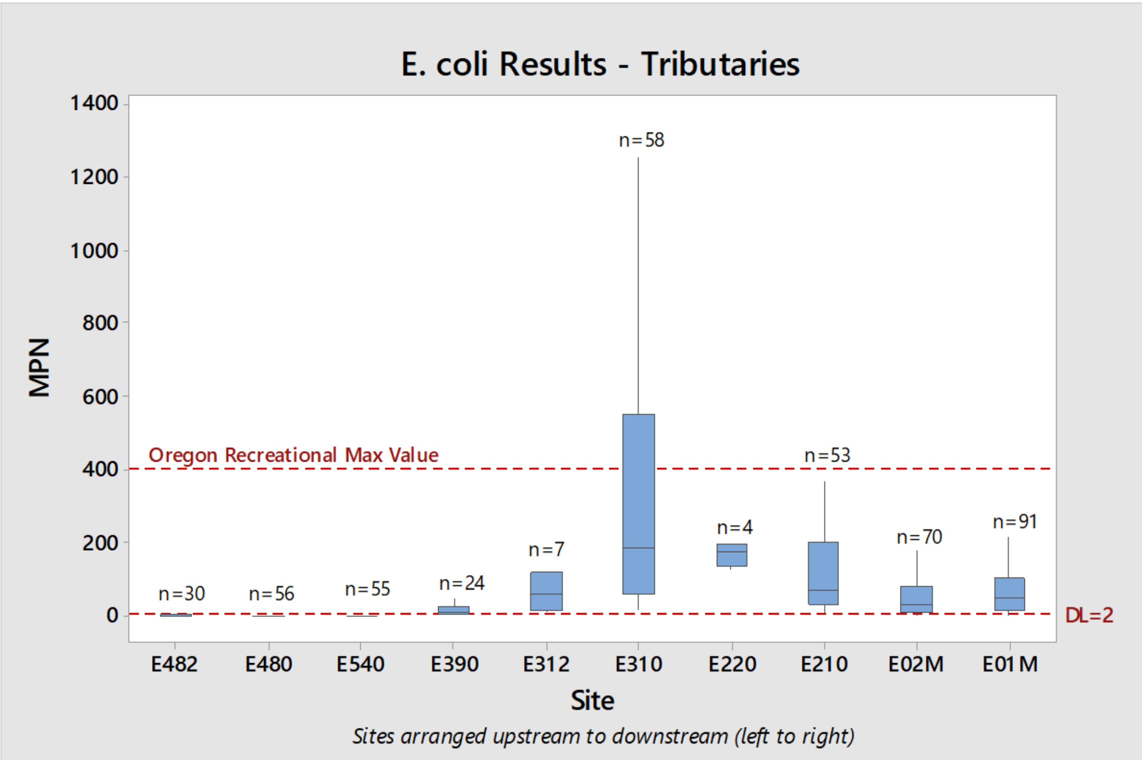
Pesticide	Analyzed	Detected	Max Value (ug/L)	Occurrence
Deethylatrazine	15	7	0.017	47%
Atrazine	21	6	0.06	29%
Hexazinone	11	6	0.0356	55%
Triclopyr	9	4	0.1607	44%
2,4-D	14	3	0.2298	21%
2-Hydroxyatrazine	10	2	0.017	20%
2,4-DB	13	2	0.0924	15%
Aminomethylphosphonic acid	3	2	0.05	67%
Diuron	9	2	0.0638	22%
Imazapyr	8	2	0.0051	25%

Figure 4-1: Land Use and Monitoring Locations in the Camp Creek Watershed



The water quality data from samples collected downstream of agricultural land uses indicates various pesticides being detected at low levels and elevated *E. coli* levels that often exceed Oregon's recreational maximum exposure limit of 406 *E. coli* organisms per 100 mL (see Figure 4-2, Camp Creek is site E310). EWEB is working with farmers in the McKenzie Watershed to reduce chemical use and increase riparian buffers while improving their economic health to keep farmland as a preferred floodplain land use (see Section 7.2). These efforts have made significant progress in removing old legacy chemicals for proper disposal, reducing pesticide and nitrogen use in hazelnut orchards, pulling cattle back from streams, and protecting and restoring riparian forests to make agriculture less of a threat than it was in the 2000 risk assessment.

Figure 4-2: E. coli Results for McKenzie River Tributaries (2000-2014)



Note: E310 = Camp Creek; see Figure 5-1 for complete list of sampling site names

4.2 Forestry

The McKenzie Watershed is comprised of 88% forested land, with a mixture of private, state, and federally owned lands. Forested watersheds, like the McKenzie, produce better water quality than any other surface water source. However, forest management activities that may adversely impact downstream water quality include: the use of chemical applications for stand treatment; road building; and various timber harvest techniques (NRC, 2000; Chang, 2003). These activities may adversely impact water quality due to increased runoff that carries pesticide residues and higher sediment loads (Chang, 2003; NRC, 2000) that can increase turbidity levels, making it harder and more expensive to treat the water, as well as increasing the likelihood of producing disinfection by-products (DBPs).

EWEB has been tracking industrial forest harvest and chemical use for a number of years to the extent possible based on spray notices submitted from timber companies to the Oregon Department of Forestry (see http://www.purewaterpartners.org/249/Forestry-Activities). This data indicates that the headwaters of the Mohawk, Gate Creek, Mill Creek and Quartz Creek basins had the highest rates of chemical applications from 2003-Sept 2014 (see Table 4-3).

Table 4-3: Summary of Industrial Forest Activities in McKenzie Watershed (2001 – 2014)

Basin Name	Acres
Headwaters Mohawk River	11,033
Gate Creek	9,199
Mill Creek	8,040
Quartz Creek	6,722
McGowan Creek-Mohawk River	5,122
Parsons Creek-Mohawk River	4,839
Camp Creek	4,462
Shotcash Creek-Mohawk River	3,859
Ritchie Creek	3,124
Goose Creek	2,971

* Note: Data goes through Sept 2014

EWEB worked with the USGS to conduct a multi-year study monitoring pesticides in runoff from urban, agriculture and forestry sites. Results indicated that urban and agricultural runoff were more significant sources of chemical runoff than forestry (USGS, 2012). Water quality data from EWEB/USGS monitoring efforts (see Section 5.2) in creeks and mainstem locations with significant industrial forestry activity upstream resulted in at least one pesticide detection in

Table 4-4: Compounds Detected in Water Samples from Forestry Sites (2002 – 2010)

Pesticide	Analyzed	Detected	Max Value (ug/L)	Occurrence
Hexazinone	28	7	0.0969	25%
Atrazine	37	6	0.0089	16%
Imazapyr	20	5	0.2094	25%
2,4-DB	32	4	0.0372	13%
Deethylatrazine	32	4	0.0127	13%
Endosulfan sulfate	10	4	0.00035	40%

Note: See Appendix A for more details on the pesticides listed, including type, common uses, and human and aquatic health benchmarks.

50% of the 42 water samples collected. A total of 29 pesticide-related compounds were detected across all forestry sites, although most compounds had only one or two occurrences. Table 4-4 summarizes the six most frequently detected compounds at these monitoring stations from 2002 to 2010.

The water quality data from samples collected downstream of industrial forest land uses indicates various pesticides being detected at low levels during significant rainfall events. Even though this data indicates forestry activities are a lower priority threat, EWEB continues to monitor water quality and work with forestry stakeholders to prevent and reduce wildfires, mitigate roads, increase riparian forest buffers, and reduce chemical use (see Section 6.2).

4.3 Human Built Environment

Urban Runoff

Urban runoff from developed areas (construction, roads, parking lots, roofs, and other impervious surfaces) can be a significant source of pollution during rainfall events that quickly and efficiently deliver runoff containing numerous contaminants into a nearby stream or river. Stormwater runoff often contains a variety of metals, such as arsenic, cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc, petroleum products including poly aromatic hydrocarbons, nutrients from fertilizers, *E. coli* bacteria from pet waste, pesticides, and other chemicals (Whalen and Cullum, 1988; USGS 2000b; Novotny and Olem, 1994; EWEB, 2011). These pollutants present a significant threat to aquatic organisms for short duration and long-term exposures. In addition, they can also pose a risk to human health.

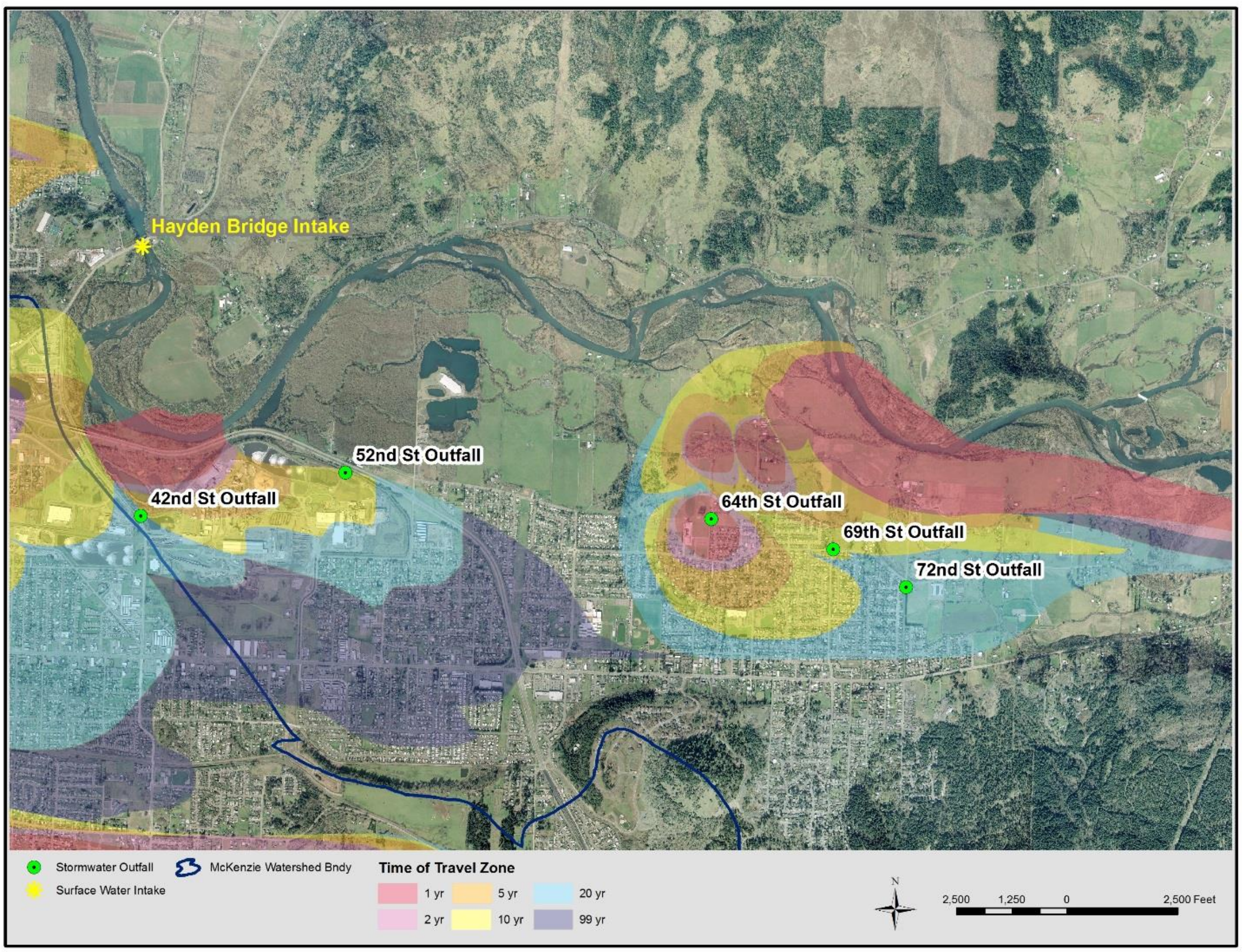
Stormwater runoff goes directly into waterbodies without pretreatment.

Urban runoff is a concern especially in the lower part of the McKenzie Watershed which includes parts of East Springfield. Several stormwater outfalls (i.e., 42nd St, 52nd St, 64th St, 69 St, and 72nd St) discharge into Cedar Creek and Keizer Slough, and then into the McKenzie River just upstream from EWEB's intake. This area also contains a number of Springfield Utility Board (SUB) and Rainbow Water municipal well fields. These wellfields and their area of influence are protected through the Springfield Drinking Water Protection Overlay District that was adopted by the City of Springfield in May 2000 (see Figure 4-3 and section 3.3-200 of the

Springfield Development Code). The overlay was developed to prevent contamination of the City's drinking water source, and regulates the storage and handling of hazardous or other materials that pose a risk to groundwater. Regulations include requiring secondary containment, inspection and monitoring programs, employee training, and a restriction on the use of dense non-aqueous phase liquids (DNAPLs), such as chlorinated solvents, within the ten-year time-of-travel zone. The overlay generally applies to commercial uses within the 20-year time-of-travel zone. (http://qcode.us/codes/springfield-development/).

The 42nd and 52nd Street stormwater outfalls drain a large area of Springfield, approximately 2000 acres, that contains a concentration of industrial and commercial activities, while the other three outfalls drain areas of eastern Springfield containing mostly residential neighborhoods and some commercial uses (see Figure 4-3).

Figure 4-3: Stormwater Outfalls and SUB Wellhead Protection Time-of-Travel Zones



The 42nd and 52nd stormwater outfalls pose a higher threat to Eugene's drinking water than the other outfalls due to the large quantities of chemicals stored and used in this area and the close proximity to EWEB's intake. The types of chemicals stored and used in these commercial and industrial facilities include various corrosive materials, solvents, poisons and other potential health hazards. A summary of select chemicals reported by three businesses just upstream of EWEB's intake is presented in Table 4-5. This information was retrieved from the Oregon State Fire Marshal Community Right-to-Know Hazardous Substance Information website (www.sfm.state.or.us) and represents only a few of the many chemicals stored and used in the McKenzie Watershed . Please keep in mind that the quantities listed below are the respective maximum quantities for each product that may be on site at any given time over the course of the reporting period. These chemicals pose a significant threat to Eugene's drinking water not only from accidental spills and releases at the facility, but also through transporting these chemicals to the facility by truck on a regular basis. However, this threat is somewhat mitigated by SUB's wellhead protection ordinance that regulates the storage and handling of hazardous materials as described above.

Table 4-5: Example of Chemicals Stored and Used in the 52nd and 42nd Street Stormwater Basins

Product Name	Hazardous Ingredient	Physical State	Max Quantity	Unit	Hazard Classification
White Liquor	Sodium Hydroxide	Liquid	2,500,000-4,999,999	Gallons	Corrosive Material
Turpentine	Turpentine	Liquid	50,000-99,999	Gallons	Acute Health Hazard
Methanol	Methanol	Liquid	10,000-49,999	Gallons	Acute Health Hazard
Aluminum Sulfate	Aluminum Sulfate Hydrate	Liquid	10,000-49,999	Gallons	Corrosive Material
Diesel Fuel 2	Petroleum Distillates	Liquid	10,000-49,999	Gallons	Chronic Health Hazard
Kymene LBW Resin	1,3-Dichloropropan-2-Ol	Liquid	5,000-9,999	Gallons	Acute Health Hazard
Accord XRT II	Glyphosate DMA Salt	Liquid	1,000-4,999	Gallons	Pesticide
Sulfomet Extra	Sulfometuron Methyl	Solid	1,000-4,999	Pounds	Pesticide
Velpar DF and	Hexazinone	Solid	1,000-4,999	Pounds	Pesticide
Nalstrip 497C	1-Methoxy-2-Propanol	Liquid	1,000-4,999	Gallons	Reactive Material

Many facilities within eastern Springfield also have National Pollutant Discharge Elimination System (NPDES) permits for various regulated discharges from process wastewater, wash water, storm water, and other sources. The City of Springfield has a municipal separate storm sewer system (MS4) NPDES Phase II permit that regulates the outfalls from its stormwater system. The permit requires that Springfield control pollutants to the maximum extent practicable. Implementation of this permit has led to many improvements in the stormwater system such as increased street sweeping, installation of natural features that treat stormwater onsite, and other best management practices (BMPs). These efforts help reduce the risk to drinking water.

EWEB, the USGS, City of Springfield, and student water quality teams have conducted extensive water quality monitoring of these 5 stormwater basins (including Cedar Creek and Keizer Slough) over the past 15 years (Figure 4-1). The USGS pesticide monitoring study suggested that urban pesticide use is a larger threat to drinking water quality than either agriculture or forestry. Pesticide data from water samples collected from these five stormwater outfalls show high detection rates and concentrations of 2,4-D, Pentachlorophenol, Prometon and Carbaryl in all stormwater outfalls (see Table 4-6). Several pesticide detections exceeded water quality benchmarks, including DEQ's Human Health Criteria and the USGS Health Based Screening Level. Over 50 of more than 200 different pesticides and pesticide degradates analyzed were detected in stormwater sources originating from the City of Springfield.

Table 4-6: Pesticides Detected in East Springfield Stormwater Outfalls, Cedar Creek and Keizer Slough

Pesticide	Analyzed	Detected	Max (ug/L)	Occurrence	Exceedance
2,4-D	83	37	1.6489	45%	
Pentachlorophenol	97	24	0.8	25%	DEQ HHC
Prometon	78	24	0.0568	31%	
Carbaryl	79	20	0.2931	25%	
Diuron	52	18	6.065	35%	USGS HBSL Low
Diazinon	84	17	0.115	20%	
Desulfinylfipronil	56	15	0.006	27%	
Sulfometuron-methyl	54	15	1.607	28%	
Atrazine	118	14	0.0533	12%	
Deet	12	12	0.29	100%	
2,4-DB	82	10	0.0998	12%	
Trifluralin	106	9	0.005	8%	
Tebuthiuron	67	8	3.47	12%	
trans-Propiconazole	22	8	0.08	36%	
cis-Propiconazole	22	7	0.051	32%	
Dacthal	101	7	0.0029	7%	
Fipronil	56	7	0.0411	13%	
Glyphosate	9	7	0.43	78%	
Metolaclor (Dual)	97	7	0.0122	7%	
Triclopyr	52	7	0.2156	13%	

Note: See Appendix A for more details on the pesticides listed, including type, common uses, and human and aquatic health benchmarks.

As indicated in Table 4-7 below, downstream impacts from these stormwater outfalls are significantly reduced by dilution, photo degradation, and other processes. The two most detected pesticides in Cedar Creek and Keizer Slough are 2,4-D and Sulfometuron-methyl.

EWEB is working with a number of partners to mitigate this high priority threat by designing wetlands to treat runoff and reducing toxics in stormwater by preventing their use in the first place (see Section 6.3).

Table 4-7 Summary of Pesticide Detections at Urban Sites (2002-2016)

Site ID	Site Description	Unique Compounds	Total Detections	Total Analyses	Estimated Values*
E220	Cedar Creek, above stormwater outfalls	5	6	724	6
E720	Stormwater Channel, primarily residential	8	13	610	6
E690	Stormwater Channel, primarily residential	29	86	1516	49
E640	Stormwater Channel, primarily residential	13	25	857	8
E210	Cedar Creek, below stormwater outfalls	25	53	1737	35
E520	Stormwater Channel, mixed use	30	81	1354	52
E420	Stormwater Channel, primarily industrial	24	52	1197	24
E810	Keizer Slough, McKenzie Side Channel	17	28	1079	15

*Estimated values are generally values that fall between the reporting limit and the detection limit, meaning the compound was detected but could not be quantified resulting in an estimated concentration.

Spills

Spills are a substantial threat to consider in the McKenzie Watershed due to the presence of Highway 126, which runs right next to the river for the majority of its length. Furthermore, due to EWEB's reliance on the McKenzie as its sole source of drinking water, a hazardous spill could be particularly dangerous. An older ODOT study found that about 500 trucks a day traveled Highway 126 through the McKenzie with 5% of them carrying hazardous materials (ODOT, 1998). As indicated earlier, chemicals used in industrial and commercial facilities may also be accidently spilled during transport to the facility, during off-loading once at facility, as a result of use, and/or as part of a waste stream. The McKenzie Watershed has experienced a number of smaller spills, largely due to traffic accidents, with the vast majority involving petroleum products. Numerous automobile accidents, including several submerged vehicles, have occurred over the past 10 years. Several large truck accidents have also resulted in fluid releases to the McKenzie River. One of the more recent releases involved a tractor-trailer that left the road near the town of Leaburg and crashed directly above Johnson Creek. An estimated 60 to 80 gallons of diesel fuel was released to the ground and directly to the creek. EWEB staff responded to assess contamination, collect samples and monitor spill response efforts. No major spills have occurred in the watershed since 1991, when a truck transporting waste oil crashed along Leaburg Lake. However, adjacent watersheds, including the Santiam and Middle Fork, have experienced a number of larger releases involving petroleum products.

In 2012, a tanker truck overturned on Highway 58 resulting in the release of 3,100 gallons of gasoline and 2,500 gallons of diesel into a ditch adjacent to the Middle Fork Willamette River. EWEB has worked with a number of local, state, and federal agencies to design and implement a GIS-based spill response system, called the McKenzie Watershed Emergency Response System

(MWERS), which is described in more detail in Section 6.1. The Region II Hazmat team that initially responded to the Middle Fork fuel release brought an MWERS trailer along, which proved to be extremely useful. Boom from the trailer was deployed to prevent diesel fuel from reaching the river. All used equipment was replaced at the expense of the trucking company.

Development/Septic Systems

Approximately 4,200 septic systems exist in the McKenzie Watershed upstream of EWEB's intake. Using the average sewage discharge amount from households of 225 gallons per day provided by Oregon Department of Environmental Quality, approximately 950,000 gallons of sewage are discharged to the shallow subsurface on a daily basis, or 345 million gallons per year.

Septic systems that pose the highest risk to drinking water sources are systems that are older than 20 years, clustered with other septic systems on smaller lots, located adjacent to ditches, lakes, streams or rivers, and are on thin or excessively permeable soils (U.S. EPA, 2003; Schueler and Holland, 2000; Novotny and Olem, 1994). Approximately 2,250 of the total 4,200 septic systems in the McKenzie watershed are in clusters and located adjacent to streams or the McKenzie River. Without regular maintenance, septic systems could fail, releasing bacteria, nutrients, chemicals and pharmaceuticals into the ground water and ultimately ending up in surface water. In 2008, EWEB conducted a septic system study with grant funds from the Oregon DEQ 319 funds to assess impacts to water quality from septic cluster areas and develop a septic assistance program (see Section 7.1). Analytical results from this one time investigation indicated increased concentrations of e. coli bacteria, total coliforms, nitrates, and manganese in various downstream monitoring locations when compared to samples collected immediately upstream from a septic cluster area (EWEB, 2009).

In addition to septic systems, development in the watershed may lead to increased impervious surfaces, riparian vegetation removal, and use of fertilizers and chemicals on yards. If development occurs adjacent to the river in the floodplain, flood events can wash contaminants from sheds or garages into the river, flood septic systems, and wash entire structures into the river. Of the approximately 4,200 homes upstream of EWEB's intake, about 205 structures are within 50 feet of the river, 210 exist in the floodway, and over 1,100 structures are in the 100-year floodplain. Based on LiDAR analysis of canopy cover within a modeled riparian/inundation zone (consisting of 8612 acres), 42% were without canopy cover, 26% was significantly degraded, and 32% appeared as intact forest (LCOG, 2015d; EWEB, 2016).

Since 2002, EWEB has collected water quality samples from monitoring stations that are downstream of higher density development and septic systems, such as Haagen Creek and Camp Creek. Haagen Creek flows through a dense development of approximately 80 homes on one side and a golf course along the other. The golf course is currently being developed as a 26-home subdivision. Camp Creek has mixed land use consisting of higher density residential properties, agriculture, and industrial timber ownership (see Section 4.2). Table 4-8 summarizes compounds detected in water samples collected downstream from higher density development using passive sampling devices. These are devices contain a lipid membrane, similar to fish fat, which attenuate organic contaminants. Passive devices are deployed up to a month at a time and are sent to USGS laboratory for analysis.

Table 4-8: Summary of Detected Compounds Using Passive Devices at Multiple Locations (May 25 - June 23, 2010)

Location	Polycyclic Aromatic Hydrocarbons	Organohalogen Compounds	Anthropogenic Indicators
Camp Creek	16	26	0
Cedar Creek	11	15	2
Haagen Creek Lower	18	25	2
Haagen Creek Upper	18	19	3
McKenzie River	6	4	2
Finished Water	5	4	1

Source: USGS, 2013

As indicated in Table 4-8, Camp Creek and Haagen Creek reported the highest number of polycyclic aromatic hydrocarbons (PAHs) and organohalogen compounds (OHCs) when compared to Cedar Creek and the McKenzie River. Upper Haagen Creek also had a similar number of detected compounds when compared to lower Haagen Creek. There were some homes in the vicinity of upper Haagen Creek, but most homes were located in between the two sites. However, during a previous deployment, upper Haagen Creek reported far fewer PAHs and no anthropogenic indicators (AIs) when compared to the lower site.

In 2009, EWEB contracted with LCOG to conduct a preliminary analysis on how many future homes could be built above EWEB's intake based on existing land use laws and development code using conservative assumptions (LCOG, 2010). Results indicate that between 734 and 979 future homes could be built, with the vast majority being constructed within 300 feet of the river and in the lower part of the watershed.

EWEB has worked with landowners and partners to design and implement programs to reduce impacts of development by inspecting and maintaining septic systems, repairing or replacing failing septic systems, reducing chemical use, adopting naturescaping practices (increasing riparian buffers, using native plants), protecting and restoring riparian forests, and removing household hazardous waste (see Sections 6.3, 6.4, 7.1, 7.3 and 7.4).

Highway Spray

The Oregon Department of Transportation typically sprays along both sides of Highway 126 in the McKenzie Watershed to control invasive weed populations. Chemicals have included: Indazifam, Glyphosate, Metsulfuron-methyl, Triclopyr, Imazapyr, Aminopyralid, and Flumioxazin (ODOT, 2015). EWEB obtains annual spray data from ODOT, which shows that approximately 20-30 gal of active ingredient is applied on an annual basis in the watershed. They generally leave a buffer around streams, and if they need to spray within 10ft of a waterbody, they use an aquatically-approved herbicide. However, as with any chemicals applied to vegetation, there is a potential for runoff into nearby waterbodies.

EWEB and the USGS collect water samples from various locations along the McKenzie River during storm events to assess pesticide runoff (see Section 5.2). These analytical results show that pesticides such as glyphosate and triclopyr, which can be used along highways, have been detected in the McKenzie watershed. Of course, other applications of these chemicals may have occurred elsewhere in the watershed, making it hard to tie the presence of these chemicals in water to these specific applications.

Dams

The McKenzie Watershed contains four EWEB hydroelectric dams and two large Army Corps of Engineers dams. Threats from dams include the storage of hazardous materials such as diesel, turbine oil, and transformer oil, and the use of grease, solvents, paints, and other chemicals for maintenance purposes. Because dams are part of the river, the main threat is from spills during normal operations and rare transformer failures.

Dams can also impact water quality in a number of other ways. This is particularly true for the larger flood control/irrigation dams in the area operated by the U.S. Army Corps of Engineers (USACE). These dams significantly impede the flow of sediment downstream, causing sediment deposition behind the dam. Occasionally, often during routine or emergency maintenance operations, water levels are dropped and lacustrine sediment is exposed. If these drawdowns coincide with significant rainfall events, large quantities of sediment can quickly be released and flushed downstream. Mobilized sediment may contain metals, nutrients and legacy contaminants, such as DDT. In 2005, the USGS conducted a study of DDT in sediment following the Cougar Reservoir drawdown and found low levels of DDT in sediment downstream of the dam and confluence of South Fork McKenzie River (USGS, 2007).

Reservoirs often provide opportune conditions for the development of large planktonic algal blooms, which generally appear annually in both Blue River and Cougar reservoirs. Blooms can increase both the total and dissolved organic carbon loads downstream and may also be a source of toxins (see section 5.3). Below the dam, regulated flow conditions may reduce the scouring nature of large storm events and may increase the presence of benthic algal populations.

Industry/Point Sources

Although the McKenzie Watershed is largely rural and forested, there are some industrial facilities located in the East Springfield and Thurston areas, including International Paper, Oregon Industrial Lumber, auto shops, gas stations, fabrication facilities, equipment repair shops, construction companies, etc. See the previous discussion on *Urban Runoff* for more details on the types and location of industrial facilities, amount of hazardous materials stored and used by these facilities, NPDES permitted discharges to Springfield's stormwater system, and results of downstream water quality monitoring.

4.4 Climate Change

Climate change is a reality that is becoming an increasing concern for drinking water utilities across the West, from both a water quantity and water quality perspective (http://www.carpediemwest.org/). While we are fortunate to have such an excellent and abundant drinking water source, climate change will impact this resource. Extensive modeling and research by OSU, U of O, PSU and others, and several studies by the USGS provide water managers with a good fundamental understanding of what these impacts will likely be to the McKenzie and larger Willamette Basin, which generally include:

- More winter precipitation falling as rainfall (less snow pack) that could increase frequency and magnitude of flooding; and
- Longer dryer summers that result in more severe low flows, leading to increased algal bloom frequency and severity, increased wildfire frequency and severity, and result in more water quality problems due to less dilution in the streams and rivers.
- More volatile and severe weather patterns and storms causing more damage to infrastructure, homes, and buildings.

(Sproles, et. al., 2013; Nolin et al, 2015; Climate Leadership Institute, 2009; Resource Innovations, 2005; Farley et al., 2011; Willamette Water 2100 (http://water.oregonstate.edu/ww2100/**)**

Harmful Algal Blooms

Increasing summer temperatures may contribute to an increase in harmful algal blooms (HABs) in the reservoirs or the river. HABs can produce toxins and affect drinking water, recreational opportunities, and aquatic life. Treating HABs effectively is challenging and, most frequently, they are left to die off on their own and advisories are posted near the affected water body. For more information on HAB monitoring and results in the McKenzie see Section 5.3.

Current HAB advisories are listed at the Oregon Health Authority website: http://public.health.oregon.gov/HealthyEnvironments/Recreation/HarmfulAlgaeBlooms/Pages/Blue-GreenAlgaeAdvisories.aspx

Floods/Drought

Climate change will produce more extreme weather events as weather patterns shift, including longer drier summers and wetter winters that could lead to both more flooding and drought. OSU research on climate change impacts in the McKenzie Watershed shows a loss of snow pack between 3,000’ and 4,500’ elevation AMSL that would lead to 56% more runoff during the winter that used to be held as snowpack, melting slowly throughout the spring (Sproles, et. al., 2012). In addition, floodwaters can wash toxic chemicals stored in garages or sheds into the water, along with other yard debris. If septic systems and drainfields are flooded, additional untreated or partially treated sewage containing nutrients, bacteria, viruses, and pharmaceuticals can get into the river. Watersheds with healthy riparian areas are more resilient to these kinds of climate change effects.

It is estimated that floods now cause an average of $8 billion in damage on an annual basis across the nation (EPA, 2012).

At the other extreme, drought conditions can cause water quality concerns (increased concentrations of total dissolved solids, algal blooms), as temperatures rise. In addition, the risk of wildfires increases due to the extended drier and hotter summers (see below).

Snowpack

One of the climate change predictions for Oregon is that snowpack will decline in the Cascade Mountains with warming temperatures. This means more precipitation in winter will be in the form of rain, rather than snow, increasing flows in creeks and rivers, which in turn reduces the water available later in the summer. Generally, snowpack melts slowly in the late spring/early summer and helps to sustain streamflow throughout the summer. If snowpack melts sooner due to warmer temperatures, less water will be available late in the summer and hydrologic systems will be more vulnerable to drought. Lower flows can impact water quality through: increased water temperatures; less dilution for fertilizers, pesticides, and fecal bacteria; and more organic carbon resulting from increased temperatures and nutrients fueling aquatic vegetation growth (e.g., algal blooms). The increased organic carbon load can affect taste and odor, and increase disinfection by-products when chlorine is used to treat raw water (Kraus, 2010).

Wildfires

Increasing summer temperatures also increases the risk of wildfires in the watershed, which can pose a risk for drinking water sources. During severe wildfires, large quantities of retardant are aerially applied and end up in streams and rivers as increased nutrient load. Burned areas, especially if severe, can result in hydrophobic soils and large pulses of sediment and burned debris running off into streams and rivers during rain events following the fire. In addition, burned landscapes are more prone to increased flooding in the years following a wildfire. Such dramatic increases in turbidity can make treating the water more difficult and more expensive. For instance, Denver Water has spent more than $27 million to address water quality impacts caused by the Buffalo Creek and Hayman fires that occurred in 1996 and 2002 (Denver Water, 2017).

5.0 WATER QUALITY MONITORING/WATERSHED HEALTH

5.1 Baseline Monitoring

5.1.1 Purpose

EWEB's baseline monitoring program is a long-term effort to assess ambient water quality conditions in source waters over time and to better understand the overall health of the watershed. Data collected as part of this effort are compared to human health and aquatic toxicity benchmarks to determine how different land use types affect water quality. When benchmarks are exceeded or water quality conditions deteriorate, then targeted monitoring can be used to identify potential upstream pollution sources. This information can help staff make informed decisions regarding outreach efforts and resource allocation geared towards improving water quality. Long-term water quality trends can also be used to determine the overall effectiveness of watershed protection programs and conservation efforts. Results provided in this section represent only a small component of baseline data that will be presented in the next Baseline Report, due in the fall of 2017.

5.1.2 Background

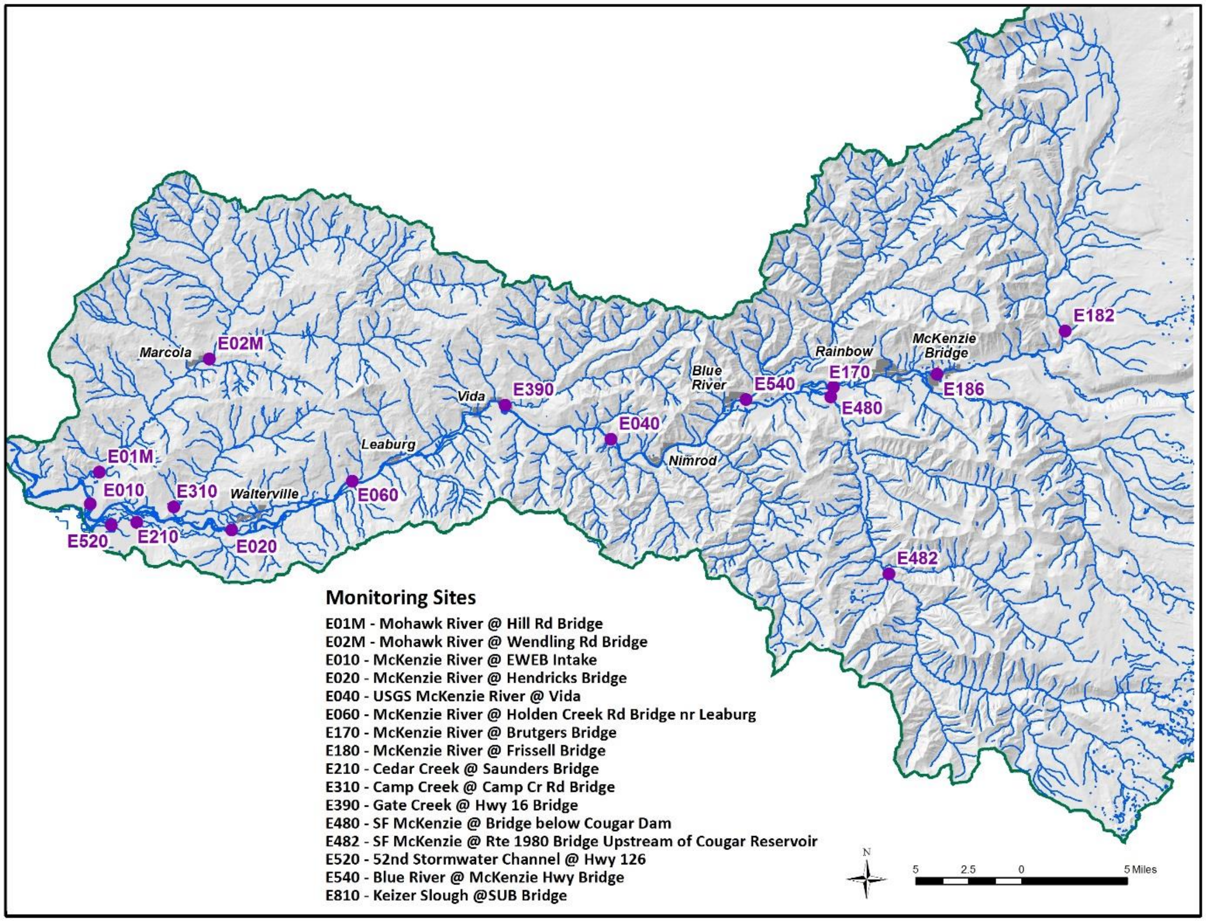
From 1993 to 2005, the Oregon Department of Environmental Quality (DEQ) collected water quality samples from seven monitoring sites in the McKenzie watershed on behalf of the McKenzie Watershed Council (MWC), EWEB, Willamette National Forest (USFS), U.S. Bureau of Land Management (BLM), Springfield Utility Board (SUB) and the U.S. Army Corps of Engineering (ACOE). The DEQ watershed monitoring efforts were conducted eight times a year and samples were analyzed by the DEQ Laboratory for general water quality parameters (temperature, dissolved oxygen, turbidity, pH, conductivity, total suspended solids, total organic carbon, alkalinity, and biological oxygen demand), nutrients (total Kjeldahl nitrogen, nitrates, nitrites, orthophosphate, ammonia, and total phosphate), and bacteria/algal communities (E. coli, fecal coliform, pheophytin-a, and chlorophyll-a) (Oregon DEQ, 2000; Oregon DEQ, 2001; Oregon DEQ 2003). The purpose of this monitoring effort was to assess long-term trends in water quality as part of a state-wide water quality monitoring program.

In 2006, a decision was made by EWEB, MWC and SUB to begin a watershed monitoring effort conducted and funded by partners. This effort would partially replace the work previously done by DEQ. DEQ continues to monitor three of the seven sites intermittently as part of its state-wide water quality monitoring effort. EWEB led an effort to continue and expand the long-term baseline monitoring program by coordinating sampling events at 13 sites with multiple partners (McKenzie Watershed Council, USFS, City of Springfield, Springfield Utility Board, and DEQ).

Baseline sampling occurs on a quarterly basis and includes metals, nutrients, other inorganics, microorganisms, organics and field parameters (i.e. pH, Temperature, Turbidity, etc.). By 2014, the baseline list for the McKenzie watershed had been expanded to include 16 sites, (see Figure

5-1). Sites were selected to represent water quality conditions across multiple land use types and to bracket water quality inputs to the main stem McKenzie in the upper, middle and lower sections of the watershed.

Figure 5-1: McKenzie Watershed Baseline Sites



5.1.3 Current Status

Current baseline monitoring efforts regularly include quarterly sampling at 16 sites in McKenzie Watershed. Grab samples are analyzed for metals, nutrients, bacteria, total organic carbon, general water quality parameters, and in some cases, organic contaminants. During each sampling event, a Yellow Springs Institute (YSI) EXO2 multiparameter water quality sonde is deployed at each site to measure temperature, dissolved oxygen, turbidity, conductivity, pH, chlorophyll and fluorescent dissolved organic matter (fDOM).

Every effort is made to complete sampling in a single day to facilitate better comparison between sites. Typically, two sampling teams are required. Sampling events are selected randomly throughout the year and are intended to cover a range of hydrologic conditions. Some of these events may coincide with peak storm events, but most do not.

5.1.5 Monitoring Results

Monitoring results are generally plotted collectively by either their respective channel type or site identification number on the y-axis and the analyte concentration on the x-axis. Most concentrations are plotted on a logarithmic scale in micrograms per liter (ug/L). Analytical results are compared to a number of different water quality benchmarks to determine watershed health and potential sources of water quality impairment. EPA drinking water regulations and guidelines used in this evaluation include both the primary Maximum Contaminant Level (MCL) and Secondary Drinking Water Standard (Secondary MCL). Also included are EPA's national recommended water quality criteria for aquatic life, which includes both the freshwater Criterion Maximum Concentration (CMC) and the Criterion Continuous Concentration (CCC). Finally, and depending on the analyte, additional comparison may involve Health-Based Screening Levels (HBSLs) developed by the USGS and Human Health Benchmarks for Pesticides (HHBPs) developed by the EPA.

Given the large amount of data available, baseline monitoring sites have been grouped together by channel type or segment. All sites labeled as Mainstem are located on the McKenzie River. Upper Mainstem sites include McKenzie Bridge, Frissel Bridge and the outlet of Clear Lake. These sites collectively represent pristine reference conditions. The next group of sites, labeled Mid Tributary, represent tributaries in the mid-section of the watershed, which generally include a portion of private timber Sites in this group include the South Fork McKenzie, Blue River and Gate Creek. Mid Mainstem sites include Vida and Holden Creek Bridge (Bridge Street). Lower Tributary sites generally drain low elevation areas marked by increased development and agriculture. Sites include Camp Creek, Cedar Creek, two sites on the Mohawk River, and Keizer Slough. The last site, Keizer Slough, isn't technically a tributary, but a side channel that receives both mainstem flows and stormwater inputs. The Stormwater group includes the 42nd, 52nd, 64th, 69th and 72nd stormwater channels in eastern Springfield. The Lower Mainstem sites include Hendricks Bridge, Hayden Bridge, and Armitage Park.

Metals

Metals originate from a variety of natural and anthropogenic sources within the watershed. Natural metal inputs to surface water originate from the mineralogy of adjacent soils and the underlying geology. Anthropogenic sources include stormwater runoff from urban areas, road and highway inputs from automobiles, fertilizer and pesticide applications, mining activities and airborne deposition.

Both total and dissolved metal samples are typically collected from each site during baseline monitoring events. The total number of metal species analyzed has not always been consistent over the past 17 years. A core group of metals that has been relatively consistent includes As, Cd, Cr, Cu, Pb, Ni and Zn. However, additional metals, such as Al, Ag, Ba, Be, Ca, Fe, Hg, Mg, Mn, Na, Sb, Se, Si, Sr, Tl and V, have been included infrequently depending of the objectives of the monitoring program in affect at the time.

Several acute and chronic fresh water criterion for metals are based on hardness values collected at the time of sampling. For metal data with no associated hardness values, hardness defaults within each Level III Ecoregion in Oregon have been established by the DEQ and EPA. The default hardness value for the Willamette Valley is 34.12 mg/L, and 28.39 mg/L for the Cascades. As indicated in Table 5-1, the average and median hardness values collected during baseline monitoring events for all waterway categories, except stormwater, are below the default values for both the Willamette Valley and Cascades. Furthermore, DEQ has created a metals criteria spreadsheet listing acute and chronic values for multiple metals at various hardness levels (http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm). However, the minimum hardness value used to generate the first set of criteria is 25 mg/L, also above all McKenzie average and median values, except those for stormwater. For purposes of this report, all applicable freshwater acute and chronic criteria will be reported using the minimum hardness value of 25 mg/L.

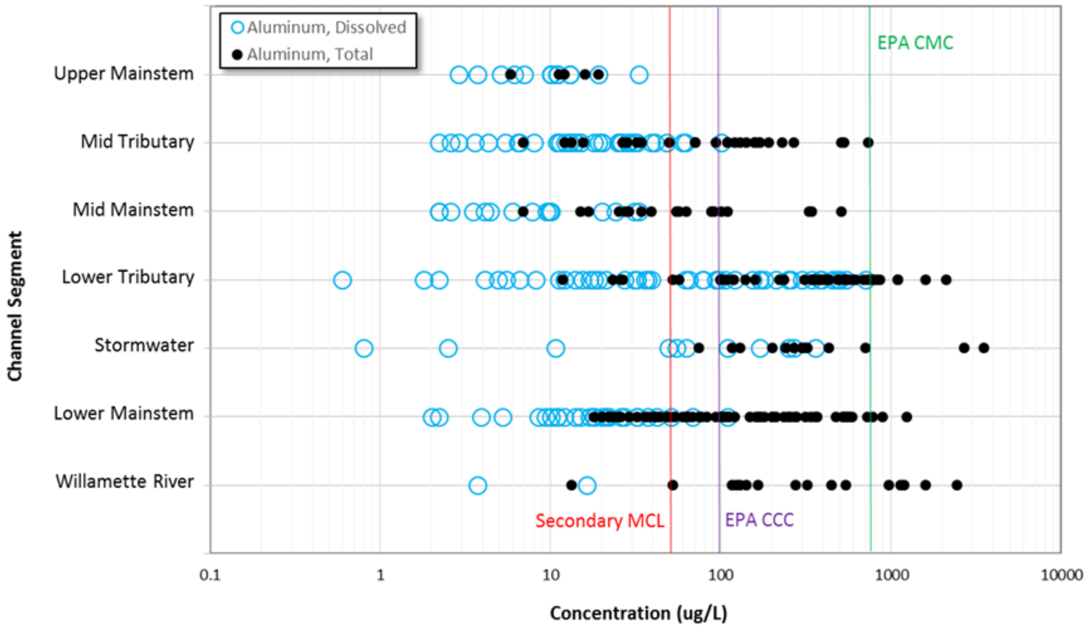
Table 5-1: Hardness (as Calcium Carbonate, mg/L)

Waterway Category	Samples Analyzed	Reportable Values	Min Value	Ave Value	Median Value	Max Value
McKenzie Mainstem Sites	297	297	5.0	16.4	17.0	38.0
McKenzie Stormwater Sites	42	42	7.8	42.6	35.5	110.0
McKenzie Tributaries	180	180	6.4	18.0	16.0	46.0
Willamette River below confluence	25	25	19.1	22.1	22.3	26.0
Composite (all sites)	544	544	5.0	19.3	17.0	110.0

In Figures 5-2 through 5-8, the range of metal concentrations generally shifts to the right, or toward higher concentrations, as the channel segment progresses downstream. This is not all that surprising considering that anthropogenic metal inputs generally increase moving downstream, especially as development and agriculture densities increase. The Lower Tributary and Stormwater groups typically exhibit the highest concentrations across all metal groups. The Upper Mainstem group generally yields the lowest range of concentrations for each metal group. It is important to note that these figures only display detected values, as many results for the Upper Mainstem group fall below applicable reporting/detection limits. As tributary metal inputs increase moving downstream, so too do the mainstem metal concentrations.

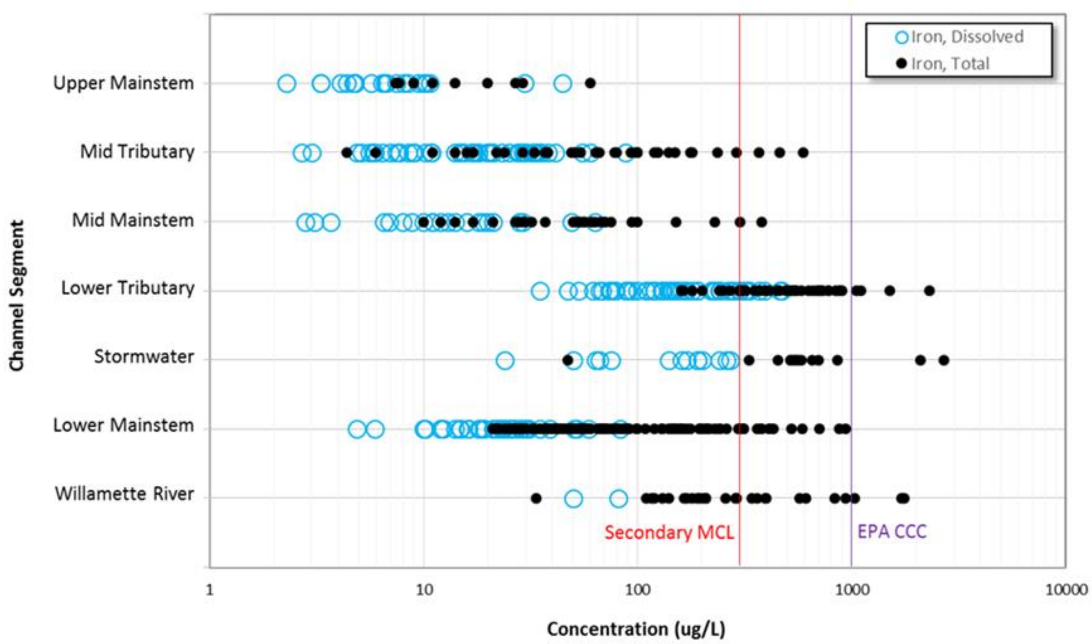
Although EPA's CCCs and CMCs general apply only to dissolved metals, the values expressed for aluminum apply to total recoverable metal in the sample, which by default includes the dissolved component. As indicated in Figure 5-2, baseline results from Mid Tributary, Lower Tributary, Stormwater and Lower Mainstem sites frequently exceed the CCC (87 ug/L), and occasionally exceed the CMC (750 ug/L). Aluminum values across all categories, except Upper Mainstem sites, exceed the secondary MCL (50 ug/L) frequently, although this benchmark is more for aesthetic and technical effects, such as color and scaling, rather than health concerns.

Figure 5-2: Aluminum Detections by Channel Segment McKenzie Watershed (2000-2016)



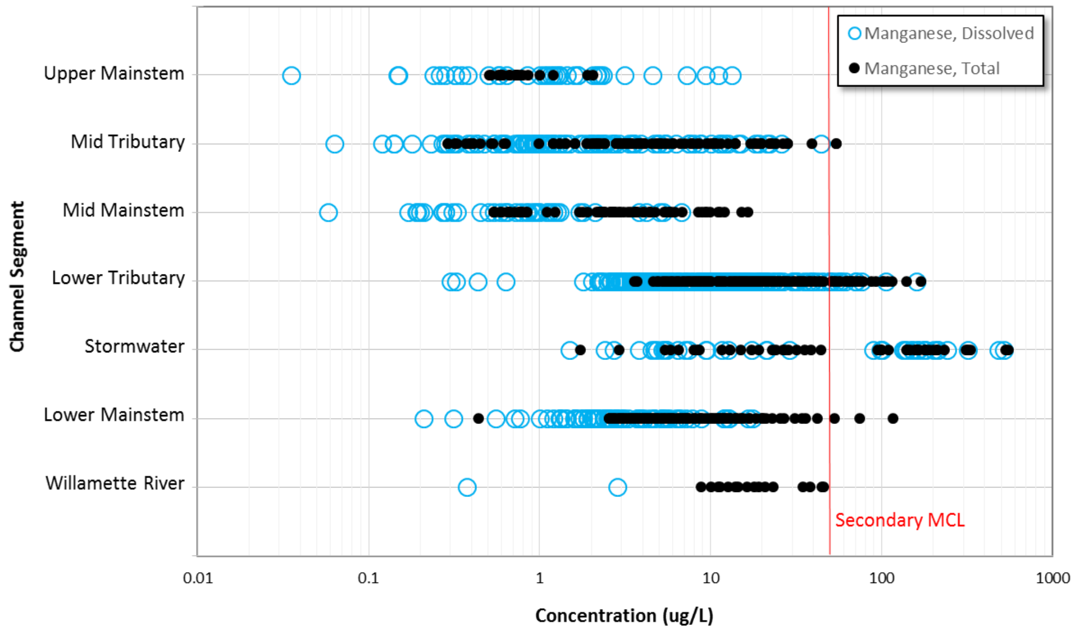
Total iron values in Figure 5-3 frequently exceed the secondary MCL (300 ug/L) in lower watershed sites, although dissolved iron only exceeds this benchmark infrequently in Lower Tributary sites. Dissolved iron values have not exceeded the CCC (1,000 ug/L) during baseline events, although a few storm event values have gone above this benchmark (not plotted).

Figure 5-3: Iron Detections by Channel Segment, McKenzie Watershed (2000-2016)



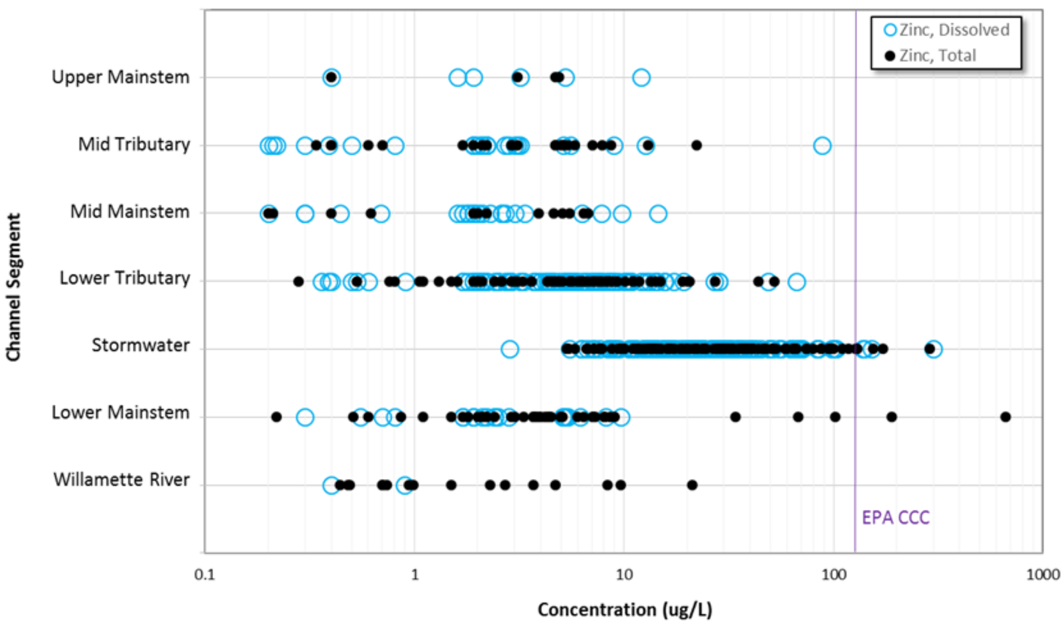
Manganese results exceed the secondary MCL (50 ug/L) frequently for the Stormwater group and only occasionally for the Lower Tributary group (Figure 5-4). CCCs or CMCs for Manganese have not been established.

Figure 5-4: Manganese Detections by Channel Segment, McKenzie Watershed (2000-2016)



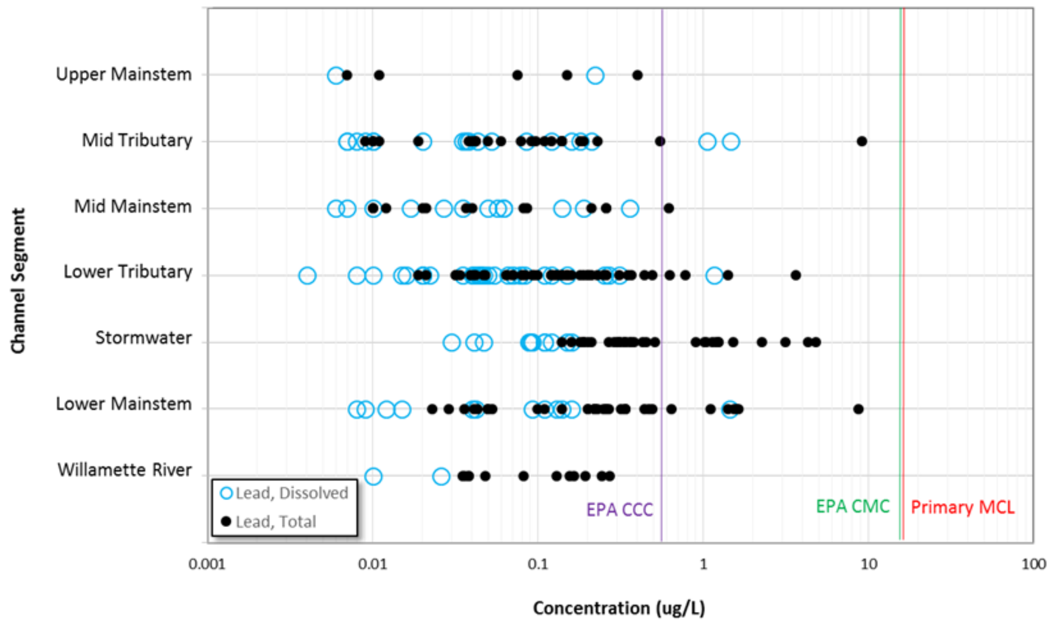
Dissolved and total zinc concentrations are typically one or two orders of magnitude higher for the Stormwater group when compared to other groups (Figure 5-5). In addition to industrial and commercial sources, zinc inputs can also stem from moss treatment applications on rooftops.

Figure 5-5: Zinc Detections by Channel Segment, McKenzie Watershed (2000-2016)



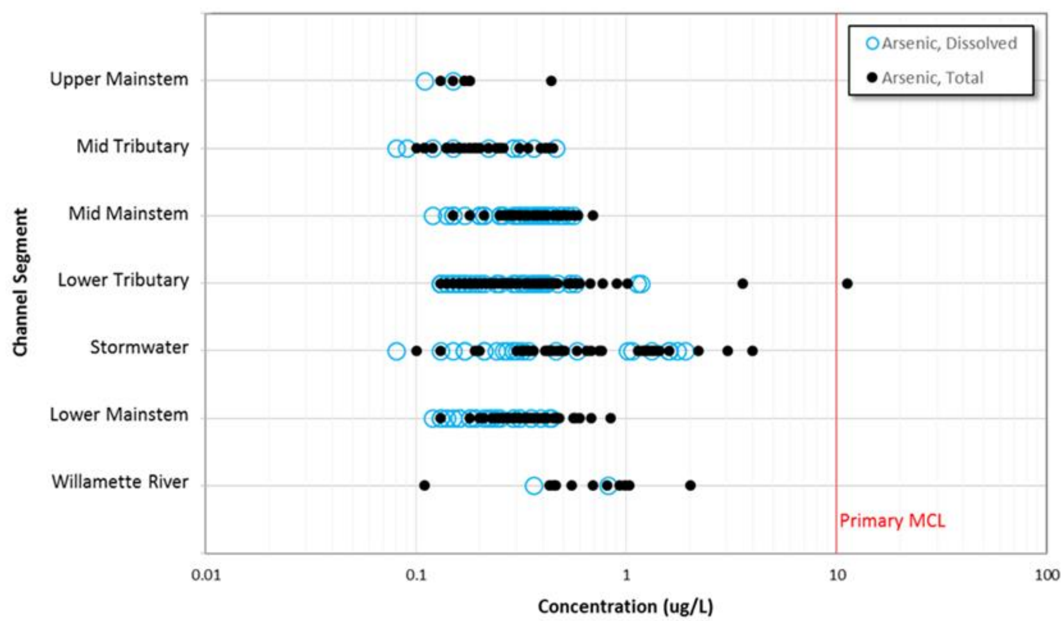
Dissolved lead results rarely exceed the CCC benchmark during baseline events (Figure 5-6). The secondary MCL and CMC are almost never exceeded, except perhaps during storm events. Please note the secondary MCL listed below is actually an action level for drinking water providers and applies if more than 10% of tap water samples exceed the benchmark.

Figure 5-6: Lead Detections by Channel Segment, McKenzie Watershed (2000-2016)



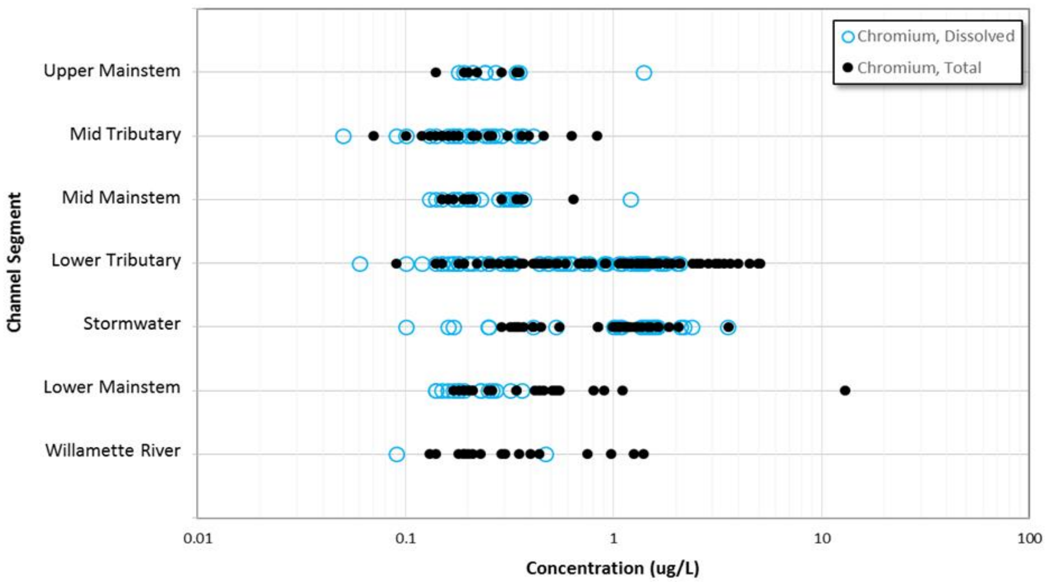
Arsenic values across most groups generally fall at least an order of magnitude below the primary MCL (Figure 5-7). Stormwater sites exhibit some of the highest total and dissolved arsenic values, although both tributary groups appear to provide additional arsenic inputs.

Figure 5-7: Arsenic Detections by Channel Segment, McKenzie Watershed (2000-2016)



Chromium results indicate that both the Lower Tributary and Stormwater groups tend to have higher chromium concentrations than other groups (Figure 5-8). The range of values for the Lower Tributary group are often an order of magnitude higher than the values for the Mid Tributary group.

Figure 5-8: Chromium Detections by Channel Segment, McKenzie Watershed (2000-2016)



Metal results discussed above represent baseline conditions. Baseline monitoring events are generally scheduled on a quarterly basis throughout the year and are intended to assess ambient water quality conditions throughout the year. Although storm events are not targeted for baseline monitoring, occasionally storms do occur on preselected baseline events. This approach captures the natural variation in water quality conditions throughout the year. However, a great deal of research indicates that in many cases the highest pollution loads entering surface water systems are associated with large storms. Depending on the intensity, duration and frequency of storm events, mobilized sediments and associated contaminants often get flushed into local waterways.

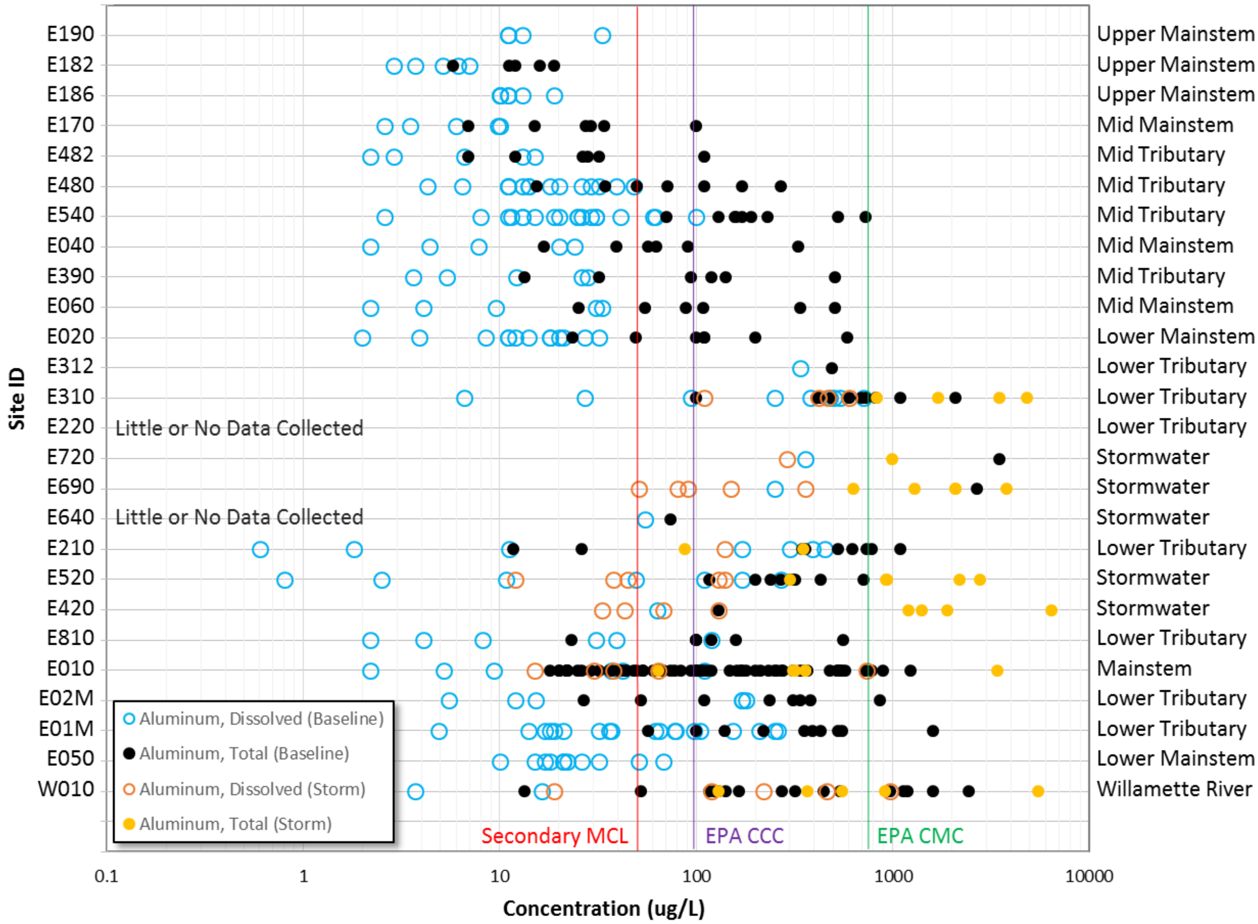
Figures 5-9 and 5-10 provide two examples highlighting the shift in higher metal concentrations during storm events for iron and aluminum, respectively. Storm event monitoring over the past 15 years has focused on organic contaminants and sediment loads. However, over the last 5 years, EWEB staff have included some metal analyses in combination with lower watershed organic contaminant monitoring. Storm event monitoring for metals in upper watershed sites has been minimal, largely due to the fact that anthropogenic metal contributions in these areas is expected to be fairly small.

Figure 5-9: Iron Detections by Site, Baseline and Storm Events (2000-2016)

For both iron and aluminum, upper and mid mainstem metal concentration are generally low, often near the reporting limit, and occasionally non-detect. Metal concentrations generally increase one to two orders of magnitude in the lower tributary and stormwater reaches, which can be seen in elevated lower mainstem concentrations.

Total aluminum values exceed the EPA CMC frequently during storm events. Again, the CMC is usually applied to dissolved concentrations, but in the case of aluminum, the benchmark also applies to total values.

Figure 5-10: Aluminum Detections by Site, Baseline and Storm Event (2000-2016)



Nutrients

For purposes of this plan, the nutrients section includes various forms of nitrogen (N) and phosphorus (P), as well as total organic carbon (TOC) and total suspended solids (TSS). A full analysis of all nutrient data will be provided in the next McKenzie Baseline Monitoring Report, due in the fall of 2017. Nutrient sources can vary considerably within the McKenzie watershed, both spatially and temporally. Natural sources include soils, porous or fractured bedrock, leaf fall, nitrogen-fixing organisms and returning salmon. Anthropogenic sources may include atmospheric deposition (from burning or exhaust), fertilizer runoff, animal waste, septic tanks, municipal wastewater discharges and industrial discharges.

Although nutrients play an important role in natural ecosystems, elevated nutrient levels in surface waters can impact a number of biological and drinking water production processes. Examples of nutrient-related impacts include:

1. Elevated N and P can cause eutrophication and increased algae production resulting in increased TOC levels. Algae die-offs can lead to decreased oxygen levels and possibly cyanotoxin releases (see Section 5.3).
2. Elevated N, especially ammonia, can be toxic to aquatic organisms.
3. Elevated nitrate and nitrite levels can be harmful to human health.
4. TOC, especially the dissolved component, can react with chlorine during the disinfection process and create disinfection by-products (DBPs), which are regulated compounds in drinking water. Increased TOC levels can result in elevated DBP levels.
5. Increased TSS can interfere with aquatic organisms, impede photosynthesis and increase water temperatures. In addition, elevated TSS levels may indicate higher concentrations of organic contaminants, metals and other nutrients. From a drinking water treatment standpoint, elevated TSS levels can impact chlorination and filtration processes.

Nitrogen results, in the form of nitrate, total Kjeldahl nitrogen (TKN) and ammonia-nitrogen, are presented in Figure 5-11 and 5-12. Nitrite values are not included due to the fact that very few reportable values have been recorded across all sites from 2000 to 2016. As evident in Figure 5-11, TKN and ammonia-nitrogen values are relatively evenly distributed across channel segment groups, at least within an order of magnitude. A slight increase in concentrations for both TKN and ammonia-nitrogen is noticeable for the Stormwater group. However, a significant increase in nitrate values is clearly evident in the Stormwater group. Even the Lower Tributary group experiences a shift in the upper concentration range when compared to the Mid Tributary group.

Figure 5-11: Nitrogen Detections by Channel Segment, McKenzie Watershed (2000-2016)

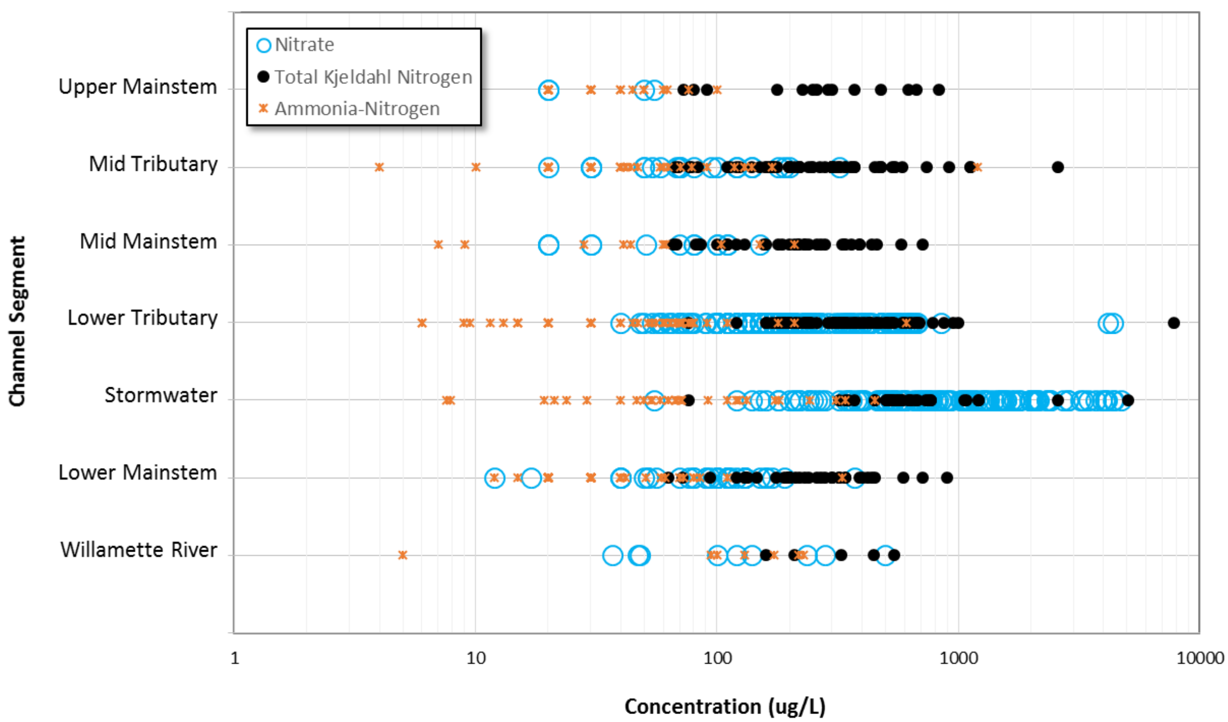
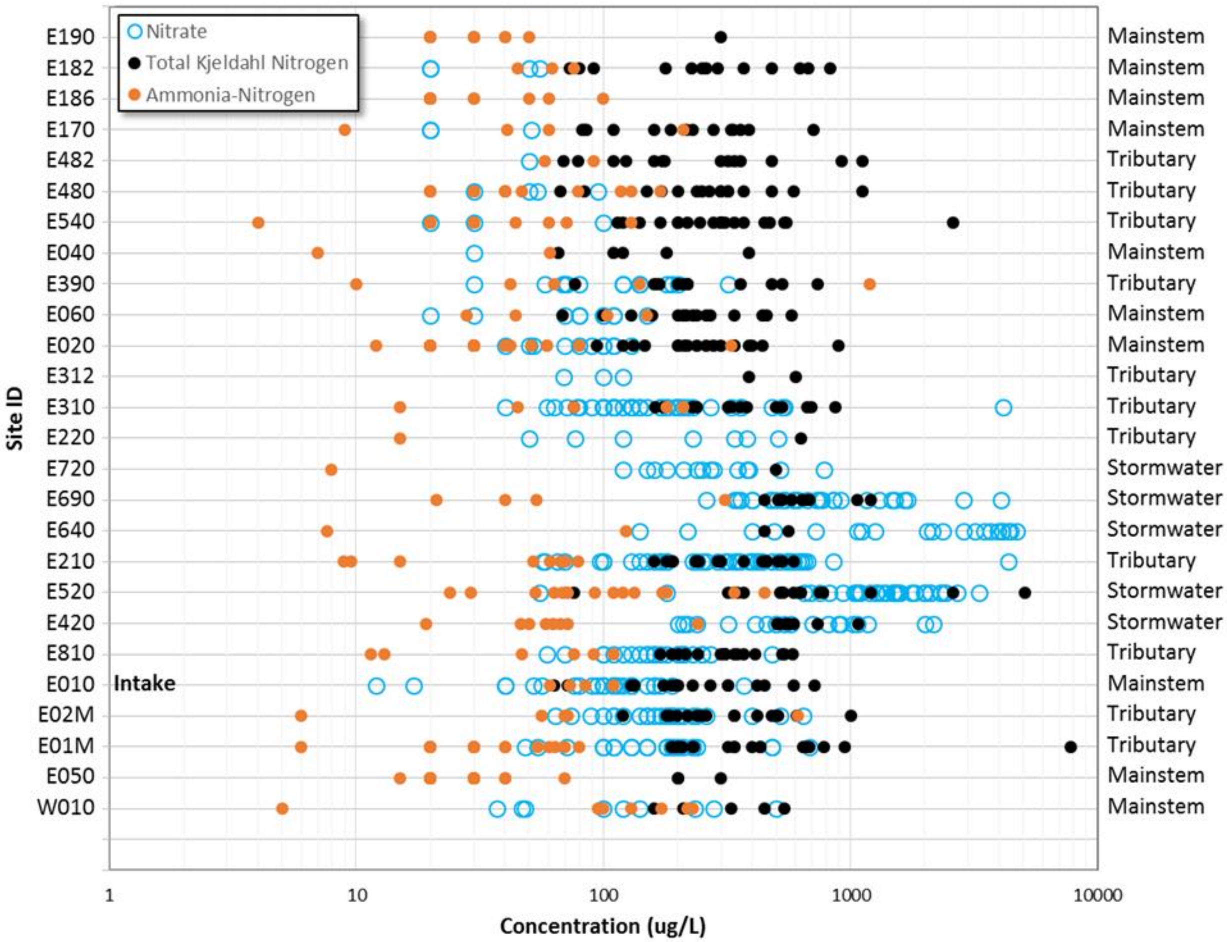


Figure 5-12 provides additional site-level details for nitrogen-related compounds. The 52nd (E520), 64th (E640) and 69th (E690) stormwater channels all have experienced elevated nitrate levels. The results are not all that surprising considering the 69th and 52nd stormwater channels have also recorded some of the highest bacteria levels in the entire watershed (see Figure 5.16).

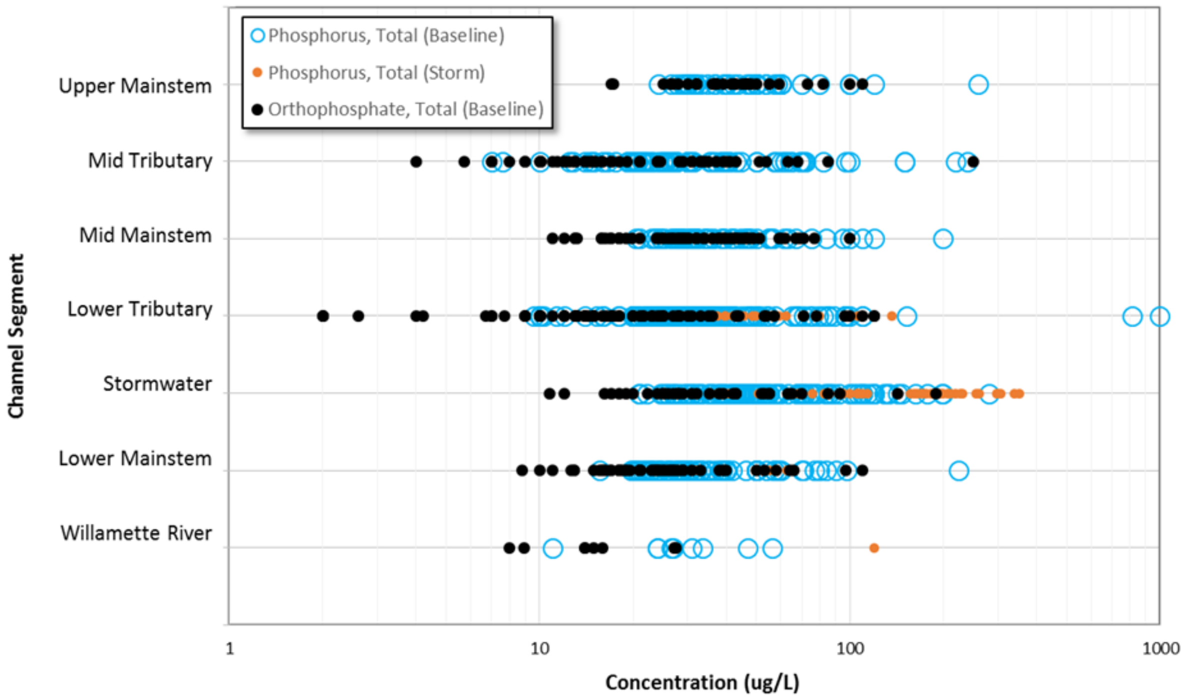
Figure 5-12: Nitrogen Compounds by Site, McKenzie Watershed (2000-2016)



Total phosphorus levels see a slight increase moving downstream, especially with the Stormwater group (Figure 5-13). The range of values between groups is remarkably similar. The Mid and Lower Tributary groups have a similar range, except for a few outliers, as do the mainstem groups. The Upper Mainstem group has a tighter range, as compared to the lower mainstem groups. The highest total phosphorus concentrations appear to originate from the Stormwater group, although it should be noted that storm monitoring at upstream locations for total phosphorus has not been completed at this time.

Orthophosphate levels tend to be higher in the upper reaches of the watershed and decrease moving downstream. This makes sense, as naturally available orthophosphate in the upper reaches of the watershed is readily consumed by aquatic organisms on its way down stream.

Figure 5-13: Phosphorus Detections by Channel Segment, McKenzie Watershed (2000-2016)



TOC and TSS (Figures 5-14 and 5-15) values are both very low across sites in the Upper Mainstem group. This is not surprising considering the region is dominated by young volcanic rock with spring-fed creeks, healthy riparian zones and relatively mature forests, with little or no logging activity. Mid Tributary sites experience increased TOC and TSS values, resulting in increased Mid Mainstem concentrations. This is partly due to the presence of private logging operations and increased road building in the middle-section of the watershed, as well as large reservoir systems with frequent summer algae blooms. The Lower Tributary and Stormwater groups experience the highest TOC and TSS values, further increasing mainstem totals in the Lower Mainstem group. Forestry practices, agriculture, livestock, rural development and urban runoff all contribute to increased TOC and TSS values in the lower watershed.

Limited storm monitoring results for TOC and TSS have been added to both figures for comparison. As expected, the highest TOC and TSS values generally occur in the Lower Tributary and Stormwater groups and tend to be higher than in baseline sampling, particularly for the Stormwater group.

Figure 5-14: TOC Detections by Channel Segment, McKenzie Watershed (2000-2016)

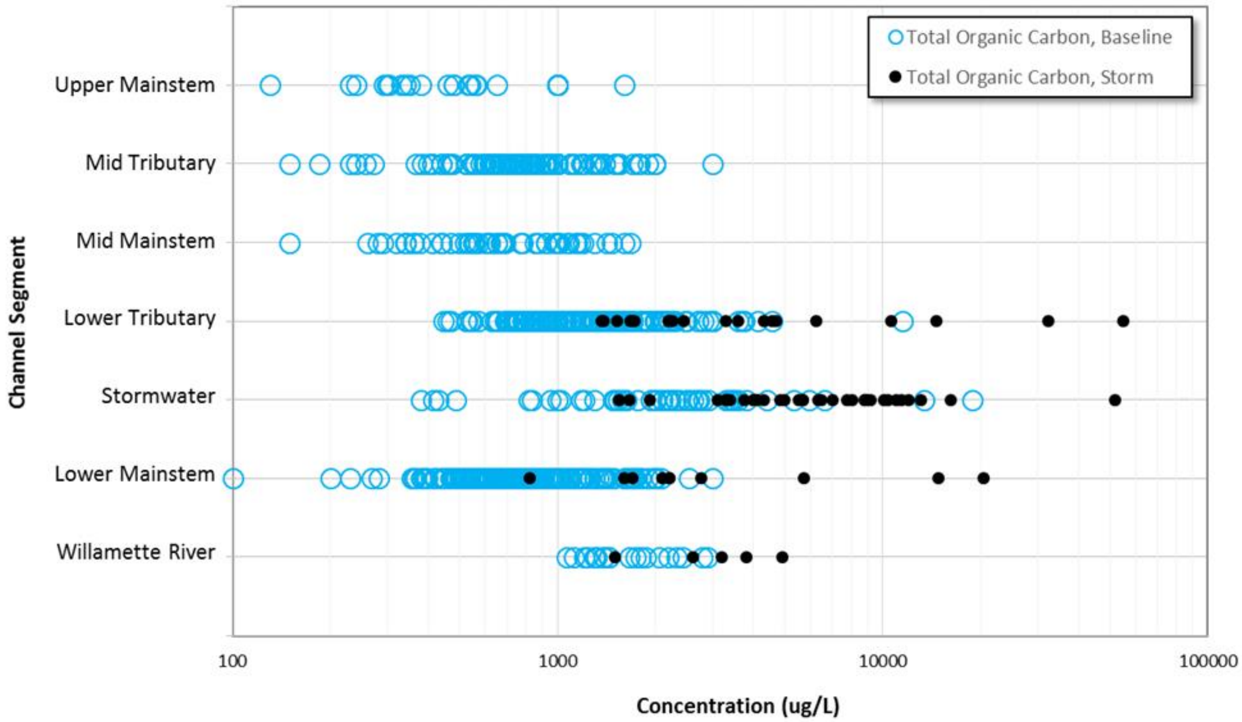
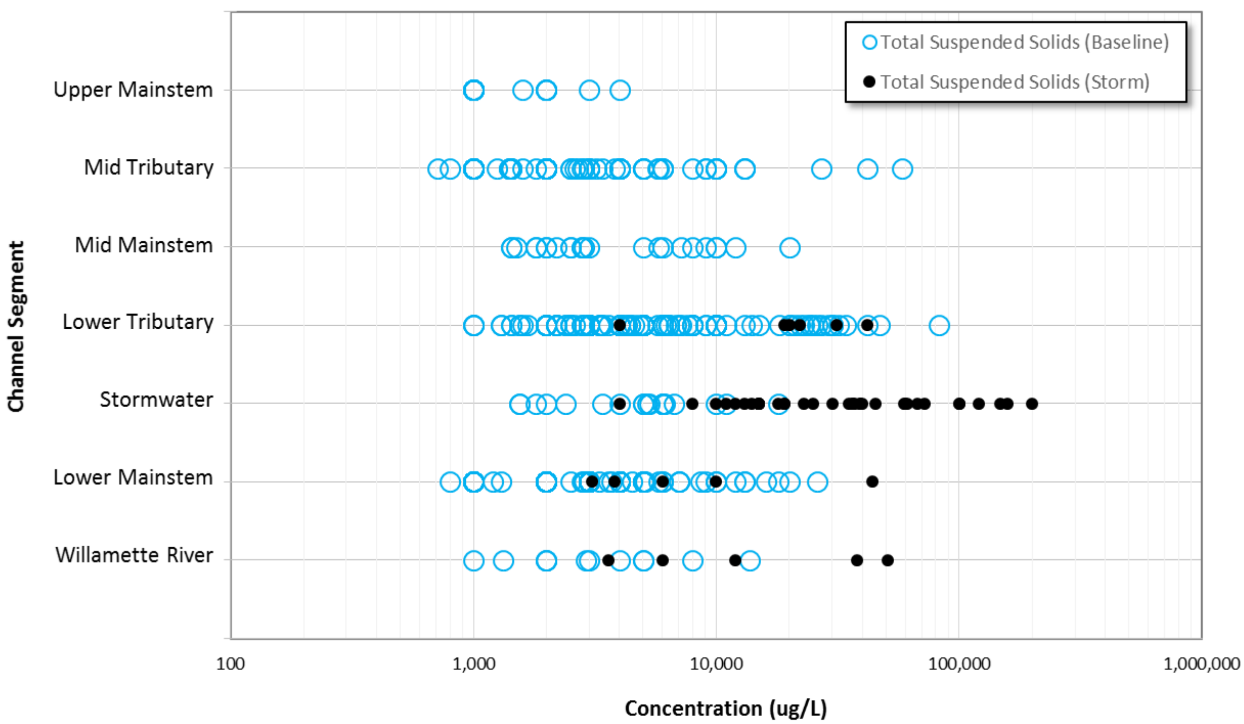


Figure 5-15: TSS Detections by Channel Segment, McKenzie Watershed (2000-2016)



Escherichia coli (*E. coli*) and total coliform have long been used to assess water quality conditions in freshwater. *E. coli*, which are a subgroup of total coliform bacteria, are specific to the intestinal tract of warm-blooded animals. Although most strains of *E. coli* will not make you sick, certain strains are particularly dangerous. Sources of *E. coli* bacteria include septic systems, domestic and wild animal fecal material, stormwater and urban runoff, human fecal material from encampments along waterways and municipal wastewater systems. Total coliform encompasses a large group of different bacteria species, many of which are completely harmless. Elevated numbers don't necessarily indicate unhealthy water conditions, unlike *E. coli*.

Oregon DEQ has established two benchmarks for *E. coli* and considers levels above either value to be unhealthy for recreation. The first, which was updated recently, establishes a 90-day geometric mean of 126 *E. coli* organisms per 100 mL with a minimum of 5 samples (OR Rec Geo Mean). The second benchmark occurs when more than 10% of samples exceed 406 *E. coli* organisms per 100 mL with a minimum of two exceedances (OR Rec Max).

As indicated in Figure 5-16, a significant jump in *E. coli* concentrations occurs in the Lower Tributary and Stormwater groups, as compared to the Upper and Mid Mainstem/Tributary segments. A noticeable increase in *E. coli* numbers from the Mid Mainstem group to the Lower Mainstem group is also apparent.

Figure 5-16: *E. coli* Results by Channel Segment, McKenzie Watershed (2000-2016)

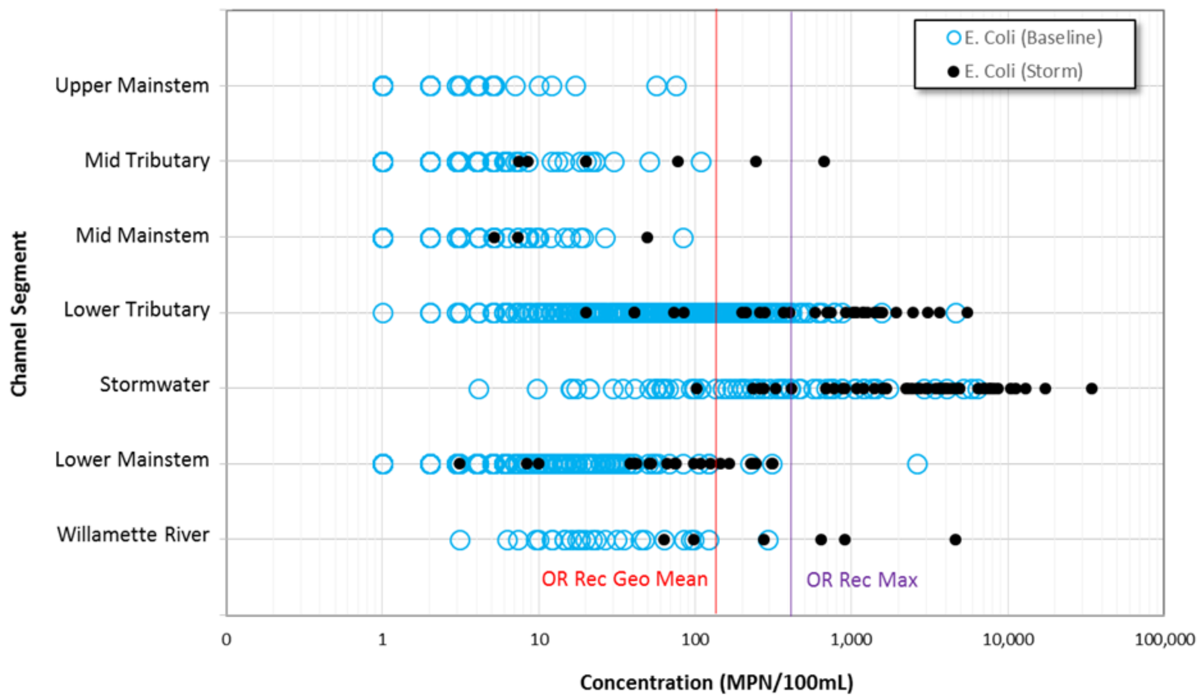
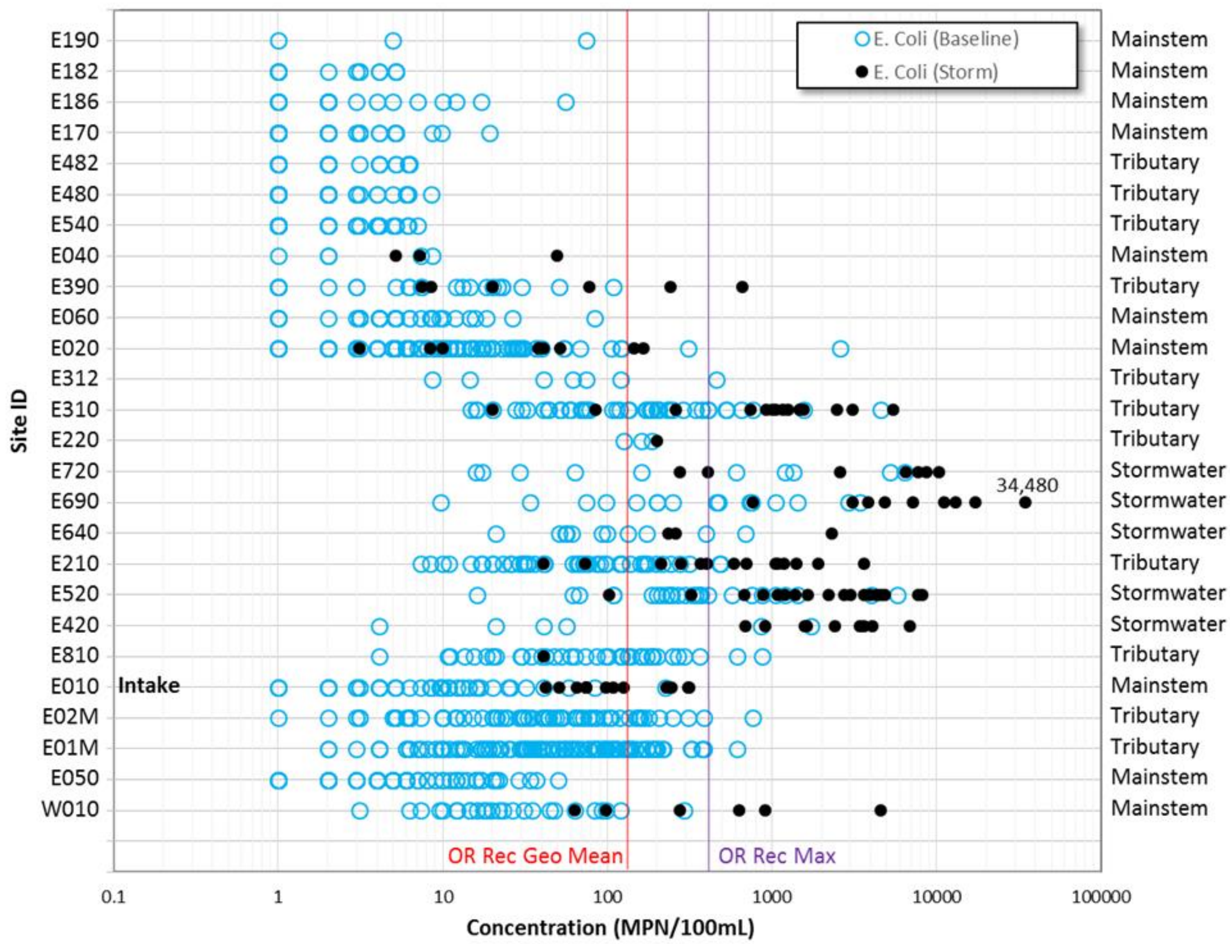


Figure 5-17 highlights specific monitoring sites with elevated *E. coli* levels within the Lower Tributary and Stormwater groups. Stormwater sites originating from eastern Springfield clearly account for the highest *E. coli* values observed across all monitoring sites. In fact, the highest stormwater storm concentrations are 4 orders of magnitude higher than most upriver concentrations until Mid Tributary sites, such as Gate Creek (E390), are reached. The 69th stormwater channel has produced 4 of the highest bacteria values ever recorded by source protection staff. The 72nd, 69th, 52nd and 42nd stormwater channels, along with Camp Creek, routinely exceed the OR Rec Max during baseline monitoring, and almost always exceed the benchmark during storm events. Although EWEB's drinking water plant is quite effective at treating bacteria, understanding the prevalence and magnitude of fecal-based bacteria sources in upstream waterways is a key component to understanding overall water quality conditions throughout the watershed. Bacteria can often be used as a surrogate or proxy for other water quality concerns, such as nutrients, PPCPs and heavy metals.

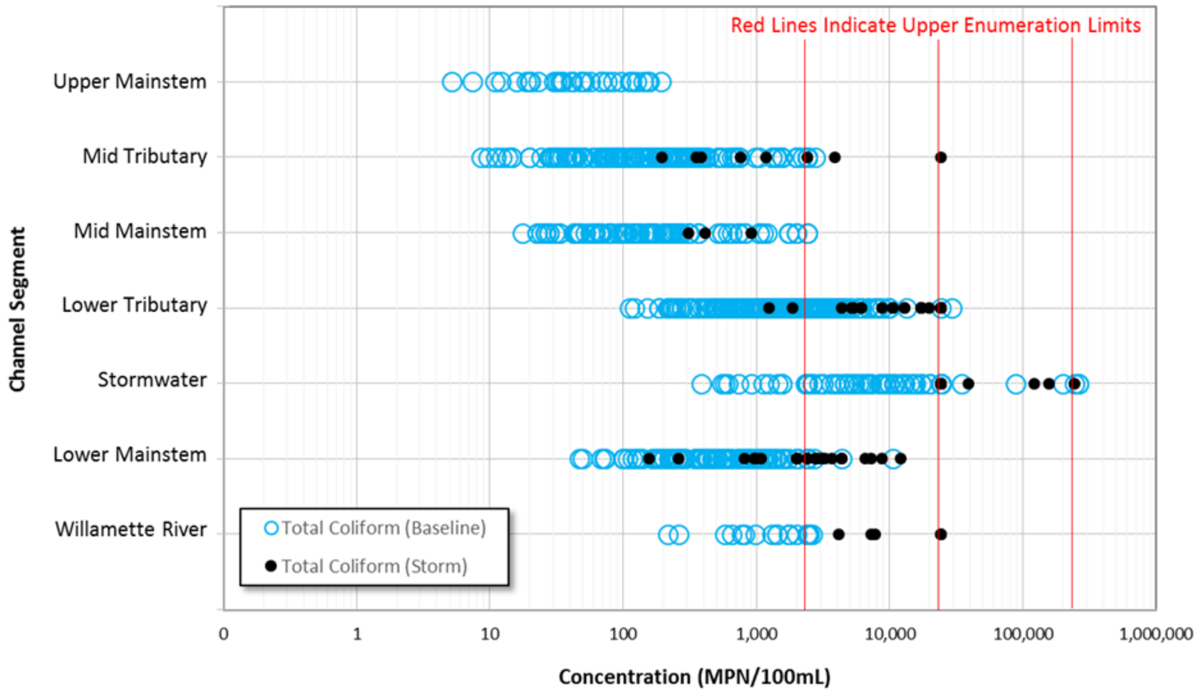
Figure 5-17: *E. coli* Results by site, McKenzie Watershed (2000-2016)



As previously stated above, Total Coliform values don't necessarily indicate unhealthy water conditions. Total Coliform results are plotted in Figure 5-18 and generally fall in line with *E. coli* results. Stormwater and Lower Tributary sites experience the highest Total Coliform levels, while mainstem sites see increasing concentrations moving downstream.

Please note the red upper enumeration lines on the figure below. The method used to quantify *E. coli* and Total Coliform is statistically-based and has an upper enumeration limit. Unless a dilution is performed, results often get truncated at the upper end if bacteria counts are higher than expected.

Figure 5-18: Total Coliform Results by Channel Segment, McKenzie Watershed (2000-2016)



5.1.5 Current and Potential Partners

- McKenzie Watershed Council
- Springfield Utility Board
- U.S. Army Corps of Engineers
- U.S. Forest Service
- U.S. Geological Survey
- U.S. Bureau of Land Management
- Oregon Department of Environmental Quality
- Coast Fork Willamette Watershed Council
- Middle Fork Willamette Watershed Council
- Lane Community College

5.1.6 Funding Sources

EWEB continues to fund most of the baseline monitoring program. MWC does provide limited funding to cover baseline costs for Mohawk River sites. SUB provides $2,000 per year toward analytical costs and funds the Cedar Creek USGS gaging station. Other organizations have provided staff support, access, expertise and additional water quality data. EWEB staff routinely accommodate both paid and unpaid interns to assist with monitoring

5.1.7 Legislative/Regulatory Outlook

On December 22, 2016, the Environmental Protection Agency (EPA) issued the "Partial Approval/Partial Disapproval of Oregon 2012 303d List". The EPA's 303(d) list is a list of impaired or threatened waters that each state has identified and submitted to the EPA. Once listed, the State must identify the pollutant causing the impairment and move to prioritize the development of a Total Maximum Daily Load (TMDL), which is based on several factors (40 C.F.R. §130.7(b)(4)). After the TMDL is approved, the impaired water body is removed from the 303(d) list, but tracked until fully restored.

The McKenzie Watershed has tributaries with segments either listed on the 303(d) list, proposed to be listed on the 303(d) list, or have approved TMDLs. The bulk of those listings are primarily related to spawning and non-spawning fish concerns. However, a number of current and proposed 303(d) listings have also been identified along main stem segments. Table 5-2 lists impaired segments for each main stem water body by parameter along with current status (LASAR, ODEQ). Again, many of the listings are related specifically to fish mortality (i.e. Dissolved Oxygen and Temperature). However, several of the 303(d) listing are based on heavy metal concentrations detected in either surface water or fish tissue. This is a potential concern for downstream drinking water providers as well as individuals consuming fish.

Table 5-2: Main stem segments either on the 303(d) list or with an approved TMDL

Water Body	River Miles	Parameter	Season	Status
McKenzie R.	0 to 7.5	Dissolved Oxygen	9/1-6/15	303(d) list, TMDL needed
McKenzie R.	7.5 to 34.1	Dissolved Oxygen*	9/1-6/15	303(d) list, TMDL needed
McKenzie R.	0 to 84.5	Lead*	Year Round	303(d) list, TMDL needed
McKenzie R.	0 to 84.8	Mercury*	Year Round	303(d) list, TMDL needed
McKenzie R.	0 to 54.6	Temperature	Year Round	TMDL approved
McKenzie R.	36 to 54.6	Temperature	9/1-6/15	TMDL approved
McKenzie R.	7.5 to 34.1	Temperature	9/1-6/15	TMDL approved

*Impaired water body for specified parameter recently added, or proposed to be added, to the 303(d) list

5.1.8 Outreach

Baseline monitoring data is publically available through EWEB's external water quality data website (http://reach.northjacksonco.com/EWEB/). In addition, baseline data is periodically analyzed and condensed into a comprehensive baseline monitoring report (EWEB, 2011). The next baseline report will be available in 2017.

5.1.9 Future Projects in the McKenzie Watershed

At this time, the only significant change to the current baseline program is to reduce the number of monitoring station from 16 to 14 (eliminating the two Mohawk River sites). The 16 sites currently monitored throughout the watershed represent the maximum number of sites that can be reasonably sampled in a single day. Although a few sites have been added to the baseline list recently, most sites have had at least 10 consecutive years of data collection. Maintaining long term data sets at each site ensures enough data is collected to adequately evaluate trends over the long term. Trend analysis can help determine changes in watershed health and the effectiveness of ongoing source protection programs. We will continue to explore opportunities to adjust the parameter list, due to costs, lower detection limits or occurrence information.

5.1.10 Recommendations

Water quality conditions across multiple baseline parameters, such as metals, nutrients and bacteria, have experienced varying degrees of degradation in many Lower Tributary and Stormwater sites. *E. coli*, nitrate, and metals, such as aluminum, iron and lead, remain a concern in many of these areas, which also tend to have increased levels of development, agriculture, forestry and industry. In addition, elevated TOC/TSS levels in the Mid Tributary reach warrant continued monitoring, especially as they relate to dam operations and forestry practices. Staff recommend continued baseline monitoring to better understand long-term water quality threats and trends in upstream reaches, and how they affect EWEB's drinking water quality.

Staff recommend maintaining quarterly baseline monitoring at current levels over the next 10 years. This includes monitoring at 14 sites strategically located throughout the watershed. Water quality analysis will include the following parameter groups:

- Metals – all sites
- Nutrients (including TOC and TSS) – all sites
- Physical Parameters (i.e. temp, turbidity, hardness) – all sites
- SVOC/VOC Parameters – urban sites/intake only

Maintaining efficiencies and affordability are crucial components of the baseline monitoring program. In the past, efficiencies have been gained by the following actions:

- Removing analytes with low or no detection frequency. Analytes such as Bromide, Chlorophyll-a, and Pheophytin-a, were discontinued.
- Monitoring frequency was reduced from 6 events per year to 4.
- Bacteria analyses shifted from private lab to Hayden Bridge lab to cut costs.
- Use of interns to assist with monitoring events.

Staff will continue to evaluate additional efficiencies within the baseline monitoring program without compromising data quality, integrity or representativeness.

5.2 Organic Contaminant Monitoring (USGS)

5.2.1 Purpose

EWEB has implemented a long-term, multi-pronged approach to better understand the occurrence, distribution and origin of organic contaminants in source waters. For purposes of this report, "organic contaminant" refers to any carbon-based compound found in surface water. Examples include pesticides, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), pharmaceuticals and personal care products (PPCP). For a list of additional groups and potential sources, please see Table 5-3. Long-term exposure to elevated levels of organic contaminants in drinking water can result in a range of health effects. Although the bulk of EWEB's efforts to date have focused on anthropogenic, or man-made organic contaminants, naturally occurring organic compounds are frequently monitored and are also included in this section. The challenge many drinking water providers (and wastewater treatment operators) face, is the threat posed by the multitude of organic contaminants that were historically used, are currently in use, or are just entering local markets. Many of these compounds have relatively little long-term environmental health or human health information available, especially when it comes to safe exposure levels over extended periods in surface waters. The other challenge many water quality experts are facing involves the analytical resolution required to adequately assess new and emerging contaminants. Although laboratory and analytical methods are constantly improving, new compounds are constantly entering the market, and finding the right assortment of analytical methods with adequate resolution to assess those compounds at meaningful levels is a challenge. Furthermore, it often takes years of environmental data and significant cost to reliably understand the source, fate, unintended consequences and risks associated with each new compound that finds its way into surface waters.

Monitoring for organic contaminants can occur throughout the year and under a range of different conditions depending on the objectives and goals of a particular study or project. However, most monitoring typically occurs during large storm events, when contaminants are flushed through the system during peak flow conditions. During these flushing events, heavy or prolonged rainfall can mobilize contaminants from terrestrial, groundwater and surface water sources.

Table 5-3: Organic Contaminant Groups and Potential Sources

Contaminant Group	Abbreviation	Example(s)	Use(s) or Source(s)
Organic Carbon	OC	Dissolved Organic Carbon (DOC)	Natural and synthetic forms
Dioxins and furans		2,3,7,8-Tetrachlorodibenzo-p-dioxin	Waste or fuel incineration
Disinfection Byproducts	DBPs	Haloacetic Acids	Water treatment

Hormones and sterols		Coprostanol	Natural and synthetic forms
Pesticides		Atrazine	Forestry, Agriculture, Urban, Hwy
Petroleum Hydrocarbons		Diesel	Roads, Urban areas
Pharmaceuticals and Personal Care Products	PPCP	Diphenhydramine	Septic Systems, Waste Water Plants
Plasticizers		Phthalate Esters	Industry, Urban Areas
Polybrominated diphenyl ethers	PBDEs	Decabromodiphenyl ether	Flame retardant
Polychlorinated biphenyls	PCBs		Transformers, electrical equipment
Polycyclic aromatic hydrocarbons	PAHs	Anthracene	Combustion by-products
Semi-volatile organic compounds	SVOCs	Pentachlorophenol	Synthetic compounds predominantly from industrial sources.
Surfactants			
Volatile organic compounds	VOCs	Benzene	Various sources, although predominantly industrial

Monitoring studies routinely look to determine the relative contribution different land use types make to the total contaminant load at EWEB's drinking water intake. Often, many land use types occur within a smaller sub-watershed or catchment, making it challenging to conclusively determine contaminant sources. The primary land use types assessed for organic contaminants related to storm event runoff include the following:

- Urban Runoff - Numerous studies have demonstrated that 70-90% of annual contaminant loading to receiving streams from urban runoff occurs during the flushing action of major storm events following periods of dry weather. Typically, the longer the dry period between storm events, the larger the potential contaminant loading associated with that particular urban stormwater runoff event (Schueler and Holland, 2000; Ferguson, 1998; USGS, 2000a; Kerst, 1996).
- Forestry - EWEB used the notification forms that forest operations are required to submit to the Oregon Department of Forestry (ODF) to map areas where pesticide applications occurred using geographic information system (GIS) software. Monitoring locations were selected based on those creek basins that tended to receive higher amounts of chemical applications relative to other creek basins in the McKenzie watershed.
- Agriculture - EWEB focused on creeks/drainages in the large agricultural area around Walterville for storm event monitoring. Because these creeks were fairly flat, it became apparent that surface runoff from this area would be difficult to collect. EWEB focused on collecting grab samples from these streams during major rain events when shallow groundwater was clearly increasing the flow in these systems.

Organic carbon plays an important role in many biotic processes within local waterways. However, too much carbon can overburden systems and impact downstream drinking water quality. Organic carbon can react with disinfectants during the water treatment process to create disinfection byproducts (DBPs), a regulated group of compounds in drinking water. Organic carbon can also contribute to taste and odor issues in drinking water. Sources of organic carbon in the local subbasins can range from natural process, such as leaf fall and primary phytoplankton production, to anthropogenic inputs, namely wastewater discharges and urban landscapes.

Organic carbon sources in the McKenzie subbasin have been assessed on numerous occasions over the past 15 years to compare how different sources vary both spatially and temporally, and in terms of relative contribution to the overall system. Analysis of both total and dissolved organic carbon, TOC and DOC respectively, provides valuable information to facilitate this comparison.

5.2.2 Background

In 2002, EWEB began working with the U.S. Geological Survey (USGS) to design and implement a storm event monitoring program that focuses on pesticides and other dissolved organic compounds that are flushed off the land surface during storms events. EWEB used the USGS laboratory in Denver, Colorado to analyze for nearly 180 different pesticides, pesticide degradation products and other organic compounds. Pesticides were the primary focus of these monitoring efforts since pesticide compounds and their degradation products are known to have adverse effects on human health and aquatic life. These effects are of particular concern for downstream drinking water providers, particularly because many organic compounds are unaffected by conventional drinking-water treatment (Coupe and Blomquist, 2004; Stackelberg et al., 2004).

Since that time, a number of subsequent collaborative studies with the USGS assessing organic contaminants in the McKenzie subbasin have been completed, or are currently in progress. In addition, a number of independent efforts focusing on organic contaminants have been undertaken by EWEB staff.

A chronological summary of organic contaminant monitoring efforts is listed below:

- **2002-2005** – USACE modified the Cougar Dam intake tower to allow selective withdrawal capabilities to mitigate downstream temperature impacts on spring Chinook salmon and bull trout. The construction resulted in prolonged sediment releases during the dewatering phase. Approximately 17,000 tons of suspended sediment was released to the South Fork McKenzie River in 2002 alone (Anderson, 2007). Although the primary scope of the joint USACE-USGS study was to evaluate suspended sediment loads resulting from construction activities, DDT and associated metabolites were also assessed. EWEB staff participated in multiple sampling efforts throughout the study.

- **2007** – EWEB and USGS initiated a cooperative study to assess multiple sites for the presence of low-level anthropogenic organic compounds using passive samplers. Both polar organic chemical integrative samplers (POCIS) and semipermeable membrane devices (SPMDs) were used to detect compounds at concentrations well below detection limits associated with conventional techniques (McCarthy et al., 2009).

- **2007-2008** – Beginning in 2007 and extending into 2008, EWEB and the USGS conducted a joint study to determine sources of dissolved organic carbon (DOC) and DBP precursors to the McKenzie River. In addition, dissolved organic matter (DOM) optical properties were measured to evaluate whether DOM could be used as a proxy for DOC and DBP precursors (Kraus et al., 2010).

- **2010-2011,** – EWEB and USGS begin a second passive study to continue low-level organic contaminant assessment at multiple sites. However, this round also sought to compare results between time-integrated (passive) and point-in-time (conventional) monitoring techniques, as well as between raw and finished water samples. A total of 5 deployments, at 6 different sites over various hydrological regimes, were completed during the study. According to authors of the study (McCarthy, K.A., Alvarez, D.A., 2013), this is the first known use of passive samplers to compare raw water to finished water at a municipal drinking water treatment plant.

- **2002-2010** – Spanning almost 10 years, EWEB and USGS staff conducted a pesticide monitoring program in the McKenzie Subbasin to both identify and characterize pesticide inputs from various land use types. Monitoring generally targeted two large storm events per year, in the spring and fall. Samples were analyzed by the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado.

- **2012-2014** – In 2012, a second carbon study was initiated in collaboration with the USGS to build upon knowledge gained from the 2007-2008 study. The second study included multiple objectives. First, it used high resolution absorbance and fluorescence spectroscopy, in conjunction with DOC concentrations, to identify sources of DOM in the McKenzie subbasin by land use type and relative contribution. Second, it evaluated how DOM sources vary across different hydrological events and how these variations effect DOM reactivity with disinfectants, potentially leading to the formation of DBPs during treatment processes. Lastly, how do upstream changes, such as reservoir operations, impact DOM loading and drinking water quality. To effectively evaluate these objectives, USGS staff analyzed DOM samples using 3-dimensional excitation-emission matrix (EEMs) methods, as well as constructed a parallel factor analysis (PARAFAC) model to interpret optical data and characterize DOM sources. Additional details and explanations for the study can be found in the 2012 monitoring proposal prepared by the USGS (Goldman, 2012). As of 2016, a final report detailing results and conclusions from the study was under review by USGS staff. EWEB expects the final report to be released in 2017.

5.2.3 Current Status

Over the last several years, EWEB has continued to build upon organic contaminant monitoring efforts conducted between 2002 and 2010 with the USGS. Although monitoring objectives have been narrowed over the last several years to focus primarily on lower watershed sites, new analytical tools are being used to assess a wider array of organic contaminants. Stormwater sites, along with intake locations (current and proposed) have been assessed for a wide range of pesticides, SVOCs, PPCPS and other wastewater indicators. Sampling efforts generally target the first significant fall storm event and a mid-to-late spring storm event after pesticides have been applied. Results from each of these contaminant groups are presented below.

5.2.4 Monitoring Results

Pesticides

Source protection monitoring efforts have targeted hundreds of pesticide compounds and related degradates over the past 16 years, including herbicides, insecticides, bactericides and fungicides. Pesticide detections listed in Table 5-4 represent compounds detected at primary monitoring locations. These locations include the baseline monitoring group, forestry sites, agriculture sites and urban stormwater sites. Please note that results listed below do not include all monitoring locations in the McKenzie watershed over this time period. A full organic contaminant analysis is due later this year and will be included in the Baseline Monitoring Report. Also worth noting is that the detectable values include estimated values, which are values below the reporting limit, but above the detection limit. With estimated values, there is a high degree of confidence the compound is present, but less certainty on the actual value.

Table 5-4 lists the 20 most frequently detected pesticides and pesticide degradates in the McKenzie watershed. Three of the top five compounds are pesticides (2,4-D, Diuron and Hexazinone), one is a pesticide degradate of glyphosate (Aminomethylphosphonic acid) and one is an insecticide (Carbaryl). Generally speaking, most of the values are fairly low and below any applicable MCL, although very few applicable MCLs have been established at this time. Pesticides such as 2,4-D, Atrazine and Carbaryl are detected frequently throughout the mid and lower portions of the watershed.

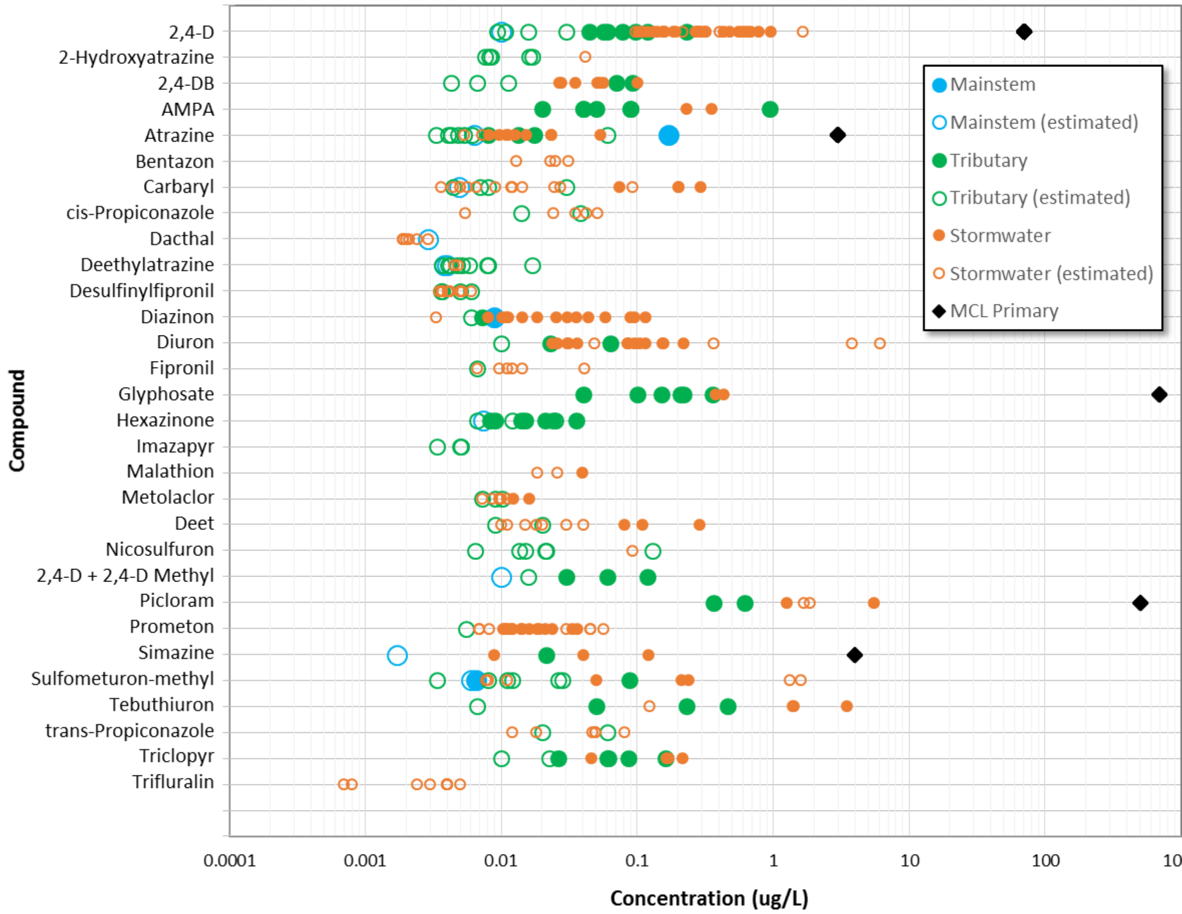
As clearly indicated in Figure 5-19, the highest concentrations for most pesticides typically occur in stormwater systems, followed closely by tributary sites. Although mainstem concentrations of certain pesticides have been documented, generally these concentrations are on the low end. One exception is the Atrazine hit, although this value is still an order of magnitude below the MCL. One interesting note is the distribution of certain pesticides. Hexazinone is almost exclusively detected in tributaries, where it is used largely in forestry applications. Other pesticides, such as Prometon, Diazinon and Diuron, are more frequently detected in stormwater channels.

Table 5-4: Pesticides Detected in the McKenzie Watershed, 2000-2016

Analyte	Total Analyses	Total Detects	Max Value (ug/L)	Detection Frequency	EPA MCL (ug/L)
2,4-D	199	51	1.6489	26%	70
Aminomethylphosphonic acid	44	11	0.95	25%	
Carbaryl	186	45	1.3	24%	
Diuron	119	28	12.18	24%	
Hexazinone	87	18	0.0969	21%	
Prometon	145	27	0.0568	19%	
Sulfometuron-methyl	122	22	2.2249	18%	
Atrazine	252	37	0.171	15%	3
Diazinon	160	23	0.115	14%	
Pentachlorophenol	178	24	0.8	13%	1
Desulfinylfipronil	127	17	0.006	13%	
Triclopyr	115	15	3.1017	13%	
Deethylatrazine	159	20	0.017	13%	
Glyphosate	83	9	0.43	11%	700
2,4-DB	154	15	0.0998	10%	
2-Hydroxyatrazine	121	10	0.0419	8%	
Tebuthiuron	143	10	3.47	7%	
Fipronil	130	9	0.0411	7%	
Metolachlor	236	14	0.016	6%	
Dacthal	187	10	0.0029	5%	
Simazine	240	10	0.228	4%	4

Note: See Appendix A for more details on the pesticides listed, including type, common uses, and human and aquatic health benchmarks.

Figure 5-19: Pesticide Detections in the McKenzie Watershed by Channel Type, 2000-2016



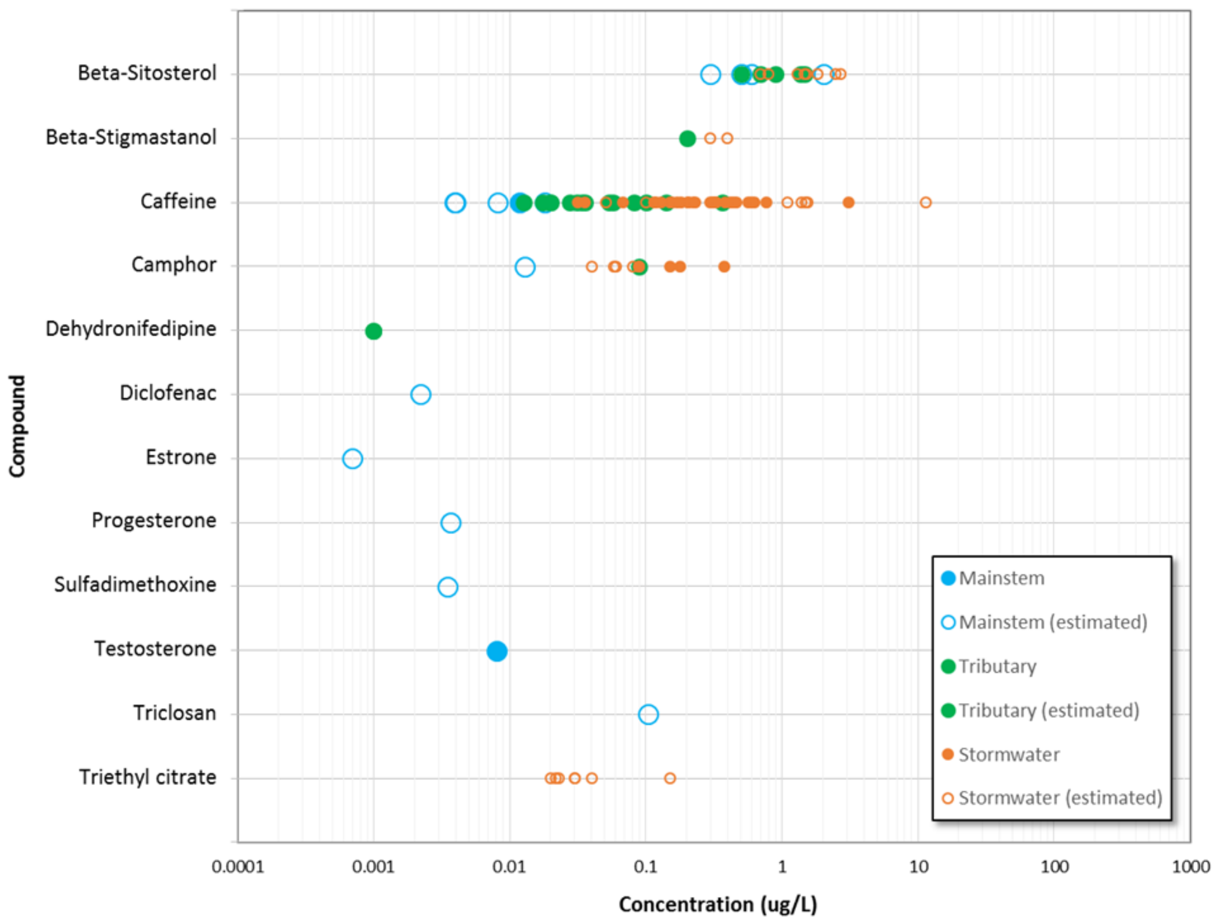
Pharmaceuticals and personal care products (PPCPs) have been gaining interest as emerging contaminants of concern. One reason is that many pharmaceuticals are designed to work at very low doses, and another is because analytical methods are emerging to detect concentrations in environmental samples at very low concentrations. Table 5-5 lists PPCPs detected at least twice in the McKenzie watershed. Some PPCPs, such as beta-Sitosterol, are naturally produced locally, but also used in PPCPs. Other compounds, such as caffeine, are naturally produced, but not locally. Caffeine detections can be used to trace septic or wastewater sources, but it should be noted that many people often use coffee grounds in their gardens or compost piles. Many PPCPs are compounds created synthetically, such as the drug Nifedipine. Dehydronifedipine is a metabolite of Nifedipine.

Table 5-5: PPCPs Detected in the McKenzie Watershed, 2000-2016 (minimum two occurrences)

Analyte	Total Analyses	Total Detects	Total Estimated	Max Value (ug/L)	EPA MCL (ug/L)	Detection Frequency
beta-Sitosterol	24	17	17	2.7		71%
beta-Stigmastanol	24	3	3	0.4		13%
Caffeine	120	54	18	11.3757		45%
Camphor	24	11	6	0.38		46%
Dehydronifedipine	10	2	2	0.001		20%
Triethyl citrate (ethyl citrate)	24	7	7	0.15		29%

Figure 5-20 depicts PPCP concentrations across multiple channel types. Caffeine occurrences have been documented throughout the lower watershed. The highest concentrations typically occur in stormwater channels.

Figure 5-20: PPCP Detections in the McKenzie Watershed by Channel Type, 2000-2016



Volatile and Semi-Volatile Organic Compounds

EWEB has conducted a significant amount of VOC and SVOC monitoring in urban runoff from east Springfield, which enters the McKenzie River immediately above EWEB's drinking water intake. This area has a combination of residential, commercial, light industrial and heavy industrial activities. As indicated in Table 5-6, a number of VOCs and SVOCs have been detected in the McKenzie watershed. Pentachlorophenol (PCP) and Bis(2-ethylhexyl) phthalate (DEHP) are the two most detected compounds. PCP is a wood treatment/pesticide compound. A PCP plume exists on the north end of the IP/Weyerhauser property adjacent to the McKenzie River. EWEB staff have provided several Board correspondences on threats associated with the plume. The plume has been well documented and is currently being monitored by IP with DEQ involvement. DEHP is a phthalate, which is commonly used as a plasticizer. A number of detections for this compound in the lower watershed surface water samples have exceeded the drinking water MCL.

Table 5-6: VOC and SVOCs Detected in the McKenzie Watershed, 2000-2016 (3+ occurrences)

Analyte	Total Analyses	Total Detects	Total Estimated	Max Value (ug/L)	EPA MCL (ug/L)	Detection Frequency
Pentachlorophenol	289	24	21	0.8	1	8%
DEHP	294	19	17	22.8	6	6%
p-Cresol	24	16	10	0.91		67%
Chloroform	154	15	1	8.8		10%
Phenol	90	12	4	47		13%
Pyrene	147	12	6	0.92		8%
Isophorone	103	11	10	0.066		11%
Benzyl alcohol	66	10	11	0.8		15%
Bromodichloromethane	155	9		2.1		6%
Fluoranthene	147	8	5	0.12		5%
Benzoic acid	66	6	6	2.2		9%
Phenanthrene	147	6	4	1.3		4%
Dibromochloromethane	156	5	1	0.9		3%
2-Methylnaphthalene	91	4	3	14		4%
9,10-Anthraquinone	14	4	4	0.08		29%
Toluene	157	4	3	1.2	1000	3%
3 & 4 Methylphenol	15	3	3	0.17		20%

VOCs have been detected almost exclusively in stormwater outfalls and lower tributary sites, the former largely being from Keizer Slough (Figure 5-21). Bromodichloromethane and Chloroform are the two most frequently detected compounds.

Figure 5-21: VOC Detections in the McKenzie Watershed by Channel Type, 2000-2016

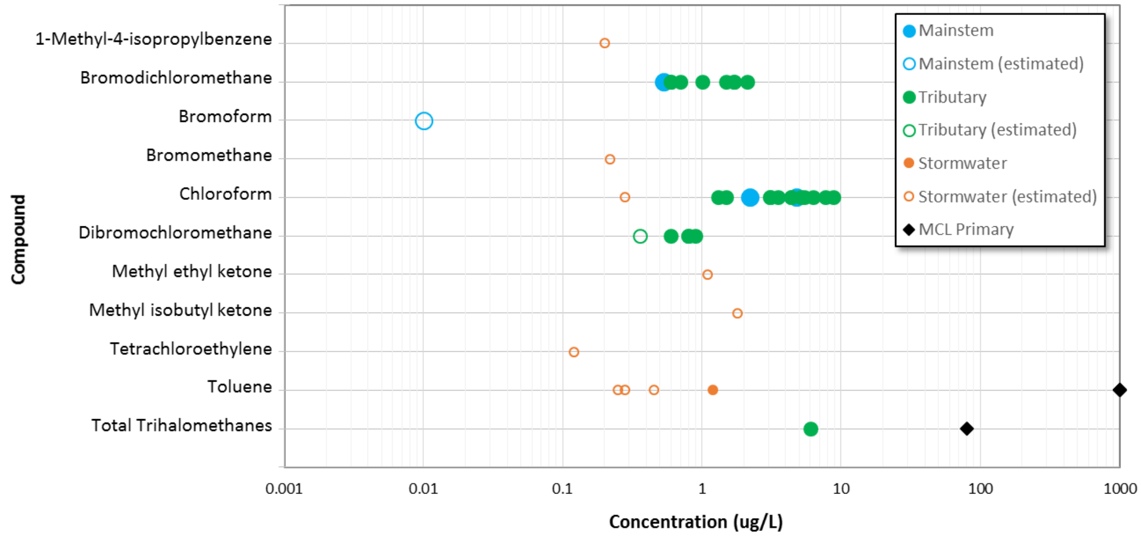
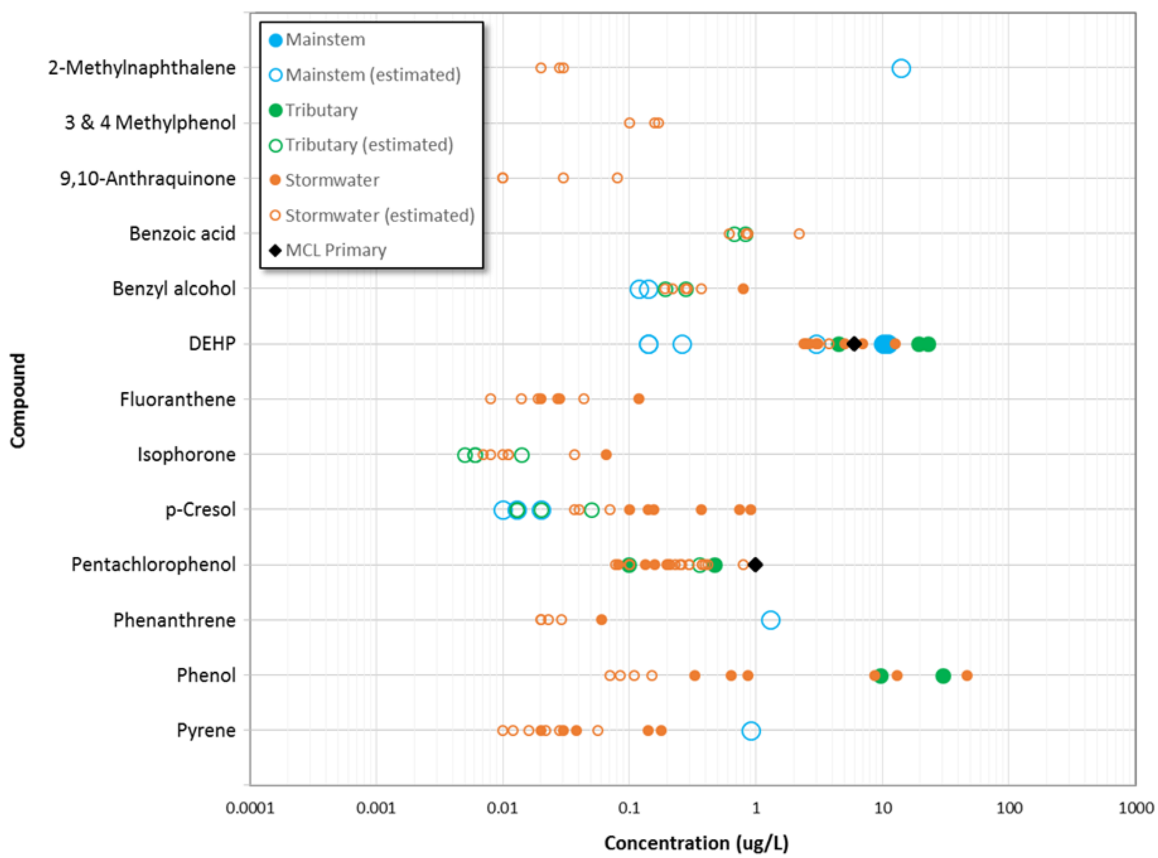


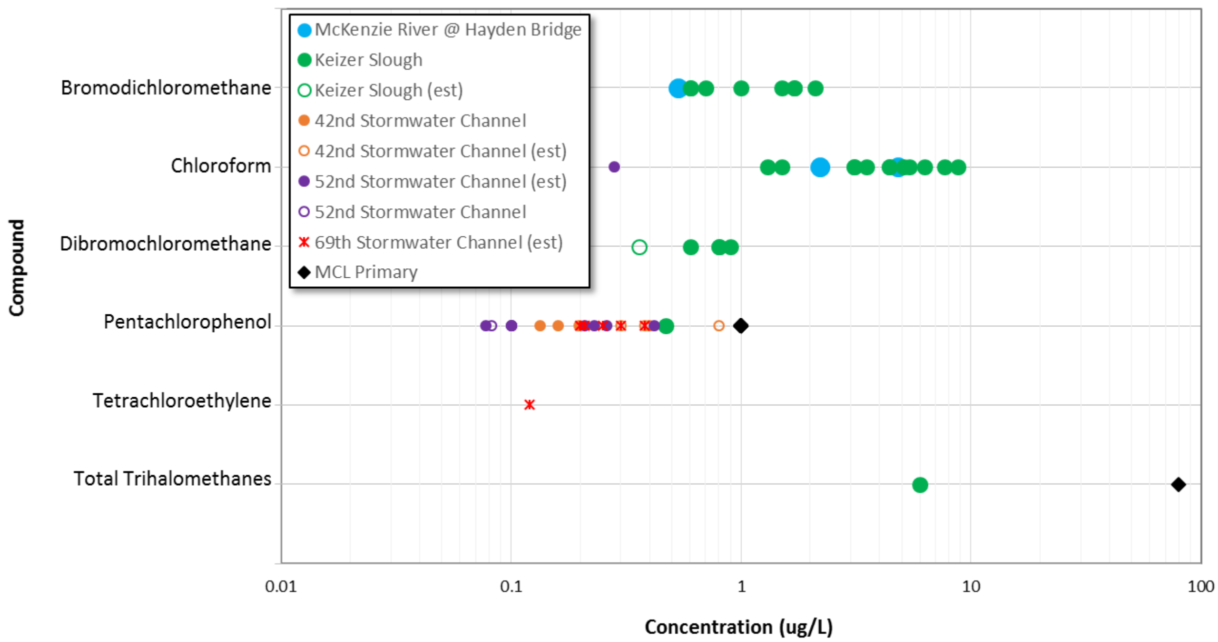
Figure 5-22: SVOC Detections in the McKenzie Watershed by Channel Type, 2000-2016



SVOC detections, as highlighted in Figure 5-22, are largely confined to stormwater and lower tributary sites, although several detections have been recorded in the mainstem McKenzie, but generally at very low concentrations. DEHP MCL exceedances have been recorded in all three channel type categories.

A closer look a chlorinated compounds detected in the McKenzie watershed reveals PCP hits in multiple stormwater channels, as well as Keizer Slough (Figure 5-23). All detections have been below the primary MCL, although not by much. Keizer Slough receives the most detections of Bromodichloromethane and Chloroform. Both of these compounds are likely related to the PCP plume, although other industrial sources should not be ruled out.

Figure 5-23: Chlorinated Compounds Detected in the McKenzie Watershed by Site, 2000-2016



Other Organic Compounds

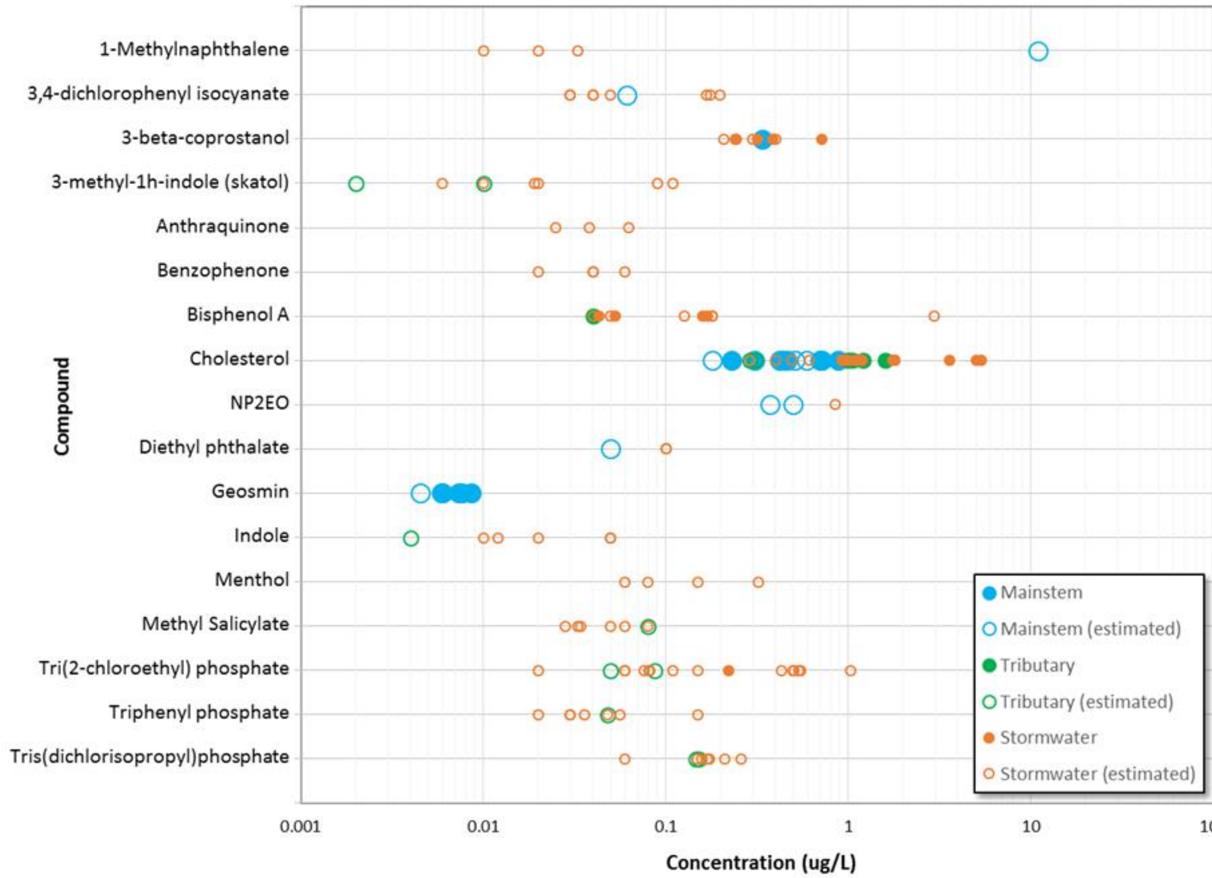
Table 5-7 and Figure 5-24 present a number of other organic compounds detected in the McKenzie watershed. These compounds don't necessarily fall into the groups presented above.

Table 5-7: Organic Compounds Detected in the McKenzie Watershed, 2000-2016 (min 2 occurrences)

Analyte	Total Analyses	Total Detects	Total Estimated	Max Value (ug/L)	EPA MCL (ug/L)	Detection Frequency
1-Methylnaphthalene	40	4	3	11		10%
3,4-dichlorophenyl isocyanate	24	9	9	0.198		38%
3-beta-coprostanol	49	9	4	0.712		18%
3-methyl-1h-indole (skatol)	24	8	8	0.11		33%
5-methyl-1h-benzotriazole	24	2	2	1.18		8%
Anthraquinone	10	3	3	0.063		30%
Benzophenone	24	4	4	0.06		17%
Bisphenol a	49	11	6	2.97		22%
Butyl benzyl phthalate	122	2	2	0.42		2%
Cholesterol	51	35	11	5.36		69%
Coprostanol	2	2		0.015		100%
Diethoxynonylphenols- total	10	3	3	0.85		30%
Diethyl phthalate	146	3	3	0.1		2%
Geosmin	18	7	1	0.0086		39%
HHCB	24	2	2	0.01		8%
Indole	24	6	6	0.05		25%
Menthol	24	4	4	0.32		17%
Methyl Salicylate	24	7	7	0.08		29%
Tri(2-butoxyethyl) phosphate	24	8	8	1.03		33%
Tri(2-chloroethyl) phosphate	24	9	8	0.22		38%
Tributyl phosphate	24	1	1	0.09		4%
Triphenyl phosphate	24	8	8	0.15		33%
Tris(dichlorisopropyl)phosphate	25	9	9	0.26		36%

Most detections in this group of “Other” organic compounds occur in stormwater channels. This group will likely expand in scope as more information becomes available as to the fate and transport of many new and emerging organic compounds, especially those classified as potential endocrine disruptors. Tris(dichlorisopropyl)phosphate, or TCEP, is one such compound that has been detected in the McKenzie watershed. TCEP, is used as a flame retardant and plasticizer.

Figure 5-24: Organic Compound Detections in the McKenzie Watershed by Channel Type, 2000-2016



Passive Data Analysis

In 2007, a cooperative USGS-EWEB passive study looked to assess anthropogenic compounds in surface waters at concentrations far below what conventional water sampling techniques offered. Passive, or time-integrated, sampling devices are deployed in the water column over extended periods to collect contaminants over a range of hydrologic conditions. SPMDs contain a lipid membrane that attracts dissolved hydrophobic compounds in the water. A POCIS device contains a sorbent material which also acts to sample dissolved organic compounds. Three sites were sampled in the McKenzie subbasin, which included the McKenzie River at Hayden Bridge, Camp Creek and Cedar Creek. Both POCIS and SPMD samplers were deployed in triplicate at each site. All samplers were deployed for 35 days during the fall season, which coincided with at least one significant storm event.

Results from the POCIS data indicate very low levels of diethyl phthalate were likely present in the McKenzie River during the deployment (McCarthy et al., 2009). The SPMD results yielded a variety of compounds across all sites, although most were at or near the method quantification limit (MQL). The MQL is the limit at which an analytical method can quantify the amount of a compound present with confidence, below the MQL compounds can be detected but are estimated. Only pentachloroanisole, a potential degradate of pentachlorophenol, was detected consistently above the MQL at all sites, including the duplicates (see Table 5-8). The study concluded that passive sampling techniques were well suited for organic compound monitoring in the McKenzie subbasin.

Table 5-8: Concentration of Select Compounds from POCIS and SPMD Deployments

Monitoring Site:				Camp Creek		Cedar Creek		McKenzie River	
Organic Compound	**Units**	**MDL**	**MQL**	**Repl. 1**	**Repl. 2**	**Repl. 1**	**Repl. 2**	**Repl. 1**	**Repl. 2**
Diethyl phthalate	ng/POCIS	20	100	ND	ND	670	ND	1800	550
Pentachloroanisole	ng/SPMD	.9	2.2	21	18	20	18	5.9	7.3

A second cooperative passive study was conducted in the McKenzie subbasin during 2010 and 2011 to expand upon work initiated in 2007. The number of sampling locations increased to 6, while the number of sampling events increased to 5. Unlike the 2007 study, this round included both raw and finished water, as well as overlapping time-integrated and point-in-time sampling techniques at several sites.

In general, detected compound concentrations were extremely low, typically in the picogram per liter range (McCarthy et al., 2013). However, the total number of compounds observed remained high (Table 5-9). The McKenzie River at Hayden Bridge (E010) yielded the highest number of different organohalogen compounds (OHCs) detected during a single deployment at 31 compounds. Camp Creek (E310) was close at 26 different OHCs. The Lower (E271) and Upper (273) Haagen Creek sites yielded the highest number of PAHs, at 18 apiece. Interestingly, at least one PAH and OHC were detected at every site during each sampling event. Both E010 (raw water) and EWEB's finished water (E011) had 7 unique anthropogenic indicator compounds detected during a single event. E310 also had 18 agricultural-related compounds detected during a single event, the highest number observed across all sites. Cedar Creek (E210) only had one agricultural-related compound detected during any one single event.

Table 5-9: Highest Number of Unique Compounds Detected During a Single Deployment

Organic Compound	Method	E010	E011	E210	E310	E271	E273
Anthropogenic Indicators	POCIS	7	7	2	0	2	3
Polycyclic Aromatic Hydrocarbons	SPMD	9	14	11	16	18	18
Organohalogen Compounds	SPMD	31	15	15	26	25	19
Agricultural Compounds	POCIS	5	1	1	18	-	-
Dioxins/Furans	SPMD	1	1	-	-	-	-
Hormones	POCIS	1	1	-	-	-	-
Pharmaceuticals	POCIS	2	1	-	-	-	-

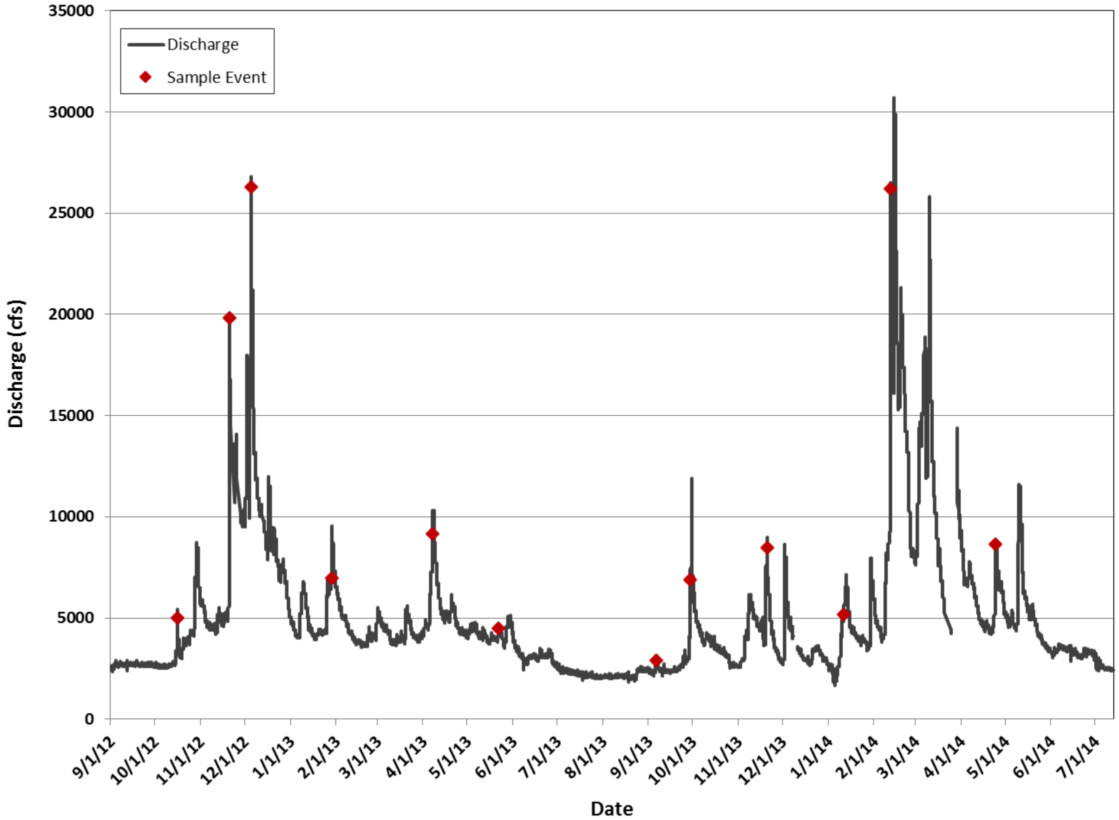
Overlapping time-integrated (passive) and point-in-time (conventional) sampling methods yielded a number of interesting results. Over the two-year study period, four different combinations of passive and conventional results were observed within a single deployment at a particular site. Specifically, organic compounds were either detected in both methods, in one method but not the other, or in neither method. This observation highlights the complexity of accurately detecting organic contaminants is surface waters at very low concentrations, especially with regard to the potential variability individual concentrations may exhibit throughout various hydrologic regimes.

Total and Dissolved Organic Carbon

Results from a joint USGS-EWEB study in 2007 and 2008 revealed that dissolved organic matter (DOM) inputs to the McKenzie River were predominantly from terrestrial sources (Kraus et al., 2010). These inputs largely occurred during winter rain events, when soils were saturated and surface runoff rates increased. DOC concentrations dropped when groundwater discharges were the highest, typically during the drier summer months. Although inputs from downstream tributaries contained high DOC concentrations, collectively, they represented only a small fraction of total flow in the mainstem. The study also found that optical measurements, such as in-situ optical sensors, can provide continuous assessment of DOM concentrations. This is important because DOM reacts with disinfectants, such as chlorine, to form DBPs, a regulated class of halogenated compounds. If operators know when DOM concentrations are dramatically increasing, they can increase chlorine contact time (using lower concentrations of chlorine) or reduce intake rates until the DOM peak passes.

During the second carbon study, which extended from 2012 to 2014, 16 different monitoring locations were sampled based on varying land use types. In an effort to better understand how these different land use types affect DOM quality and quantity seasonally, sampling events were conducted during a range of hydrologic conditions throughout the year. Figure 5-25 highlights the timing of sampling events at single site (McKenzie River at Hayden Bridge) during various flow regimes.

Figure 5-25: DOC and EEMs Sampling Events on the McKenzie River at Hayden Bridge.



DOC concentrations ranged from non-detect (<.16 mg/L) at the uppermost mainstem site on the McKenzie River and in finished (treated) water, to a maximum value of 16 mg/L at the 52nd stormwater channel (Table 5-10). Generally, the highest DOC concentrations across most sites occurred during large fall storm events, likely in response to terrestrial organic material, such as leaves, being flushed into the system.

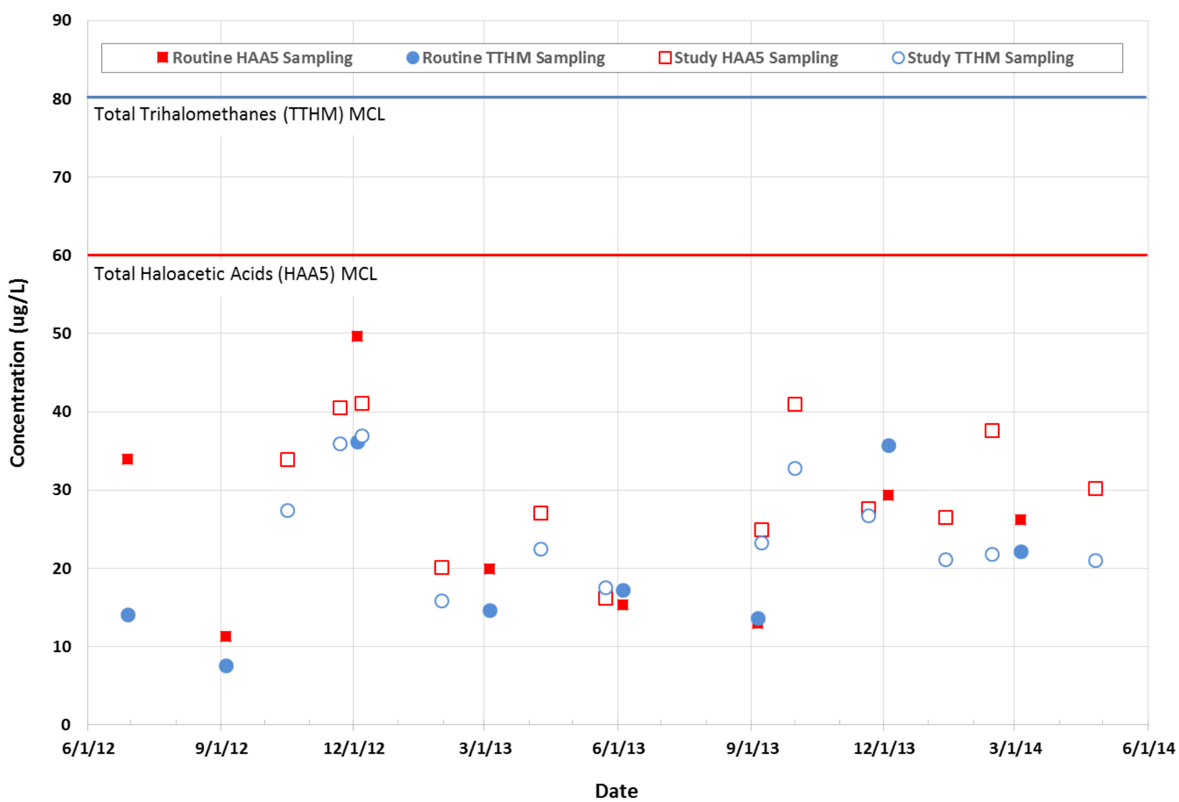
Table 5-10: DOC Concentrations in mg/L from 2012 to 2014

Site ID	10/15/12	11/19/12	12/04/12	01/28/13	04/07/13	05/21/13	09/05/13	09/29/13	11/19/13	01/11/14	02/12/14	04/24/14
E182 - McKenzie @ Frissell	1	1.4	1	0.38	0.5	-	-	1.2	1.1	ND	1	1.0
E485 - SF Above Cougar	3.4	3.2	2.1	0.67	1.1	-	-	2.3	2.6	1.3	2.1	1.3
E486 - SF Below Cougar	0.82	1.4	1.3	0.78	0.65	-	-	1	1.3	1	1.3	1.3
E540 - Blue River	1.5	2	1.4	0.82	0.71	-	1.2	1.2	2.3	1.8	1.7	1.6
E470 - Quartz Creek	4.4	4.2	2.7	1.7	2.1	-	3.5	3.9	3.7	2.1	2.4	3.1
E040 - McKenzie @ Vida	2.2	2.7	1.8	0.78	0.98	0.64	1.2	2.1	2.2	1.3	2.4	1.5
E393 - Gate Creek	6.1	3	1.9	0.91	1.5	1.4	3.6	3.2	2.4	1.6	1.9	2.3
E270 - Haagen @ Bridge	7.7	5.3	2.5	1.3	1.4	2.3	4.7	4.3	3.4	2.5	2.1	3.3

E272 - Haagen @ Cnfl.	3.7	5.3	2.2	1.3	1.4	2.1	3.1	4.1	3.6	2.3	2.2	3.3
E020 - McKenzie @ Hendricks	1.9	3	1.8	0.81	1	0.81	1.5	2.5	2.1	1.4	2	1.3
E210 - Cedar Creek	3	5.5	2.2	1.9	1.3	1.6	1.9	3.1	2.7	2.1	2.6	1.5
E334 - Ag Tributary	5.5	4.2	2.1	1.4	1.3	1.5	3	3.1	3	2.5	2	2.0
E310 - Camp Creek	6.4	4.8	2.5	1.9	2.3	2.8	5.9	5.1	4	2.3	2.9	2.6
E520 - 52nd Storm Chnl.	10	5.7	4.2	4	4.1	13	16	2.6	4.2	2.7	3.4	2.5
E010 - McKenzie @ Intake	1.7	3	1.9	0.89	0.97	0.78	1.2	2.8	2	1.5	2.1	1.3
E011 – Finished Water	0.89	1.1	ND	0.53	0.49	0.53	0.83	1.5	0.82	1.1	1.1	0.8

Increased organic material in upstream water sources, specifically DOM, can translate into higher rates of DBP production during the disinfection process. During the 2 year study period, neither Total Trihalomethanes (TTHM) nor Total Haloacetic Acids (HAA5) exceeded EPA's maximum contaminant level (MCL) for drinking water. However, as indicated in Figure 5-26, HAA5 levels approached the MCL on several occasions, particularly in response to the significant storm event that occurred in the early part of December, 2012. The highest HAA5 value recorded was actually collected by Hayden Bridge staff as part of their routine monitoring efforts, and not as part of this study, although the event did coincide with the early December storm event.

Figure 5-26: Finished Water DBP Concentrations at the Hayden Bridge Plant.



Additional optical data analysis due in the pending USGS report, including discussion of the EEMs data and the PARAFAC model, will ultimately give EWEB staff a better correlation between different types of DOM, their associated land use types, how they vary during different hydrological regimes, and their propensity to form DBPs.

5.2.5 Current and Potential Partners

- U.S. Geological Survey
- McKenzie Watershed Council
- Springfield Utility Board
- Oregon Department of Environmental Quality
- Coast Fork Willamette Watershed Council
- Middle Fork Willamette Watershed Council

5.2.6 Funding Sources

Most collaborative organic contaminant studies in the McKenzie subbasin between the USGS and EWEB were executed and completed through a joint funding agreement (JFA) between the two organizations. Generally, the funding split has been 65% EWEB and 35% USGS for most collaborative projects. Future contaminant studies, using both passive and conventional approaches, would likely continue to seek matching federal dollars, if available, as well as contributions from other potential stakeholders.

5.2.7 Legislative/Regulatory Outlook

Several pieces of pending legislation, along with upcoming regulatory obligations, could potentially influence or redirect future monitoring efforts for organic contaminants. A few examples of how State and Federal actions could influence the direction of source protection monitoring efforts are as follows:

- **UCMR 4** – The fourth Unregulated Contaminant Monitoring Rule (UCMR4) was published on December 20, 2016. Under the 1996 Safe Drinking Water Act amendments, every five years the EPA is to issue a list of unregulated contaminants that must be monitored by public water systems (EPA, 2016). The UCMR4 contaminant list includes 8 pesticides, 1 pesticide manufacturing byproduct, 3 alcohols, 3 SVOCs and 1 indicator (total carbon) that are relevant to future organic contaminant monitoring efforts. EWEB will be required to monitor for these contaminants at the drinking water intake over the course of 4 months, likely in 2018. During this time source protection staff will evaluate any significant contaminant detections and look to identify potential sources in the subbasin.
- **Pesticide General Permit** – EPA's 2016 Pesticide General Permit (PGP) is effective from October 31, 2016 through midnight October 31, 2021. Certain pesticide applications will be required to obtain NPDES permits for point source discharges of pesticide residues. EWEB staff intend to evaluate NPDES permits for pesticide applications in all three subbasins to determine if additional, targeted pesticide

monitoring is warranted in downstream water corridors above EWEB's current or proposed drinking water intakes.

5.2.8 Outreach

Plenty of opportunities exist for providing the public with information about the types of organic contaminants found. Organic contaminant data is publically available through EWEB's external water quality data website (http://reach.northjacksonco.com/EWEB/). In addition, these data have been published in various USGS reports that are available via the watershed health dashboard (www.purewaterpartners.org).

Potential collaboration with drinking water providers, waste water facilities, watershed councils and others in the upper Willamette watersheds to review data collected to date and identify potential gaps in our understanding of contaminant sources and transport in these watersheds.

5.2.9 Future Projects in the McKenzie Watershed

- Assessing additional classes of pesticides.
- Renewed focus in urban storm water.
- 3rd passive study seeking comparison between McKenzie, Coast Fork and Middle Fork watersheds

5.2.10 Recommendations

Over the past 15 years, a wide variety of organic contaminants, such as pesticides, PPCPs and SVOCs have been detected in surface waters throughout the McKenzie watershed. Observed concentrations for most contaminants generally remain extremely low and well below any applicable health-based benchmarks. However, the highest concentrations are usually observed in stormwater sites or in lower tributary reaches not too far above EWEB's intake. Additional monitoring is recommended by staff to continue a long-term assessment of organic contaminant sources, occurrences and distribution in the watershed.

Staff recommend the following actions related to contaminant monitoring be taken over the next 10 years:

- Continue to conduct annual McKenzie mainstem monitoring at the Hayden Bridge intake for multiple classes of organic compounds.
- Comprehensive storm event contaminant monitoring in the McKenzie Watershed will be scaled back to be conducted as a thorough, multi-season assessment once every three years. A total of 3 storm events will be targeted to capture the first fall flush, a major winter storm and spring event after pesticides have been applied. A minimum number of sites will be selected to accurately assess contaminant inputs from dominant land-use types from the following categories in order of importance:
    - Urban Runoff

    - Rural Development
    - Agriculture/Livestock
    - Forestry
- Conduct focused monitoring annually in and around industrial waterways to determine the following:
    - Extent/risk of organic contaminants related to industrial contamination and runoff, such as chlorinated compounds in Keizer Slough.
    - Provide background data to assess feasibility of future wetland mitigation projects.
    - Assess effectiveness of current mitigation efforts.
    - Determine potential risks to drinking water sources from emerging contaminants, pesticides and other organic contaminants not previously assessed.
- Assess cost and benefits of conducting a third passive study to compare contaminant inputs from multiple land use types.
- USGS analytical methods will be assessed and compared to suitable private methods in terms of cost, scope, detection limits, turn-around times and other factors. Several USGS methods have already been replaced by enhanced USGS methods or by private lab options which provided better cost, turnaround time and/or analytical capabilities (compound ranges and analytical resolution).

5.3 Harmful Algal Blooms

5.3.1 Purpose

EWEB's HAB monitoring program is an ongoing effort to assess potential impacts to drinking water from algal activity in source waters. Although most algae are benign and form an integral part of the food web, certain species have the potential to produce toxins. Large blooms can also be a significant source of organic carbon in the system. Unfortunately, upstream water body managers generally lack the funding to monitor bloom activity in source waters, especially given that recreational monitoring guidelines are voluntary.

5.3.2 Background

Cyanobacteria, often referred to as blue-green algae, are a type of photosynthetic bacteria. This large and diverse group of microorganisms occurs naturally in marine, freshwater and terrestrial environments and can occur in both planktonic and benthic forms. Under favorable conditions, cyanobacteria can form large blooms, particularly in warmer, slower moving surface waters such as reservoirs, ponds and backwater sloughs. Certain cyanobacteria genera also have the potential to produce toxins that can be harmful to humans, pets and livestock. The three primary groups of toxins are hepatoxins, neurotoxins and dermatoxins. Collectively, they are referred to as cyanotoxins. Hepatoxins include microcystin and cylindrospermopsin. Common neurotoxins include anatoxin-a and saxitoxin. To complicate matters, a number of different cyanobacteria genera are capable of producing multiple types of toxins. For example, *Dolichospermum* (formerly known as *Anabaena*) is capable of producing all four toxins listed above. However, even within a genera such as *Dolichospermum*, there can be both toxin and non-toxin producing strains (ODEQ, 2011). Table 5-11 lists provisional acute toxicity values developed by the Oregon Public Health Division (OPHD) for cyanotoxins in drinking water (OPHD, 2016).

Table 5-11: Provisional Acute Toxicity Values for Cyanotoxins in Drinking Water (µ/L)

Guidance Value	Anatoxin-a	Cylindrospermopsin	Microcystin	Saxitoxin
Drinking Water Use (adults)	3	3	1.6	1.6
Drinking Water Use (children age 5 and younger)	0.7	0.7	0.3	0.3

Observations and analytical results collected by drinking water providers and water body managers are often used to issue public health advisories in State recreational waters. OPHD is responsible for issuing and lifting public health advisories. A list of current recreational advisories can be found on OPHD's Algae Bloom Advisories page. OPHD has established several options for issuing public health advisories for recreational waters:

1. Visible algae scum with supporting documentation and pending test results
2. Combined cell count for toxigenic algae species is ≥ 100,000 cells/mL
3. Individual species cell count for *Microcystis* or *Planktothrix* is ≥ 40,000 cells/mL
4. Relevant toxin concentration is at or above guideline value

Due to the significant costs associated with frequent monitoring, including staff time to collect samples and analytical costs, many water body managers have opted to move straight to toxin testing during significant blooms (see Table 5-12 for applicable cyanotoxin guidelines). Others have elected to skip monitoring altogether and instead post permanent HAB advisory signs at recreational sites informing the public to stay out if water conditions are questionable. During the bloom season this approach fails to provide adequate information to downstream drinking water providers since routine monitoring by water body managers is discontinued.

Table 5-12: Health Advisory Guidelines for Cyanotoxins in Recreational Waters (µ/L).

Guidance Value	Anatoxin-a	Cylindrospermopsin	Microcystin	Saxitoxin
Recreational Use (Non-drinking)	20	20	10	10

In addition to potential toxin production, large blooms can be a significant source of organic carbon in surface waters, which may increase the formation of disinfection-by-products (DBPs) during the drinking water treatment process. Organic carbon reacts with chlorine to form two types of DBPs; haloacetic acids (HAA5s) and trihalomethanes (TTHMs). Although EWEB has never exceeded EPA's maximum contaminant level (MCL) for either HAA5 (60 ug/L) or TTHM

(80 ug/L), detectable levels for both compound groups are routinely observed quarterly in finished water. Bloom activity may also contribute to taste and odor issues.

5.3.3 Current Status

EWEB source protection staff currently monitor planktonic algae conditions at several locations in the McKenzie watershed on a monthly basis during the bloom season, which typically extends from April to October. Monitoring locations are sampled on a tiered approach based on algae concentrations at primary sites. Primary sites include Cougar Reservoir, Blue River Reservoir, Walterville Pond and the McKenzie River at Hayden Bridge. If algae production is evident at primary sites, then samples are collected at secondary sites to determine downstream extent of blooms. Secondary sites include the South Fork McKenzie River below Cougar Dam, Blue River below Blue River Reservoir and Walterville Canal below Walterville Pond.

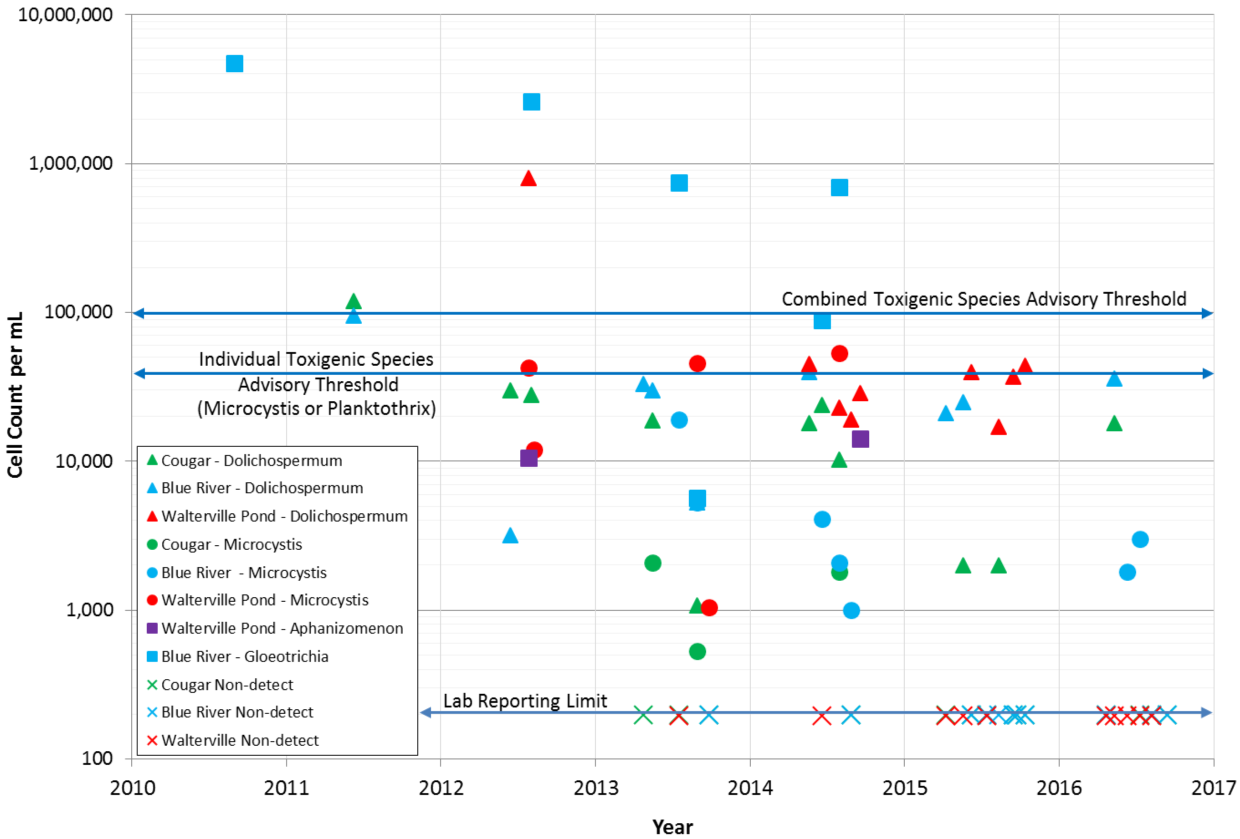
Water samples are routinely collected for planktonic algae identification and enumeration. Toxin samples are generally collected only if significant bloom conditions exist. However, beginning in 2016, EWEB staff initiated a pilot study with the USGS to assess benthic cyanobacteria populations and associated toxin production at several sites in the McKenzie Watershed. In addition, multiple samples were collected at main stem sites to assess cyanotoxin levels during periods when significant upstream planktonic blooms were not observed. Cyanotoxin occurrences during these time periods could potentially be a result of toxin production from benthic cyanobacteria species.

5.3.4 Monitoring Results

EWEB staff collected and analyzed algae samples from 1992 to 1999 (except 1993) during various months coinciding with the bloom season. Samples were collected from both Cougar Reservoir and Blue River Reservoir. Only values for *Dolichospermum* (originally reported as *Anabaena*) and total algal cells were reported. Most peak values fell below 20,000 cells/mL, although a max value for *Dolichospermum* of 28,500 cells/mL was reported on 5/4/1998 for Cougar Reservoir. Cougar Reservoir typically experienced the highest cell counts on an annual basis when compared to Blue River Reservoir. Algae sampling by EWEB staff was discontinued in 2000.

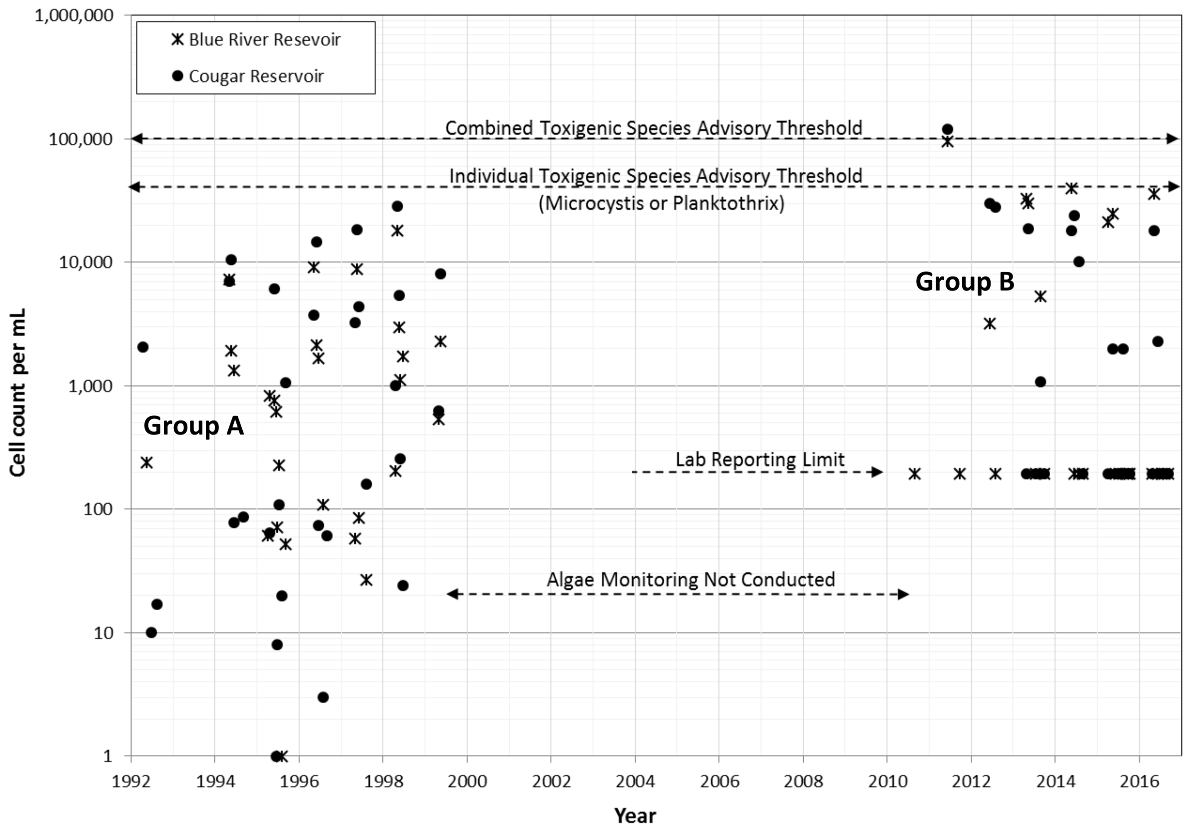
Beginning in the summer of 2010, EWEB staff began looking at bloom activity in the McKenzie Watershed after a large bloom was observed in the east end of Blue River Reservoir. Bloom concentrations in a small area adjacent to Lookout Campground were reported at 4.7 million cells/mL (*Gloeotrichia*), which resulted in a public health advisory being issued by OPHD. Subsequently, public health advisories were issued for Cougar Reservoir in 2011 (*Dolichospermum*, 120,000 cells/mL) and for Walterville Reservoir in 2012 (*Dolichospermum*, 800,000 cells/mL), 2013 (*Microcystis*, 46,000 cells/mL) and 2014 (*Microcystis*, 53,000 cells/mL). Figure 5-27 highlights cyanobacteria monitoring results from several reservoirs upstream of EWEB’s intake. Toxin samples collected during this time period were all non-detect.

Figure 5-27: Cyanobacteria Concentrations in McKenzie Watershed Reservoirs



When comparing cyanobacteria data collected during the 90s (group A) with data collected from 2010 to 2015 (group B), several observations stand out (see Figure 5-28). First, max cell concentrations observed in both Cougar Reservoir and Blue River Reservoir in group B (2011 – 120,000 cells/mL and 95,000 cells/mL respectively) are significantly higher than those found in group A (1999 – 28,500 cells/mL and 18,200 cells/mL respectively). Second, the emergence of a significant annual Gloeotrichia bloom in Blue River Reservoir appears to occur only in group B, based on data collected and conversations with staff who performed the group A analysis. Lastly, cell count figures observed in group A would not have triggered a public health advisory based on OPHD's current recreational guideline values for cell counts, whereas several events in group B have triggered advisories based solely on cell counts. Although more data needs to be collected and acknowledging the large data gap from 2000 to 2010, overall it appears blooms have increased in magnitude and diversity over the last 25 years.

Figure 5-27: Dolichospermum Concentrations at Select McKenzie Watershed Reservoirs



Over the past 25 years HAB sampling efforts have largely focused on planktonic forms of cyanobacteria. However, recent studies suggest that wadeable streams may also be a source of cyanotoxin production if potentially toxigenic benthic cyanobacteria are present (Fetscher et al., 2015). During a 2015 routine HAB sampling event on the McKenzie River at Hayden Bridge, several forms of benthic algae, or periphyton, were observed attached to the substrata. Although benthic algae are not uncommon in the lower McKenzie, the concentration appeared to be far higher than previously observed. Sample analysis revealed the presence of two cyanobacteria genera, *Nostoc* and *Nodularia*, which are both capable of producing cyanotoxins (OPHD, 2016).

During September, 2016, EWEB collaborated with the USGS in a pilot study to begin assessing cyanotoxins associated with benthic and planktonic cyanobacteria populations. *Nostoc* was identified and collected at several sites in the McKenzie River (Carpenter and Rounds, 2016). In addition to algae identification, solid-phase adsorption toxin tracking (SPATT) bags were deployed at various sites for approximately 3 weeks. SPATT bags provide a relatively inexpensive in situ method for monitoring cyanotoxins. Both the algae samples and SPATT bags were qualitatively assessed by the USGS for cyanotoxins using enzyme-linked immunosorbent assays (ELISA). The ELISA findings are considered preliminary and subject to reinterpretation, but initial results from the SPATT bag deployments indicate the presence of total microcystins in the McKenzie River during this time period. Interestingly, total microcystins and anatoxin-α were both detected in the benthic algae samples collected from the McKenzie River.

Low-level toxin analysis was previously only requested when significant HAB events were observed in upstream reservoirs. However, to better understand potential benthic cyanotoxin sources in both tributaries and main stem reaches, monthly HAB monitoring at intake sites in 2017 will include low-level cyanotoxin analysis.

5.3.5 Current and Potential Partners

Current Partners

- Oregon Health Authority
- Oregon State University
- U.S. Army Corps of Engineers
- U.S. Forest Service
- U.S. Geological Survey
- McKenzie Watershed Council

Potential Partners

- City of Lowell
- International Paper
- Lane Community College
- Oregon Department of Environmental Quality
- Portland State University
- Springfield Utility Board
-

5.3.6 Funding Sources

EWEB currently funds most of the HAB monitoring efforts in the McKenzie watershed through Source Protection. The USFS and USACE have both covered some monitoring expenses in the past, but generally the trend is to focus more on education and less on actual monitoring throughout the Willamette basin. OHA, who is responsible for issuing public health advisories, has also experienced a drop in funding and no longer provides printed outreach materials, although they still issue advisories. A potential source of matching funds with the USGS may be available for additional HAB monitoring efforts as part of a proposed regional sub-basin assessment of cyanobacteria. However, details of this proposal are still being discussed.

5.3.7 Legislative/Regulatory Outlook

The EPA proposed the 4th Unregulated Contaminant Monitoring Rule (UCMR 4) on December 11, 2015, under authority of the 1996 Safe Drinking Water Act (SDWA). This rule will require all large public water systems (PWSs), including EWEB, to collect occurrence data for contaminants that may be present in tap water, but are not currently subject to EPA's drinking water standards. Of the 30 contaminants selected, 10 are cyanotoxins. Sampling would likely commence in 2018 and EWEB would be required to collect samples twice a month for four consecutive months during the bloom season.

5.3.8 Outreach

EWEB will continue to support and/or facilitate the issuance of public health advisories for both recreation and drinking water uses when necessary and provide HAB monitoring results and updates to local stakeholders as needed. EWEB will present monitoring information to regional stakeholder groups to facilitate the sharing of ideas and enhance awareness of HAB issues. Finally, EWEB will assist with the development of high school algae monitoring program in Blue River as part of an EPA grant funded project with the McKenzie Watershed Council.

5.3.9 Future Projects in the McKenzie Watershed

Joint USGS study (Carpenter and Rounds, 2016)

- Identify smaller planktonic cyanobacteria populations in the lower McKenzie watershed and assess threat potential. Example locations include:
    - Non-contact cooling ponds (i.e. International Paper)
    - EWEB's power canals during extended low flow/outage conditions
    - Backwater sloughs and ponds along McKenzie main stem
- Investigate concerns of increased algae and aquatic vegetation in the main stem
- Assess benthic cyanobacteria communities in the McKenzie watershed
- Determine if benthic cyanobacteria populations are capable of producing toxins

OSU CyanoHAB genome database for the Pacific Northwest

- Determine if cyanobacteria strains in McKenzie watershed are toxigenic using PCR-based technologies (identify toxin producing genes).
- Develop rapid-assessment species ID/toxin analysis capabilities (field scopes and test strips)

Additional objectives for future work with partners as opportunities arise include the ability to:

- Identify potential bloom indicators or triggers
- Develop modeling capabilities to predict potential bloom occurrences
- Assess impact of reservoir operations on algae production
- Assess algae trends over time and understand how climate change could impact the magnitude, duration, frequency and diversity of blooms

5.3.10 Recommendations

A number of potentially toxigenic cyanobacteria species have been responsible for several significant blooms in the McKenzie watershed over the past 6 years. Confirmed toxin results have been reported in adjacent watersheds over the past several years and in the mainstem Willamette in 2016. Staff recommend that current funding levels with respect to McKenzie watershed HAB monitoring efforts be continued to better understand the role planktonic and benthic cyanobacteria play in producing blooms and potential cyanotoxins.

HAB monitoring activities will include monthly cyanotoxin monitoring during the bloom season (May to September) at intake sites and at sites experiencing significant bloom activity (including sites immediately downstream). Monthly monitoring will also include algae identification and enumeration at the following locations:

- Cougar Reservoir at Dam
- Blue River Reservoir – East End
- Blue River Reservoir – West End
- Walterville Pond (only when bloom activity present)
- McKenzie River at Hayden Bridge

Opportunities to leverage funding and increase efficiency:

- Explore opportunities with OSU and the USGS to develop targeted monitoring approaches for HAB-related threats using pooled resources. Examples include:
  - Genetic sequencing of algae species to determine toxin-producing potential.
  - Assess the use of both Solid Phase Adsorption Toxin Tracking (SPATT) methods and ELISA methods for toxin presence (vs. the more expensive LC/MS/MS).

5.4 Bacterial Source Tracking

5.4.1 Purpose

Identify sources of fecal pollution in impacted surface waters using microbial source tracking (MST) methods. Fecal source identification can help ensure outreach efforts are both targeted and effective.

Goals and objectives of monitoring efforts using MST are as follows:

- Evaluate bacteria levels within selected waterways of the lower McKenzie watershed
- Identify areas in the McKenzie watershed exceeding State benchmarks for *E. coli*
- Determine underlying sources of fecal contamination using MST
- Provide interpretation of results for future outreach efforts
- Evaluate the effectiveness of selected MST methods for future studies

5.4.2 Background

Over the past 10 years, EWEB has collected bacterial samples from a number of sites throughout the McKenzie watershed. At several sites, primarily those located in the lower portion of the McKenzie watershed, bacterial results often exceed Oregon's recreational benchmarks for *E. coli*, both the single max event of 406 MPN/100mL and the 30-day log mean of 126 MPN/100mL. In an effort to better understand potential sources of fecal contamination in local waterways, and effectively address those sources to reduce *E. coli* levels, EWEB staff began exploring how genetic analysis can be used to identify fecal sources.

New advances in the area of Microbial Source Tracking (MST) have recently provided more affordable options for identifying fecal bacterial sources using genetic and molecular analytical methods. Genetic biomarkers that are unique to different species or strains of fecal bacteria can be detected and quantified using quantitative Polymerase Chain Reaction (qPCR). Since some of these unique strains of fecal bacteria are predominantly associated with a specific animal group or species, they can be used as an indicator of that group or species. Biomarkers have been identified for a number of different animal groups, including dogs, humans, birds and ruminants (i.e. cattle, sheep, goats, deer, etc.).

In collaboration with the City of Springfield, EWEB initiated a small pilot study using MST in 2015 to better understand potential causes of elevated *E. coli* levels observed in several City stormwater channels that discharge to the McKenzie River above EWEB's drinking water intake. Samples were collected during significant storm events to coincide with peak flow conditions. Such events generally result in maximum turbidity values when contaminants are being flushed from terrestrial sources into receiving waterways. Two storm events were targeted in 2015 and one in 2016.

5.4.3 Current Status

Although the initial pilot study has concluded, EWEB is exploring options with City of Springfield to initiate another round of MST in the spring or fall of 2017. Additional monitoring would likely continue to target stormwater conveyances with elevated bacteria levels in an effort to identify hotspots and support outreach efforts.

5.4.4 Monitoring Results

MST results were provided by Source Molecular Corporation, a commercial laboratory founded in 2002 and based in Miami, Florida. Although MST results are provided in both qualitative and quantitative format, most results are generally assessed through a qualitative lens. For example, comparing the relative magnitude of biomarker results within a specific group, such as dogs, is fairly straightforward and acceptable. However, it is not advisable to compare different biomarkers against one another, or to compare different animal groups to one another. In addition, a single sample generally provides limited data and low reliability in determining the relative input of fecal material from a particular animal group.

Results from the 2015-2016 MST pilot study are included in this section and cover three separate storm monitoring events. Monitoring for the first event was initiated on 10/31/15 and included 9 different sites. The second monitoring event occurred on 11/19/15 and included 7 sites. The third monitoring event occurred on 6/14/16 and only included 4 sites. *E. coli* values were used to determine which MST samples to analyze. Low *E. coli* values generally indicate low levels of fecal contamination and likely not enough genetic material to detect a signal using MST. Samples were assessed for a combination of genetic biomarkers related to humans (2 markers used), birds, dogs, horses and ruminants.

The 69th stormwater channel at Thurston Road (E690) recorded the two highest *E. coli* values observed during the entire study, 34,480 and 12,997 MPN (most probable number). The 34,480 value is the highest *E. coli* result ever recorded by source protection staff in the McKenzie subbasin, essentially doubling the previous mark of 17,329 MPN, which was also collected from E690. The Oregon recreational maximum *E. coli* value for fresh water is 406 MPN. Most values for total coliforms exceeded the method's upper enumeration limit even though a dilution was requested for all samples. The highest upper enumeration limit reached was 241,960 MPN, also observed at E690.

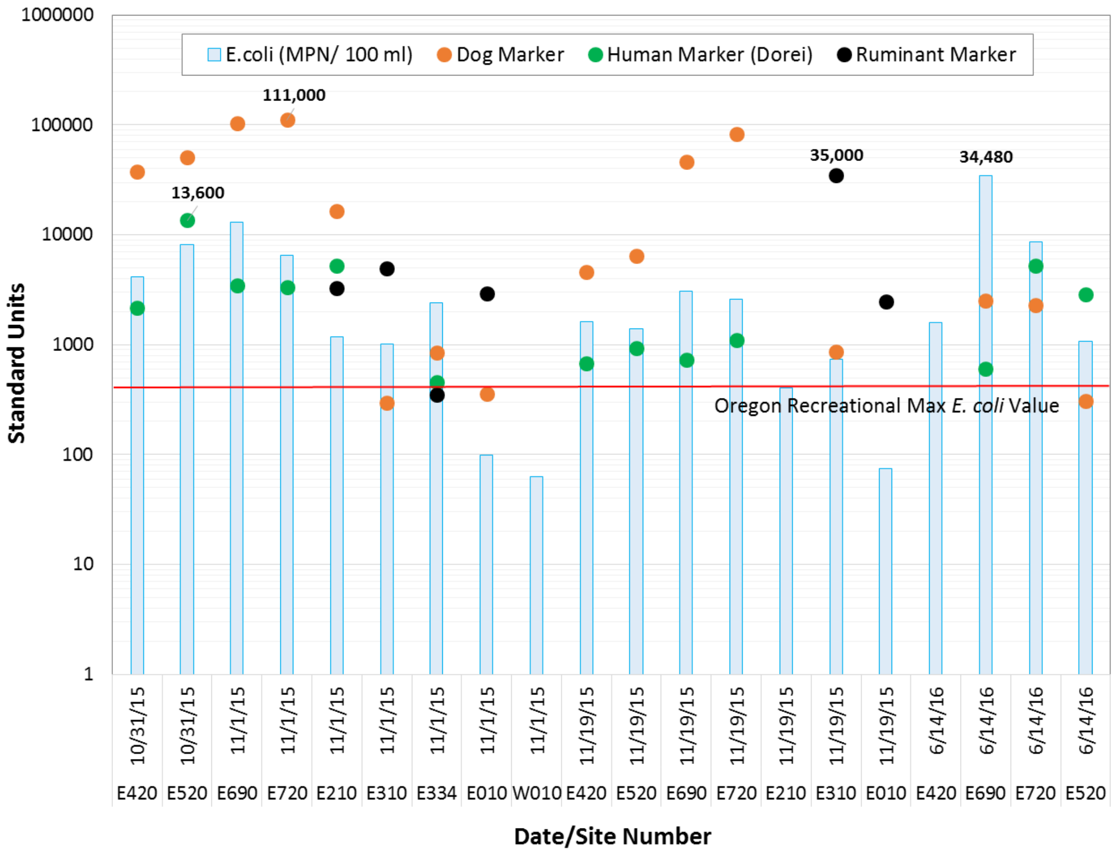
The highest human *Dorei* biomarker (13,600) total was observed at the 52nd stormwater channel along Highway 126 (E520) during the October 31, 2015 event (see Figure 5-28). The lab indicated the approximate contribution of human fecal pollution in this particular water sample as "moderate concentration". One possible source for the fecal contamination observed at E520 may have been from a large homeless camp situated upstream of the monitoring site and adjacent to a side-channel. Other sites reported detections for the human *Dorei* biomarker, but all were qualified as low, trace or absent concentrations. Results for the other human biomarker (EPA) were qualified as low, trace or absent concentrations.

Results originating from the dog biomarker included a number of moderate to high fecal concentrations across multiple sites. Both the 72nd stormwater channel at Thurston Road (E720) and E690 yielded high dog fecal concentrations during the November 1, 2015 event. Several other sites, including the 42nd stormwater channel near International Paper (E420), E520 and Cedar Creek at Saunder's Bridge (E210) recorded moderate dog fecal concentrations during the same event. Sites E690 and E720 recorded moderate dog fecal concentrations during the subsequent event on November 19, 2015. Although *E. coli* values were significant during the June 14, 2016 event, only low, trace or absent concentrations were recorded for the dog biomarker.

Samples analyzed for the bird biomarker returned only trace or absent concentrations during all three monitoring events. A few samples were analyzed for the horse biomarker during the first monitoring event, and one sample was analyzed for the same during the second event, but all samples were non-detect for this biomarker. A ruminant biomarker was also evaluated at the same sites and during the same events as the horse biomarker. Camp Creek at Camp Creek Road Bridge (E310) yielded a moderate concentration for ruminant fecal contamination, while all other sites yielded low concentrations.

Although moderate to high fecal concentrations for some groups of animals were observed in stormwater channels and lower watershed tributaries, samples collected from the McKenzie River at Hayden Bridge (E010, EWEB's drinking water intake) generally resulted in non-detect or trace biomarker values. Results for E010 did include two ruminant fecal concentrations that were considered low, as well as one dog fecal concentration that was also considered low. Given that low ruminant biomarker concentrations and moderate to high dog biomarker concentrations were found in several nearby upstream sources, corresponding low biomarker concentrations detected at E010 are not all that surprising.

Figure 5-28: Bacterial Source Tracking Results with Associated *E. coli* Values.



5.4.5 Current and Potential Partners

- City of Springfield
- SUB
- LCC
- DEQ

5.4.6 Funding Sources

For the 2015-2016 MST pilot study, the City of Springfield covered approximately one-third of the total monitoring budget while EWEB covered the remaining two-thirds. By combining efforts and pooling resources, staff were able to negotiate a reduced cost for analytical services.

5.4.7 Legislative/Regulatory Outlook

DEQ is currently in the process of revising Oregon's water quality standards for bacteria. Although changes are primarily geared towards coastal recreational waters, there is a proposal to change the averaging period for the freshwater *E. coli* standard from 30 days to 90 days. The averaging methodology will also be changed from "log mean" to "geometric mean." The result of these changes will likely mean fewer freshwater segments listed as impaired for bacteria, assuming all other conditions stay the same.

5.4.8 Outreach

Results from the pilot study were used by City of Springfield staff to develop a stormwater bill insert on pet waste targeting residents in stormwater catchments receiving the highest *E. coli* and dog biomarker results. A follow-up pet waste survey was sent out in April 2016 to determine the effectiveness of the insert. Out of 197 residents who received the survey, 30% of respondents gave the insert a successful rating. In addition, City of Springfield staff installed two new pet waste bag dispensers along 69th Street and additional signs along 72nd Street. A second pet waste mailing went out in 2016 targeting 750 residents in the 69th/72nd catchments. City of Springfield staff also sent cameras along both sanitation lines and found no evidence of failure.

5.4.9 Future Projects in the McKenzie Watershed

City of Springfield staff recently inquired about EWEB's support for another round of MST and bacteria monitoring in stormwater catchments located in the eastern portion of the city. The objectives of another round of monitoring would be to evaluate the effectiveness of previous outreach efforts and also to pinpoint where high bacteria loads originate by moving sampling efforts upstream in each catchment.

5.4.10 Recommendations

The general assumption has been that elevated levels of fecal bacteria in eastern Springfield stormwater channels is largely the result of pet waste being discarded over back fences and into open stormwater conveyances. City of Springfield staff and residents had reported witnessing such activities in both the 69th and 72nd stormwater catchments. However, by using bacterial source tracking methods, staff were able to provide direct evidence that pet waste was contributing to poor water quality conditions in specific catchments.

Staff will continue to explore monitoring and collaboration opportunities with the City of Springfield and other parties interested in using MST, especially when cost-sharing agreements can be established. Data collected from such efforts can help gauge the effectiveness of outreach programs and determine where additional work needs to be done. MST efforts to date have been opportunistic and beneficial for both EWEB and the City of Springfield.

Staff will assess MST technology periodically to determine the effectiveness and affordability in other areas of the watershed, specifically Camp Creek. Outside of Springfield stormwater outfalls, Camp Creek records some of the highest bacterial levels in the McKenzie watershed.

5.5 Continuous Water Quality Monitoring

5.5.1 Purpose

EWEB staff routinely use continuous monitoring techniques and equipment to collect water quality measurements over extended time periods. The most common technique involves the use of multi-parameter water quality sondes, which can be deployed anywhere from several minutes to months at a time. Additional techniques include pressure transducers, flow sensors and temperature loggers. EWEB staff frequently utilize these various techniques to support multiple source protection programs and objectives. In addition, EWEB contracts with external parties, such as the USGS, to collect and disseminate time-series data in real-time at key monitoring locations. The resulting time-series data are used to support a variety of monitoring objectives throughout the watershed and are a crucial component of the source protection program.

Short-term deployments, generally less than a day, support monitoring activities such as routine baseline and algae monitoring, as well as investigative monitoring, including water quality concerns and spill response. Medium-term deployments, typically a few days to several weeks in length, are often used to facilitate storm event monitoring or to assess the impact of specific land use activities, such as a recent logging event. Long-term deployments, which can extend from months to years, are currently used to assess long-term water quality conditions and trends, hydrological variability, seasonal variability, potential climate change impacts, large-scale land use impacts, illicit discharges and overall watershed health.

5.5.2 Background

In 2001, source protection staff began using multi-parameter water quality sondes to collect field measurements at various sites to support both baseline and storm event monitoring efforts. Each sonde typically contains between 3 and 6 sensors that are capable of measuring multiple parameters simultaneously at customizable intervals. Water quality parameters initially included temperature, conductivity, dissolved oxygen (DO), pH and turbidity. However, developments in sensor technology over the last 10 years have resulted in a number of new sensors being available for continuous monitoring efforts. Some of the newer sensors include chlorophyll and phycocyanin, which together can measures total algae, and fluorescent dissolved organic matter (fDOM).

During most routine baseline monitoring events, a sonde is deployed at each monitoring site to collect field measurements of various parameters during the time staff are collecting water samples for laboratory analysis (see Table 5-13). The sonde is deployed for approximately 10 minutes, and the measurement interval is set to 5 seconds, meaning that every 5 seconds all sensors collect their respective measurements. The continuous field data provides an informative view of physical conditions at the time water samples were collected, and can be evaluated at a later time if analytical results for a specific site warrant further review. Continuous data collected during these shorter events is also used to assess general water quality conditions across multiple sites throughout different hydrological regimes.

Water quality sondes, pressure transducers and flow sensors can be used both independently and in combination during storm event monitoring to help determine when and where water samples should be collected. During storm monitoring events, samples are often collected during the rising limb of a hydrograph or during peak flow events, when contaminant loads are expected to be highest. However, storm samples can also be collected during peak turbidity events, or at other specified water quality events, depending on the objectives of the monitoring effort. During the storm monitoring season, sondes, pressure transducers and flow sensors can be deployed for days, weeks and even months at designated sites to help achieve monitoring objectives. The resulting time-series datasets provide a rich context to evaluate the success of storm event monitoring efforts and also a basis for interpreting analytical results and supporting outreach efforts.

Long-term continuous monitoring deployments are initiated to provide a more detailed data record about some basic water quality parameters that can help inform the timing, duration, and trends of various changes in water chemistry that relate to activities in the watershed, such as algal bloom die offs, turbidity events from reservoir operations or landslides, and trends that may relate to climate change or changes in land use (see Table 5-13).

Table 5-13: Sensor Specifications with Typical Performance Metrics

Sensor	Units	Range*	Accuracy*	Resolution*
Temperature	°C	-5 to 50	+\- .02	0.001
Conductivity	mS/cm	0 to 100	+\- 1% Reading	0.01
Dissolved Oxygen	%Sat, mg/L	0 to 500%	+\- 1% Reading	0.1
Turbidity	FNU, NTU	0 to 4,000	+\- 2% Reading	0.01
pH	SU	0 to 14	+\- 0.1	0.01
ORP	mV	-999 to 999	+\- 20	0.1
Chlorophyll	ug/L, RFU	0 to 400 ug/L	**	.01
Phycocyanin	ug/L, RFU	0 to 100 ug/L	**	0.01
fDOM (CDOM)	ppb QSU	0 to 300	**	0.01
Depth	m, ft	0 to 100 m	.04	0.001

*Source: www.exowater.com/sensors

** Linearity: R2 >0.999 for serial dilution of recommended calibration fluid.

5.5.3 Current Status

EWEB staff currently have a number of active continuous monitoring locations in the McKenzie Watershed. In addition, EWEB has a joint funding agreement with the USGS to operate several streamflow monitoring stations and one water quality station. These stations are operated on cost share basis with the USGS (EWEB 65%, USGS 35%). However, EWEB is reimbursed by SUB for the Cedar Creek streamflow monitoring station.

EWEB staff currently monitoring water quality conditions using multi-parameter sondes in the following locations:

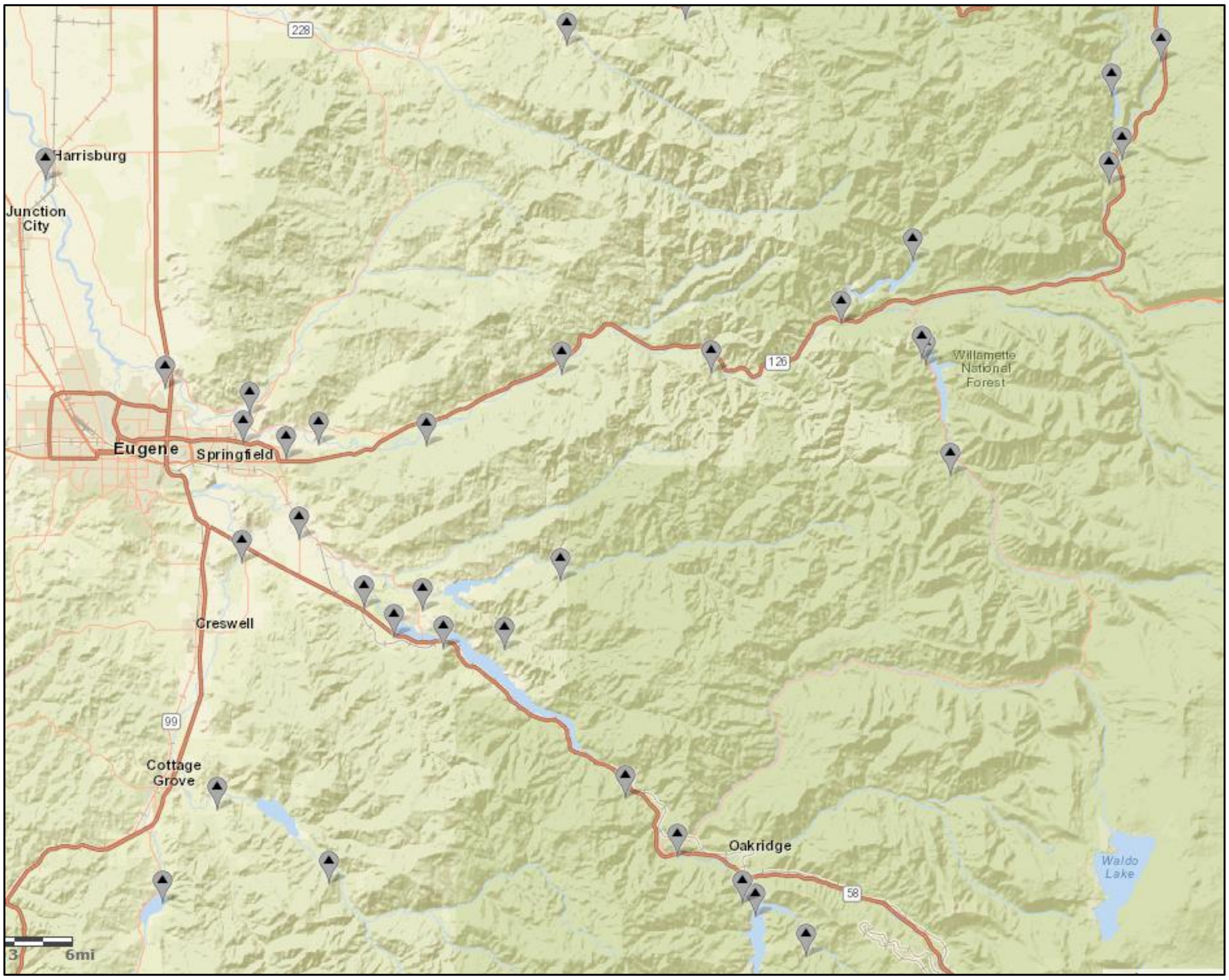
- **McKenzie River Above Hayden Bridge**
    - Water Quality**:** Turbidity, Temperature, Conductivity, pH, fDOM, Total Algae, DO
- **52nd Stormwater Channel**
    - Water Quality**:** Turbidity, Temperature, Conductivity, pH, fDOM, Total Algae, DO, Stage, Rainfall
- **Cedar Creek at Springfield**
    - Water Quality**:** Turbidity, Temperature, Conductivity
- **Camp Creek at Camp Cr Rd Bridge**
    - Water Quality**:** Turbidity, Temperature, Conductivity

USGS staff operate the following monitoring stations which are partially funded by EWEB and SUB:

- **McKenzie River Above Hayden Bridge**
    - Stage, Discharge
- **Cedar Creek at Springfield**
    - Stage, Discharge
- **Camp Creek at Camp Creek Rd Bridge**
    - Stage
- **McKenzie River Near Vida**
    - Water Quality**:** Turbidity, Temperature, Conductivity, pH, fDOM, Total Algae, DO

In addition to streamflow gages partially funded by Source Protection, the USGS operates an extensive network of gages throughout the McKenzie Watershed (Figure 5-29). This data provides an excellent resource for water quality analysis and hydrologic forecasting. Gage data can be accessed at the following url: https://waterdata.usgs.gov/or/nwis/current/?type=flow

Figure 5-29: Continuous Monitoring Stations Managed by the USGS



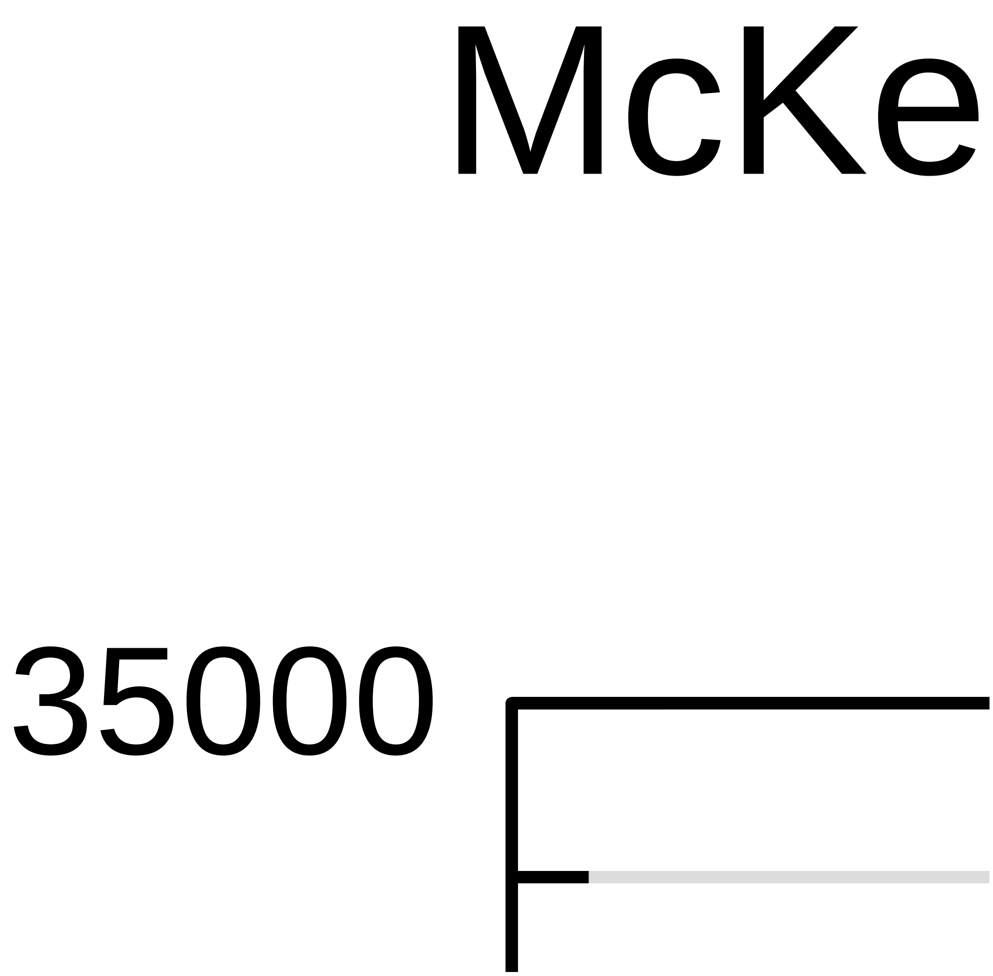
5.5.4 Monitoring Results

Continuous monitoring data or time-series data can generate copious amounts of data. Large datasets can easily exceed one million data points. Fortunately, most of the USGS data is easily accessible real-time. Figure 5-30 provides a detailed looked at three of the parameters being collected by the USGS at the McKenzie Vida monitoring station (partially funded by EWEB). The diurnal pH swings common during the summer months readily standout. A closer look at the fDOM results clearly show significant increase in dissolved organic material during the first fall flush events. These events can be problematic for downstream drinking water providers, especially during events with significant DOM levels. Less apparent is the subtle fDOM increase beginning in June/July, when aquatic vegetation and algae begin increasing in numbers. This real-time information is extremely valuable when coordinating storm event monitoring and understanding changing water quality patterns, form diurnal to seasonal swings. The Vida gage is also particularly useful for evaluating USACE reservoir operations and potential bloom formations.

Figure 5-30: Discharge, pH and fDOM at McKenzie River near Vida, OR (USGS)

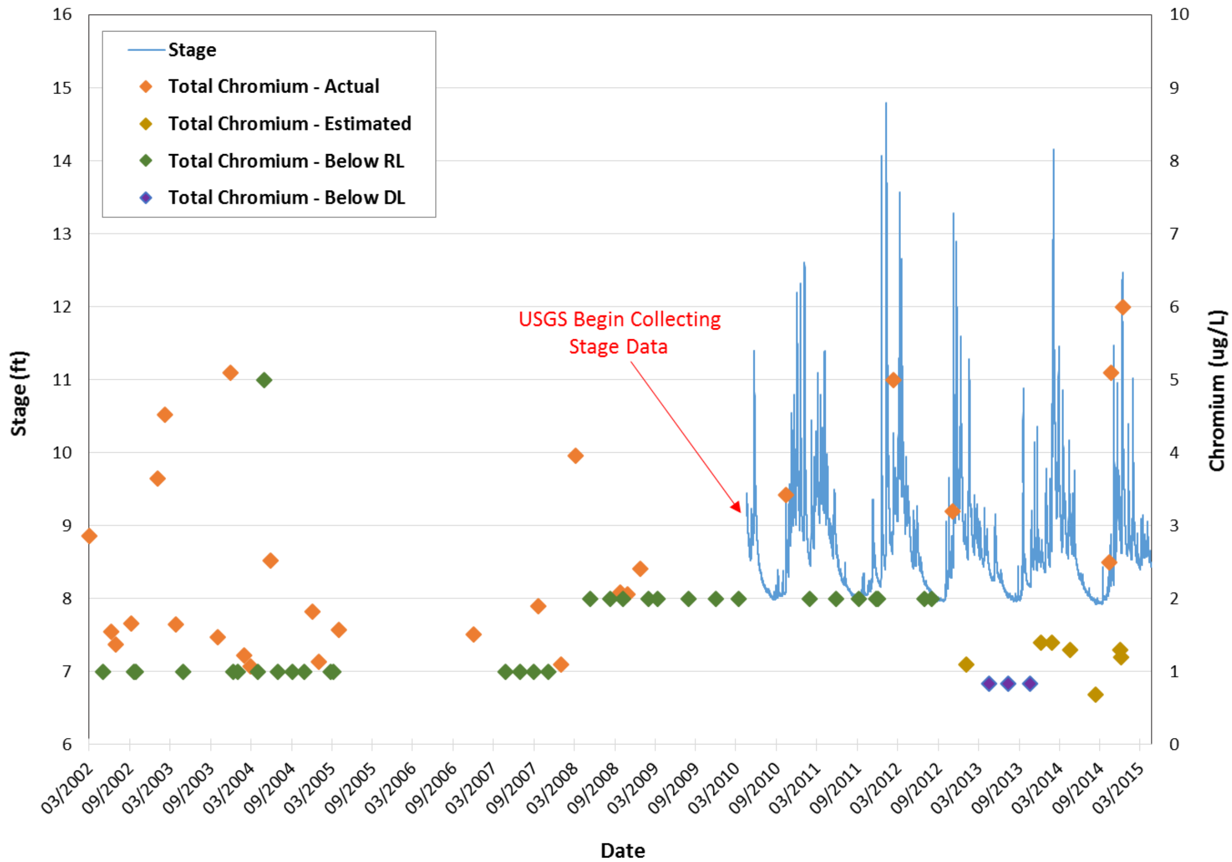
Further downstream at the Hayden Bridge gage, which is also operated by the USGS and funded by EWEB, water quantity and quality are jointly monitored. This important dataset is extremely valuable when assessing available water resources and long-term hydrological trends. For operators and source protection staff, understanding the magnitude and duration of storm-related events and prolonged dry spells through real-time hydrographs is both helpful and efficient. Figure 5-31 provides a 6-year historical look at McKenzie River flows at Hayden Bridge. The extremely low water years of 2015 and 2016 were very unusual. EWEB staff used the discharge data to communicate water consumption guidance to customers during exceptionally low flow periods. Contrast the previous two years with the current year and the difference is quite noticeable.

Figure 5-31: Historical Discharge at McKenzie River above Hayden Bridge (USGS)



Discharge data is also used to determine the particular hydrologic characteristics of a stream or river during discrete monitoring events. This information can provide insight and additional clarity when interpreting analytical data. Figure 5-32 illustrates the moment the USGS began collecting stage data in Camp Creek. Prior to that time, it was relatively difficult to understand the distribution of Chromium detections in Camp Creek. With stage data available, the distribution of chromium detections appear to correlate with significant flow events, especially during the initial rising limb of the hydrograph.

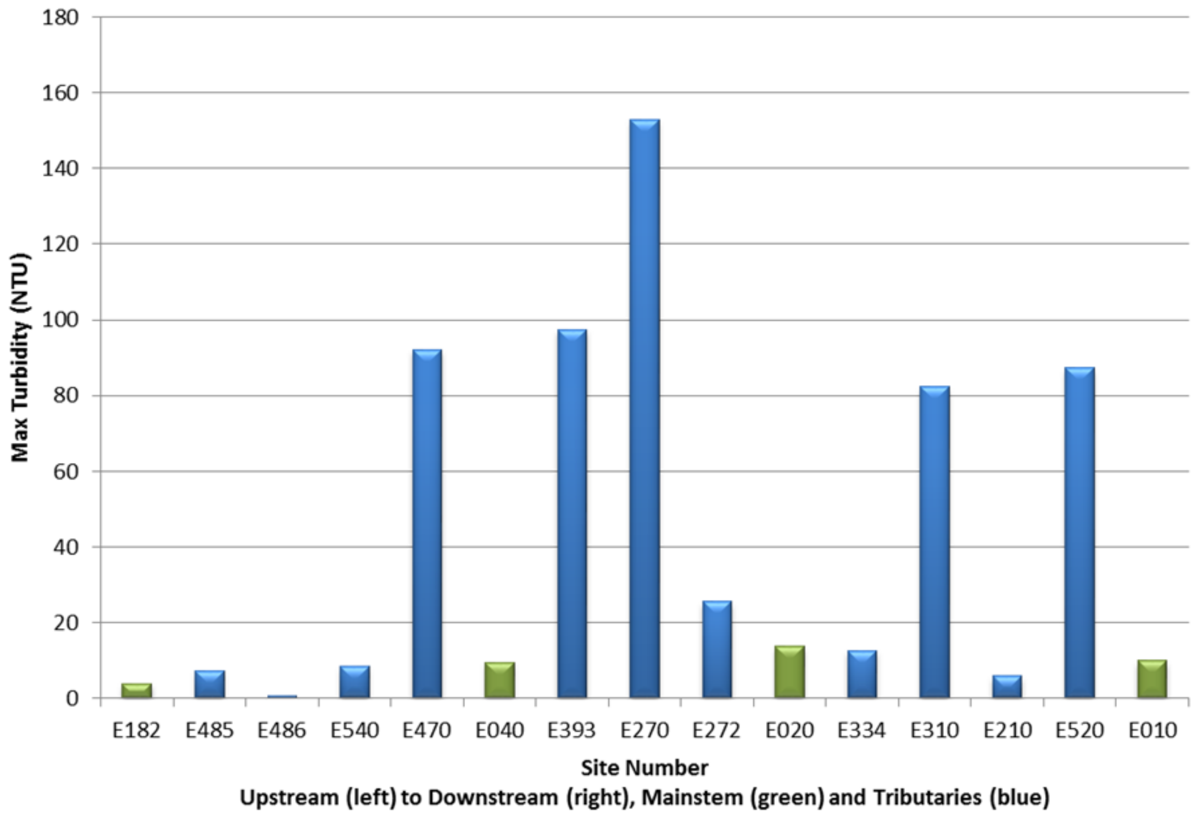
Figure 5-32: Total Chromium and Discharge Comparison for Camp Creek



Water quality sondes are frequently used to collect a variety of water quality parameters throughout the watershed. Turbidity is often used to assess the magnitude of storm events and to determine sample timing. Figure 5-33 provides an example of turbidity values during a significant storm event in October, 2012. Samples were being collected for a joint USGS carbon study.

As indicated by the relative magnitude of each bar plot, Quartz Creek (E470), Gate Creek (E393), lower Haagen Creek (E270), Camp Creek (E310) and the 52nd Stormwater Channel (E520) experienced significant turbidity events when compared to other tributaries and mainstem sites. Quartz and Gate Creek have significant logging operations upstream of each monitoring station. Camp Creek and Haagen Creek have rural development, forestry practices and agriculture in upstream reaches. The 52nd Stormwater Channel drains an area with residential, commercial and industrial land use.

Figure 5-33: Maximum Turbidity Levels Observed During October Fall Storm Event, 2012



5.5.5 Current and Potential Partners

- USGS
- SUB
- USACE
- BLM
- USFS

5.5.6 Funding Sources

Funding sources currently include a cost share program with the USGS where EWEB funds 60% and the USGS 40% of the costs of the gages and water quality monitoring sondes. Might be possible to share costs for these continuous monitoring stations with other agencies like the Army COE. SUB currently covers the cost of the Cedar Creek gage.

5.5.7 Legislative/Regulatory Outlook

None at this time

5.5.8 Outreach

EWEB staff have reached out to SUB and others to explore sharing information and costs related to continuous water quality and quantity monitoring operations. Opportunities with the USACE, watershed councils and the DEQ will be assessed.

5.5.9 Future Projects in the McKenzie Watershed

Future continuous monitoring projects in the McKenzie Watershed include plans to deploy water quality instrumentation in Gate Creek and Quartz Creek to better assess the impacts of forestry operations. EWEB staff have also been contacted by USFS and BLM to coordinate monitoring around future timber harvests.

EWEB staff plan to install infrastructure at the Camp Creek site to protect monitoring equipment and extend deployments. EWEB staff are also determining the feasibility of adding additional telemetered monitoring stations to lower watershed monitoring sites, similar to the one installed at the 52nd site.

5.5.10 Recommendations

Continuous monitoring applications continue to play a vital role in source protections efforts throughout the watershed. Continuous monitoring applications include various long-term streamflow gages and water quality stations operated by the USGS, to EWEB's variable-term continuous monitoring efforts.

Staff recommend maintaining current USGS gages and water quality monitoring stations throughout the watershed. These datasets provide an invaluable resource for assessing long-term trends and variability within the watershed, especially as we address potential climate change impacts and increasing development pressures.

Site	Application	Associated Land Use
• McKenzie River Above Hayden Bridge	Stage/discharge	Mixed
• Camp Creek at Camp Cr Rd Bridge	Discharge only	Mixed
• Cedar Creek at Springfield	Stage/discharge	Mixed
• McKenzie River Near Vida	Water Quality	Forestry

Staff also recommend maintaining EWEB's current sonde deployment installations, both temporary and semi-permanent. These deployments assist with storm monitoring, ambient monitoring and illicit discharge monitoring. Please note many of these deployments are seasonal. Deployment locations include the following:

Site	Application	Associated Land Use
• McKenzie River Above Hayden Bridge	Water Quality	Mixed
• Camp Creek at Camp Cr Rd Bridge	Water Quality	Mixed
• Cedar Creek at Springfield	Water Quality	Mixed

• 52nd Stormwater Channel	Water Quality/Stage	Urban

Staff recommend adding seasonal continuous monitoring capabilities in the fall of 2017 to the following sites:

Site	Application	Associated Land Use
• Gate Creek	Water Quality	Forestry
• Quartz Creek	Water Quality	Forestry

5.6 Macros/Fish Population

Periodic monitoring over time for macroinvertebrates and fish populations provides a biological indicator for watershed health and trends. In 1998 the McKenzie Watershed Council began working with a number of partners to generate a baseline macroinvertebrate assessment of stream health at selected sites throughout the watershed. Sampling was conducted between 1998 and 2002. The results and recommendations from this effort led to development of a monitoring program that ran from 2003-2007 collecting macroinvertebrate samples at 10-16 sites per year. This effort ended due to lack of funding. In 2011, EWEB contracted with LCOG to run this data through a macroinvertebrate stream health assessment model. This exercise identified priority areas for future monitoring efforts.

In 2016, EWEB source protection program and electric generation began working with OSU to collect fish species richness, relative abundance, and proportions of native and non-native fish species using the SLICES framework established by U of O in the McKenzie River (see SLICES framework (http://ise.uoregon.edu/slices/main.html). OSU initiated efforts in the lower McKenzie River to quantify native and non-native fish communities and their associated water quality and habitat conditions. This work will continue for the length of SLICES framework up to Cougar and Trailbridge dams. This information will be readily available via the SLICES website to assess if restoration investments are meeting their goals over time. The idea is every 10 years OSU will conduct another fish survey based on the SLICES framework to assess changes in fish species, abundance and presence of native versus non-native species that may correlate with land use/land cover and climate changes. This can be used as a tool to assess effectiveness of watershed protection and restoration investments.

5.7 Canopy Cover, Riparian, Floodplain/Floodway

Periodic assessment of canopy cover, and floodplain/floodway land use and land cover can be an effective long term watershed monitoring tool to gauge effectiveness of watershed restoration and protection investments. Repeat LiDAR and aerial photography collection every 5 years can monitor for changes in canopy cover, structural footprints, roads and other infrastructure, and channel morphology. Literature review and meetings with the USGS confirmed that LiDAR can be an effective tool for mapping these changes via use of algorithms that highlight differences between two LiDAR flights. Mapping structural footprints in particular and changes over two different flights is more challenging and will need additional analysis to determine if it is feasible. LCOG also spent time developing LiDAR specifications so that repeat flights are of similar accuracy, processing, and deliverables that will allow easier comparison and analysis over time.

As mentioned in Section 5.6, EWEB worked with other partners to extend a regional SLICES Framework developed by Hulse et al. (2002) up into the McKenzie Watershed. While on-the-ground restoration projects are the actions that will contribute to a healthier river, scientifically sound assessment and monitoring of the aquatic and floodplain ecosystem are equally important for creating a guiding vision, designing restoration efforts, and documenting the status and trends of river health and human communities over time. Upon its creation in 2007, The Willamette Special Investment Partnership identified four metrics of a healthy Willamette River:

- floodplain forest extent,
- mainstem channel complexity,
- native fish abundance, and
- water quality.

The Willamette River restoration partners found that the floodplain provides the most constant and quantifiable spatial framework for comparing physical, biological, and human characteristics of the river corridor. The river's channel position, adjacent forests, and land use may all change, but the floodplain (the area historically inundated by floods) is relatively constant. The SLICES framework, oriented on the floodplain axis, provides a consistent basis for comparing changes in geomorphic structure, aquatic ecosystems and human settlement. This framework for floodplain assessment is done by mapping one-km "slices" of the floodplain at right angles to the floodplain's center axis (Hulse et al., 2002; Hulse and Gregory, 2004) and then adding further detail on biological presence of target species at finer scales. This finer scale is nested slices of 100m lengths, and constrained to a narrower pragmatic floodplain. This pragmatic floodplain is limited by significant infrastructural investments, primarily roads. For more information on the SLICES framework, visit: http://ise.uoregon.edu/slices/main.html .

In the McKenzie River, expansion of the SLICES spatial framework will be used to incorporate baseline monitoring of status and trends for three key metrics—floodplain forest extent, mainstem channel complexity and native fish so that the central question of whether restoration goals are being met can be answered over time. This monitoring approach will be conducted every ten years as a long-term watershed monitoring effort driven by a scientifically defensible understanding of the river system and the programmatic goals derived from an understanding of what to restore. Of the four broad types of monitoring (status and trends, implementation/compliance, effectiveness, and validation monitoring), and the three relevant scales at which such monitoring can be carried out in a large river floodplain (river, reach, project), the most cost-effective and broadly useful combination for the McKenzie floodplain is status and trends monitoring at the river system extent. The McKenzie SLICES approach also provides planning level data that will help prioritize investments and map the uplift from these investments, which will assist with funders looking for mitigation opportunities.

5.8 DEQ Water Quality Index

Results from the DEQ monitoring over a nearly 20-year period indicated consistently excellent water quality as measured by the Oregon Water Quality Index (OWQI). The OWQI analyzes a defined set of water quality variables and produces a score describing general water quality. The water quality variables included in the OWQI are temperature, dissolved oxygen, biological oxygen demand, pH, total solids, ammonia, nitrate, total phosphorus, and fecal coliform/E. coli (Oregon DEQ, 2002; Oregon DEQ, 2003). OWQI scores range from 10 (worst case) to 100 (ideal water quality). In general, results indicate that water quality in the McKenzie is good to excellent and the quality tends to decrease as one moves down river. Six of the seven monitoring sites in the McKenzie had an average OWQI score that ranged from 93 to 96 (indicating some of the highest water quality in the state). The Mohawk River was the lone site that averaged 86 and was considered "good" water quality. Water quality was found to be temperature-limited during various times of the year because temperature standards set by DEQ to protect salmonid populations were exceeded (Oregon DEQ, 2002; Oregon DEQ 2003).

5.9 Outdoor Education

EWEB provides tools to help K-12 students understand water resource issues and the importance of protecting the McKenzie Watershed as a drinking water resource.

Through field-based learning, students are able to collect data that is used by others to support decisions and program development. Our hope is that students who participate in these programs will consider future careers in water resource related fields.

Student monitoring

EWEB helps to support student water quality monitoring through financial contributions and in-kind staff time. Staff from the Springfield school district and McKenzie Watershed Council partner to coordinate student monitoring in the field. Thurston High School students have been monitoring water quality at two major tributaries to the McKenzie: Cedar Creek and Camp Creek.

EWEB staff collects split samples with the students at most of their monitoring sites at least once a year and submits these samples to a commercial lab to allow students to check their lab results. Many students involved in this program participate for several years in high school and become quite skilled at water quality analysis. In addition, EWEB staff have access to the students' data, which can be assessed to identify water quality issues or concerns.

EWEB also supports the **McKenzie Watershed Council's education program** with funding and staff time. EWEB has been a McKenzie Watershed Council partner since 1993 and works with the council on many projects with landowners in the watershed. A recent grant from the EPA provides the ability to expand the education creek basin concept that Thurston High School has done for years to 3-4 other area high schools. The idea is to enable high schools focused on nearby creeks or other waterbodies to begin collection of data that can assist other agency data being collected and allow students to use all data available as part of statistics and other analysis that meet school science and math curriculum.

5.10 Monitoring Cost Summary

The following tables summarize the current, recent past and future costs for monitoring water quality and other key parameters in the McKenzie Watershed (see Tables 5-15 and 5-16). Water quality monitoring costs have increased by 38% since 2013 and are projected to level out over the next 10-years. In general there is a shift from organic contaminant storm event monitoring to increasing continuous monitoring that can provide real-time data for an early warning system.

Table 5-15: Summary of Current and Recent Past Non-Labor O & M Monitoring Costs

EWEB Costs	2013	2014	2015	2016	2017 Budgeted[1]
Baseline	$28,000	$28,000	$28,000	$34,000	$33,000
Storm Event	$30,000	$37,000	$37,000	$36,000	$44,000
HAB	$2,000	$2,000	$3,000	$4,000	$6,000
Continuous	$23,000	$26,000	$29,000	$29,000	$40,000
Investigative	$40,000	$30,000	$21,000	$10,000	$16,000
Data Mngt & Reporting	$25,000	$25,000	$25,000	$25,000	$25,000
Total	**$148,000**	**$148,000**	**$143,000**	**$138,000**	**$164,000**

Table 5-16: Summary of Future Non-Labor O & M Monitoring Costs (2018-2028)

EWEB Costs	2018	2019	2020	2021	Average 2022-24	Average 2025-28
Baseline	$34,000	$32,000	$34,000	$34,000	$34,000	$34,000
Storm Event	$8,000	$7,000	$26,000	$7,000	$11,000	$11,000
HAB	$14,000	$7,000	$8,000	$7,000	$8,000	$8,000

Continuous	$55,000	$54,000	$55,000	$56,000	$57,000	$57,000
Investigative	$14,000	$5,000	$11,000	$10,000	$10,000	$10,000
Data Mngt & Reporting	$35,000	$25,000	$26,000	$26,000	$30,000	$30,000
Total	**$160,000**	**$130,000**	**$160,000**	**$140,000**	**$150,000**	**$150,000**

6.0 MITIGATION PROGRAMS

6.1 McKenzie Watershed Emergency Response System (MWERS)

6.1.1 Purpose

In order to address the high priority threat from hazardous material spills within the McKenzie Watershed (see Section 3.3), EWEB works closely with a number of federal, state and local agencies to implement the McKenzie Watershed Emergency Response System (MWERS). MWERS is used by incident commanders to quickly gain access to crucial information, equipment and trained personnel, allowing for an effective response in the initial hours after a spill. Watershed responders use Geographic Information System (GIS) technology to access information on threats, critical resources, spill response strategies, equipment availability and other information needed during a crisis. First responders and others are able to use this information to efficiently and effectively stabilize accidental or intentional chemical releases as soon as possible and avoid the initial confusion often associated with spills.

6.1.2 Current Status

EWEB is currently in the process of modernizing its GIS-based response system and making it available online to partners. This new system will be much more user-friendly to everyone. The online version will have additional functionality to notify all responders, utilities, and other watershed stakeholders when a spill occurs, and track actions to mobilize resources and respond to the spill in a way that all interested parties can see until an Incident Command System is established to take over coordination.

MWERS has three fully-equipped response trailers staged in key areas to allow a quicker and more effective response to spills. EWEB continues to organize yearly on-the-ground drills that use these response trailers to familiarize partners with equipment, resources and procedures around spill response and implementing pre-determined booming strategies along a river. This is an opportunity for new people to learn about MWERS and for people already familiar to increase their response skills. These drills also test the pre-determined response strategies, which are then updated based on lessons learned from the drill. The new online system will allow for these updates to occur during the spill debrief with input from the drill participants to ensure these strategies are reflective of actual conditions in the field.

6.1.3 Background

In 2001, EWEB began working with McKenzie Fire & Rescue (MF&R) and Springfield Fire & Life Safety to engage nearly 30 different federal, state, and local agencies to understand and capture the existing trained personnel, equipment, GIS data, and other systems that were in place for spill response and identify gaps. It was clear from the identified gaps that first responders did not have the equipment or training to participate in an MWERS type system for a coordinated response. EWEB and MF&R were successful in getting a number of federal grants totaling over $500,000 to purchase spill response and personal protective equipment, laptops, GIS software, trailers and conduct 3-day trainings for MWERS participants on response strategies and fast water boom placement techniques. At the same time, EWEB worked with a contractor to build the MWERS desktop GIS application.

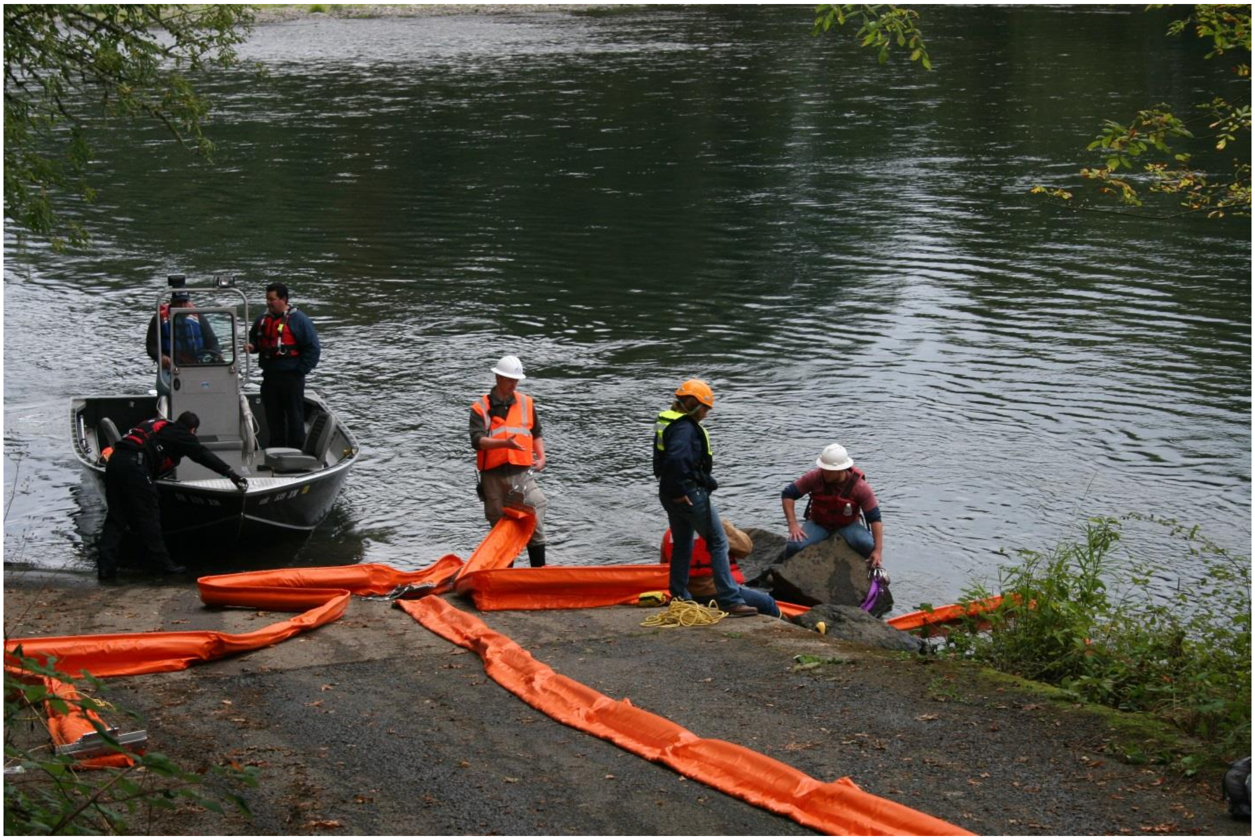
The McKenzie Watershed Emergency Response System (MWERS) is used by incident commanders to quickly gain access to crucial information, equipment, and trained personnel allowing for an effective response to emergency incidents. However, due to changing software technology, the desktop application is now out-of-date and in need of replacement (see above).

In addition to providing crucial information through a software system, an important component of EWEB's approach to watershed emergency planning is raising the level of preparedness among all partner agencies through training and by conducting drills together. EWEB has coordinated bringing in experts to conduct the following training for partner agencies:

- Incident Command System (ICS)
- Oil on Water Response Tactics
- HazMat Awareness
- HazMat Operations
- HazMat Incident Response Tactics
- Fast Water Spill Response Tactics
- Basic GIS Training

These training courses not only increased preparedness and heightened awareness of HazMat issues, but also brought together participating agencies and allowed them to understand each other's roles, build trust and working relationships, and better understand what resources/expertise each agency could bring to an incident.

EWEB organizes drills at least once a year to test pre-determined spill response strategies along the McKenzie River.



MWERS partners preparing for boom deployment during a drill.

6.1.4 Outreach

Before a drill is conducted, EWEB and partners do outreach to local stakeholders who may be affected, such as the McKenzie Guides, and make sure to have safety measures in place to alert nearby boaters during the drill. Lane County Sheriff positions jet boats upstream to warn boaters of the drill and help them navigate the booms and lines in a safe manner. Press releases are also sent out ahead of these interagency drills and in the past TV coverage has provided some good outreach to customers and county residents about this coordinated effort to protect Eugene's drinking water source.

6.1.5 Current and Potential Partners

The following agencies have supported the development of MWERS:

- Army Corps of Engineers
- Eugene Fire and EMS
- Lane Council of Governments
- Lane County Public Health
- Lane County Public Works

- Lane County Sheriff
- McKenzie Fire and Rescue
- Mohawk Rural Fire
- Oregon Department of Environmental Quality
- Oregon Department of Transportation
- Oregon Fish and Wildlife
- Oregon Health Division
- Oregon State Police
- Rainbow Water District
- Region 2 HazMat Team
- Springfield Fire and Line Safety
- Springfield Environmental Services Division
- Springfield Public Works
- Springfield Utility Board
- Upper McKenzie Rural Fire
- U.S. Bureau of Land Management
- U.S. Forest Service
- U.S. Environmental Protection Agency
- Weyerhaeuser

6.1.6 Long Term Vision

EWEB has played a leadership role in establishing MWERS, maintaining and updating the GIS data and application, coordinating drills and trainings, and updating and replacing equipment in the three response trailers. The long term vision is for the key local first responders, such as McKenzie Fire & Rescue and Region 2 Hazmat, to take over tracking, maintaining, and replacing response equipment. We envision these partners becoming even more invested in MWERS, to the point where they are taking a leadership role in running drills and other training exercises. This transition has already started with the Region 2 HazMat team taking ownership of one response trailer and assisting in drill coordination.

EWEB will finish implementing the online web application and train users in 2017. EWEB will need to continue to support maintenance and updating of the online application over time. The long term vision for the online application is that EWEB enters into a public/private partnership with Mason Bruce & Girard (the company hired to develop the online application) and works with EPA and DEQ to expand use of this application for other watersheds in the Pacific Northwest. This will potentially provide a revenue stream to EWEB from royalties as the owner of the intellectual property for this innovative approach and web application that can be used in other watersheds as a platform for increasing more coordinated and effective response to spills and other emergencies. This potential revenue can be used to maintain and enhance MWERS over time.

6.1.7 Recommendations Going Forward

1) Finish developing, testing, and rolling-out the online application and train partners/responders (2017).
2) Develop public/private partnership agreement that provides royalties (payments) to EWEB when MB&G sales application to other water utilities or watershed stakeholders (2017-2018).
3) EWEB and MB&G have been invited to present the MWERS web application to EPA Region 10 and State (OR, WA, AK, and ID) emergency response managers in September 2017.
4) EWEB is also working closely with Salem water utility and partners to be one of the first utilities to purchase MWERS when ready for protection of the North Santiam watershed.
5) Continue to hold annual drills and trainings for partners (ongoing).
6) Update spill response strategies as needed (ongoing).
7) Update/replace response equipment as needed (ongoing).
8) Update GIS data on determined update schedule (i.e., emergency contact information and partner equipment inventories are annually updated, other data may be less frequent) (ongoing).

Semi loaded with dairy products overturned on Hwy 58 two miles west of Oakridge at mp 32

9) EWEB actively facilitates coordination meetings with other Willamette water utilities (Salem, Corvallis, Springfield, Tualatin, Hillsboro, Clackamas, etc.) every four months. Water utilities that draw water from the Willamette are interested in developing a more coordinated source protection approach for the entire Willamette basin. As a result, there may be opportunity to expand MWERS to the entire Willamette with funding from other downstream utilities.

6.1.8 Current and Future Funding

Current Funding

Current EWEB funding is going to support development of an online spill response application that expands functionality beyond the current PC-based MWERS application, conducting annual drills, and updating or replacing equipment on the response trailers. Table 6-1 summarizes current EWEB costs for MWERS.

Table 6-1: Summary of EWEB Non-Labor O & M Costs for MWERS (2012-2017)

EWEB Costs	2012	2013	2014	2015	2016	2017 Budgeted
Total O & M Costs	$24,000	$24,000	$25,000	$25,000	$70,000	$195,000

As indicated in Table 6-1, funding for MWERS has been fairly stable until 2016 with the ramp-up to update the GIS-based application to a fully-functioning online application. EWEB funding for development of the web application is coming from Geographics, Water, and Generation.

Outside Funding Opportunities

In the past, we've received over $500,000 in grant funds from Homeland Security, EPA, Oregon Emergency Management, and ESRI to buy response trailers, response equipment, GIS software, laptops, and to conduct multiple hands on trainings. EWEB and our partners will continue to engage these funding sources for training and drills in the future.

MWERS Spill Response Trailer

EWEB is working with MB&G to develop a public-private partnership that would allow MB&G to market the watershed emergency response online application to other water utilities and communities who want to protect their sources of drinking water from spills. EWEB would receive royalties on revenue MB&G makes as a result. If EWEB is successful with the Oregon GIS Enterprise grant proposal, this would provide opportunities for it to be a State-sponsored system for watersheds across Oregon. EWEB and MB&G also have plans to provide Region 10 EPA with a test drive of the online application in late 2017 to begin conversations about EPA use across the Pacific Northwest.

10-Year Funding Projection (2018-2028)

Future funding projections were made assuming initial investment in the online spill response application is completed in 2018 Annual cost assumptions also include online application maintenance costs, ArcGIS Online license fees, annual data updates to the system, training and drills, response equipment inventory and replacement costs, and development and updating of response strategies. From 2019 to 2028 it is anticipated that annual costs for the watershed emergency response system will be stable (see Table 6-2).

Table 6-2: Summary of EWEB Non-Labor O & M Future Costs for MWERS (2018-2028)

EWEB Cost	2018	2019	2020	2021	2022	2023	Average 2024-28
Total O & M Costs	$60,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
Revenue[1]		$15,000	$15,000	$15,000	$30,000	$30,000	$45,000

[1] – Anticipated revenue from royalties from public/private partnership associated with sale of the MWERS web application to other utilities.

Note: Table 6-2 does not account for other outside investments in MWERS from partners and/or grants.

6.2 Healthy Forests Clean Water

6.2.1 Purpose

EWEB recognizes that Forestry is a central land use in the McKenzie Watershed. In general, forested watersheds produce the best water quality when compared with other land uses. That being said, the McKenzie Watershed contains a substantial amount of industrial forest land, which carries with it the potential threats from chemical use and sediment running into tributaries and into the mainstem McKenzie River. EWEB would like to be proactive by working with private timber owners to reduce chemical use and increase buffers along streams wherever possible. The Healthy Forests Clean Water Program aims to increase the economic viability of forestry in the area while reducing chemical use and other potential impacts to the watershed from forestry activities.

In addition, the U.S. Forest Service owns approximately two-thirds of the land in the watershed. EWEB has been working with the Forest Service for years on activities designed to address water quality, wildfire risk, emergency response, riparian and floodplain restoration.

6.2.2 Current Status

EWEB is working on several forestry-related activities, which are described in more detail in the next section:

1) McKenzie Watershed Stewardship Group
2) Leaburg Forest
3) Pursuing Land Acquisitions and Conservation Easements
4) Establishing a carbon off-set market in the McKenzie

6.2.3 Background

McKenzie Watershed Stewardship Group

EWEB has been working with the Willamette National Forest and a number of local partners to initiate a 'stewardship contracting' group in the McKenzie watershed. Stewardship contracting allows the Forest Service to enter into long-term contracts to meet land-management objectives, such as reducing wildfire risk and improving forest health. Stewardship contracts on timber sales in the McKenzie watershed would allow the funds generated from the sale to remain in the watershed to fund other restoration work (such as culvert removal, riparian restoration, large wood placement, road decommissioning) instead of going to the General Treasury. This can support both forest restoration projects as well as local communities.

The McKenzie Watershed Stewardship Group (MWSG) meets monthly at EWEB. The group plans to produce periodic memos to send to the Forest Service with specific recommendations relating to upcoming stewardship sales, potential for new stewardship sales and/or recommendations for how to spend stewardship contracting retained receipts. This process has been tested and used as part of the first successful stewardship contract sold to Seneca Timber on the 7-Thin sale. This generated approximately $110,000 in retained receipts of which $30,000 is recommended to support Pure Water Partner program riparian restoration on private property. The group is now working on advising the USFS on stewardship contracts associated with the upcoming Green Mountain planning area.

The group is governed by an operating agreement
and meetings are open to the public.

Collaborative forest planning groups are common around Oregon and becoming more and more accepted as an effective way to work with the US Forest Service and accomplish more work on the ground. In particular, stewardship contracting can be a good potential source of funding for important restoration work on both national forest and private land. Stewardship contracting retained receipts are expected to be one source of funding for EWEB's Pure Water Partners program (see Section 7.3).

Leaburg Forest

The McKenzie Watershed is comprised of 88% forested land, with a mixture of public and privately-owned lands. Forested watersheds, like the McKenzie, produce better water quality than any other land uses. However, some forest management activities can adversely impact downstream water quality, including aerial application of pesticides, road building and failures, and various timber harvest techniques.

The EWEB Leaburg Forest is a patchwork of properties bordering the Leaburg canal and consisting of approximately 500 acres, of which over 350 acres are forested. The land was purchased in the 1920s during construction of the Leaburg hydro-electric project, largely to safeguard the canal from landslides. The forest was managed into the early 1970s by an EWEB contractor through selective harvests. Since the early 1970s, activity in the area has been limited to the removal of hazard trees.

As part of EWEB's annual dam safety inspection in 2014, the Federal Energy Regulatory Commission (FERC) required EWEB to submit a plan and schedule for the removal of hazard trees along the canal embankment to maintain dam safety.

Previous research into using the Forest as a local carbon offset marketplace concluded that without recent management to establish baseline conditions, this was not viable. However, there is an opportunity to improve forest conditions for fish and wildlife habitat (as required by the forthcoming Carmen Smith hydroelectric project FERC license), to mitigate fire and nuisance risks, provide education and recreation benefits, and maintain the stable slope conditions above the canal that are necessary for safe power generation.

In 2012, EWEB hired Sperry Ridge Forestry to conduct a timber cruise and natural resource survey of the Leaburg Forest. Results indicated over 13,000 MBF in merchantable timber averaging 37 MBF/acre, which is sequestering nearly 33 metric tons in carbon.

In 2016, EWEB hired Trout Mountain Forestry to develop a management plan for the Leaburg Forest to guide future activities on the property and demonstrate forestry practices that are protective of water quality and forest health. The plan is designed to meet multiple objectives, including sustainable timber harvest, clean water, soil stability, wildlife habitat and recreational opportunities. Trout Mountain will also work with EWEB in a public outreach process. The Leaburg Forest Management Plan was completed in December 2016.

The forest management plan includes conducting selective timber harvests every 5 years to maintain forest health, reduce wildfire risk, address hazard trees, obtain habitat goals associated with Carmen-Smith FERC license, and generate revenue for EWEB. The first harvest is planned for summer 2017 and includes removal of hazard trees along the canal to satisfy FERC dam safety requirements and a selective harvest on 63 acres of forest. It is anticipated that this initial harvest will generate approximately $350,000 in revenue. Project representatives will share more information with the EWEB Board about stakeholder and public engagement around the planned forestry activities.

If possible, revenue from any timber harvests conducted in the Leaburg forest would be used to fund forest management and watershed conservation. These funds could be directed under an existing agreement with the McKenzie Watershed Council to be combined with FERC Section 412/413 funds as required under the Leaburg/Walterville license that are targeted for land acquisition and conservation easements in the lower McKenzie watershed. These investments are prioritized by a technical team and leverage BPA and OWEB funds.

Carbon Offset Market
EWEB has been working with the City of Eugene to assess the viability of creating a local carbon sequestration offset market in the McKenzie watershed to help the City meet its mandate to be carbon neutral by 2020 (Climate Recovery Ordinance, 2014). In 2016, EWEB hired the Good Company to conduct a detailed analysis and "how-to" guide to establishing carbon offset markets that could leverage the riparian restoration and protection efforts being done through the Pure Water Partners program (see Section 7.3). The report illustrated the complexities and costs associated with third party verifiers and registration that precluded using lands that are less than 1000 acres or under multiple ownerships (Good Company, 2016). As a result there are two potential pathways for continuing this effort:

1. Design the carbon offset program to focus on industrial timber land. Acquire conservation easements to increase amount of forest retained as riparian buffers that is above and beyond what is required under the Oregon Forest Practices Act. In this way, one can clearly demonstrate that these trees were slated for harvest and are being protected for purpose of carbon sequestration, and it could include a large number of acres under single ownership (e.g., Weyerhaeuser).
2. EWEB and the City of Eugene could reach agreement that for the purposes of meeting the City's climate resolution mandate. The City can contract for carbon offsets without the need for onerous market verifications since the area under protection is local and readily available for monitoring and inspection. EWEB is in the process of acquiring a 180-acre parcel from Weyerhaeuser to support the Thurston substation expansion project. The excess acreage can be used to offset City carbon needs and provide a revenue stream for management of this land for carbon sequestration that also benefits source protection goals.

The establishment of a local carbon offset market that invests third party funds in the McKenzie watershed for forest protection and restoration has large upside potential. The market could be expanded beyond providing carbon sequestration to offset the City of Eugene needs to providing offsets to other government entities (EWEB, LTD, other cities, ODOT, etc.) as well as EWEB residential and business customers. This would provide EWEB customers the opportunity to offset their carbon through their local utility.

6.2.4 Regulations/Legislation

- Private timberlands are regulated by the Oregon Forest Practices Act.
- Stewardship Contracting was authorized by Congress in the 2014 Farm Bill.
- Carbon reduction goals and offsets per Oregon Senate Bill 101, City of Eugene Climate Recovery Ordinance, California Global Warming Solutions Act

6.2.5 Outreach

Cascade Pacific RC&D hosts the McKenzie Watershed Stewardship Group notes. EWEB has also shared information about the Leaburg Forest draft management plan at appropriate venues such as the stewardship group and the McKenzie Watershed Council. More outreach to the public around this project will occur as the project progresses and a communication plan and approach is developed with EWEB's Communications, Marketing and Research Department.

6.2.6 Current and Potential Partners

- U.S. Forest Service
- McKenzie Watershed Council
- McKenzie River Trust
- Upper Willamette Soil & Water Conservation District
- Oregon Wild
- Cascade Pacific RC&D
- Oregon Department of Forestry
- Whitewater Forests, LLC
- Bureau of Land Management
- City of Eugene
- East Lane Forest Protection Association

6.2.7 Long Term Vision

Forest owners in the McKenzie Watershed are aware of the connections between forest management activities and water quality and are working to reduce any potential negative impacts.

6.2.8 Recommendations

1) Continue participation in the McKenzie Watershed Stewardship Group
2) Continue to work with Generation and Trout Mountain to implement the management plan for the Leaburg Forest, and conduct outreach to McKenzie landowners and EWEB customers
3) Start to work with private non-industrial forest landowners where possible to implement Best Management Practices to reduce potential impacts to water bodies.
4) Work with OSU Extension to develop educational programs/public tours around Leaburg Forest
5) Continue to explore the possibilities of establishing a local carbon offset marketplace with the City of Eugene using EWEB's newly acquired parcel. Explore possibility of expanding the marketplace as we learn from the City project to include acquiring carbon offsets via increased riparian buffers on industrial timber lands.

6.2.9 Current and Future Funding

Current Funding

Current EWEB resources (staff hours and/or funding) are going to complete the Leaburg Forest Management Plan and public outreach component, support the McKenzie Stewardship

Contracting Group, assess the potential feasibility of a local carbon offset market, and engage with the ELFPA. Table 6-3 summarizes current EWEB costs for Healthy Forests Clean Water program.

Table 6-3: Summary of EWEB O&M Non-Labor Costs for Healthy Forests (2012-2017)

EWEB Costs	2012	2013	2014	2015	2016	2017 Budgeted[1]
O & M Costs	$14,000	$30,000	$16,000	$20,000	$29,000	$27,000

[1] – Contractor and logging costs not included since paid for by timber receipts from sale. Net revenue minus contractor and logging costs is estimated to be $400,000. .

As indicated in Table 6-3, funding for the Healthy Forests Clean Water program has fluctuated from $45,000 to $65,000 as EWEB conducted a timber cruise, developed management and timber harvest plans, and used consultants to assess carbon market potential. As noted, selective harvest is scheduled for July 2017 that will generate approximately $400,000 in revenue. EWEB staff time for the Leaburg Forest planning effort included Property, Source Protection, Environmental, Generation, Engineering, Surveyors, and Public Affairs.

Outside Funding Opportunities

Outside grant funding opportunities would mainly involve potential funding of local carbon market development and Leaburg Forest education components with OSU Extension Service. The Healthy Forests Clean Water program is designed to generate revenue for EWEB from selective timber harvests every 5 years, and potentially from future carbon offset credits with the City of Eugene. USFS retained receipts will generate revenue for watershed restoration on the Willamette National Forest and through the Pure Water Partners program on private lands along the McKenzie River and its tributaries.

10-Year Funding Projection (2018-2028)

Future funding projections were made to continue managing the Leaburg Forest, support the McKenzie Stewardship Contracting Group (participation, facilitation, and monitoring), and work with the City of Eugene to ;pilot and if successful develop a carbon-offset program.

Table 6-4: Summary of EWEB Future Costs for Healthy Forests (2018-2028)

EWEB Cost	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
O & M	$5,000	$5,000	$10,000	$10,000	$20,000	$20,000	$20,000	$20,000
Revenue					**$400,000**			**$133,000**

6.2.10 Other Engagement with Forest, Industry

EWEB actively participates with and is a Board member of the East Lane Forest Protection Association (ELFPA). The ELFPA manages forest protection funds from an assessment on private forested lands to pay for wildfire protection through the Oregon Department of Forestry (ODF). EWEB's forested lands are assessed this fee each year and EWEB participates on the ELFPA Board of Directors to ensure adequate coordination and response to wildfires in the McKenzie. Participation in this association has provided an opportunity to understand State and Federal priorities and capacity to respond to wildfires. It is clear that ODF and the Willamette National Forest have a well-coordinated and effective response to wildfire on public and private forest lands. Industrial timber landowners play a key role in maintaining this unique well-coordinated approach to wildfire management.

6.3 Urban Runoff

6.3.1 Purpose

To actively work with local government partners and private landowners to employ pollution prevention measures while establishing treatment buffers between stormwater outfalls and the McKenzie River, and other future water sources.

6.3.2 Current Status

Springfield Collaborative Wetland Enhancement Project

One current project in the planning stages is the Springfield Collaborative Wetland Enhancement Project, which involves the City of Springfield's 48th Street stormwater channel, located just upstream from the confluence of Keizer Slough and the McKenzie River. EWEB has received two $30K grants from the Oregon Health Authority to do some survey work and invasives removal in the channel, as well as design work around enhancing the water treatment capacity of this channel. The concept is to design a simple weir structure and do some regrading and replanting work to effectively slow down the normally flashy stormwater flow, treat pollutants via infiltration and vegetative uptake, and act more like a functional wetland (see Section 4.3 for list of contaminants found in the 48th Street Stormwater cannel).

EWEB has recently hired an engineering firm to finalize the designs and manage construction for this project.

Partners on the project include the City of Springfield, Springfield Utility Board, Rainbow Water District, Oregon Department of Transportation and International Paper.

Source Tracking

EWEB and the City of Springfield have begun a partnership to do some joint monitoring and source tracking for runoff from a handful of city stormwater outfalls. The purpose of source tracking is to determine whether bacteria is coming from humans, domestic animals, or wildlife in order to better focus outreach and protection efforts to improve water quality (see Section 5.4).

Pollution Prevention Coalition

The Lane County Pollution Prevention Coalition (P2C) is a cooperative effort between the City of Eugene, City of Springfield, Lane County, Eugene Water & Electric Board (EWEB), Springfield Utility Board (SUB), Lane Regional Air Protection Agency (LRAPA), and the Oregon Department of Environmental Quality (DEQ).

P2C works together to provide pollution prevention information and some technical assistance to citizens and businesses in Eugene, Springfield and Lane County. P2C supports Ecobiz, a program to recognize auto businesses who are engaging in practices that minimize their environmental impact. Past projects involving multiple P2C partners include a Drug Take Back Event, Rehab the Lab (a program to remove outdated and unwanted chemicals from school labs), and an agricultural chemical collection event. See http://www.lanep2c.org/ for more information.

6.3.3 Background

EWEB's risk assessment conducted in 2000 identified urban runoff as one of the highest threats to the drinking water quality of the McKenzie River. EWEB routinely monitors the five major City of Springfield stormwater outfalls which empty into the McKenzie (or Keizer Slough) just upstream of EWEB's drinking water intake. These locations have consistently had elevated levels of nutrients, bacteria, metals and other contaminants when compared with other baseline monitoring sites throughout the watershed. EWEB has been working to identify and take advantage of opportunities to partner on projects to reduce the impacts of these outfalls and developed areas.

Several years ago students at Thurston High School were involved in a project to monitor bacteria levels in the 69th St basin in Springfield and conduct outreach to residents around cleaning up dog poop in order to improve the water quality in that area. The student effort informed a larger City of Springfield effort that led to increased signage and poop bag dispensaries along 72nd and 69th Stormwater green spaces where residents tend to walk their dogs. Bacteria levels remain elevated in 69th Street stormwater effluent and bacteria source tracking continues to point to dog feces as a strong contributor to this problem (see Section 4.3).

The City of Springfield has a Stormwater Management Plan (SWMP) and Total Maximum Daily Load Implementation Plan (TMDL IP) that were developed to provide policy and management guidance for activities affecting stormwater throughout Springfield and its urbanized area. They are intended to help fulfill certain State and Federal water quality requirements, and to meet local water resource management objectives. The Federal Clean Water Act requires Springfield to apply for and maintain a Municipal Separate Storm System (MS4) permit under the National Pollutant Discharge Elimination System (NPDES) program. Springfield's first MS4 NDPES Permit was issued in 2007 and its first TMDL IP Plan approved by the Oregon DEQ in 2009.

Both regulated programs require Springfield to demonstrate efforts to reduce pollution in urban stormwater "to the maximum extent practicable" in protecting beneficial uses of State waters, including drinking, recreation and fish habitat. Springfield spends an average of $2.5 million for capital improvement projects to upgrade and provide treatment for its piped and open channel storm system and approximately an average of $3 million to maintain, provide education and outreach, provide enforcement, and implement best management practices in demonstrating efforts to reduce pollution in urban stormwater and to address specific requirements under the MS4 Permit and Willamette Basin TMDL. EWEB has and will continue to partner with the City on urban runoff projects that can benefit both agencies.

EWEB has also helped to fund bioswales at the Child Care Center located just above EWEB's drinking water intake to treat and route stormwater away from the intake area.

Until recently, EWEB contributed funds to Oregon Industrial Lumber (OIL) to help defray some of the annual maintenance costs associated with its parking lot drain treatment inserts. OIL installed a small wetland that also receives runoff from the parking area flowing to the west, allowing some treatment before discharging to the roadside ditch.

Future Projects

42nd St Stormwater Channel Diversion to Q Street
EWEB is also interested in working with City of Springfield to consider re-routing runoff from the 42nd St stormwater channel to Irving Slough at all times of the year (currently it follows into Keizer Slough and then into the McKenzie River during the wetter part of the year). Downstream development needs to go in first to accommodate the additional flows.

Keizer Slough Wetland Enhancement
Opportunities may exist to enhance wetland function in the Keizer Slough area to help treat pollutants before they enter the McKenzie River upstream of the Hayden Bridge water treatment plant. Keizer Slough is slowly silting in due to International Paper relocating their industrial water intake to the McKenzie River, eliminating the need to dredge Keizer Slough.

Cedar Creek Treatment
Cedar Creek receives stormwater runoff from 72nd, 69th, and 64th Street outfalls. EWEB is currently in negotiations to purchase a 183-acre parcel from Weyerhaeuser to accommodate the Thurston substation expansion project. The property encompasses the confluence area of Cedar Creek and the McKenzie. Given that the substation needs are confined to 10-acres, there is opportunity to develop additional wetland capacity in the confluence area to buffer and treat pollutants from urban runoff. EWEB is currently evaluating the potential for such a wetland project to generate wetland mitigation bank credits that EWEB could capitalize on and create revenue from.

6.3.4 Current and Potential Partners

- City of Springfield

- International Paper
- Oregon Department of Transportation
- Springfield Utility Board
- Rainbow Water District
- University of Oregon Landscape Architecture Department
- Weyerhaeuser Company
- McKenzie Watershed Council
- McKenzie River Trust
- Willamalane Parks
- City of Eugene
- Lane County

6.3.5 Recommendations Going Forward

1) Continue to work with partners (outlined above) to construct the completed designs for enhancing an existing wetland to treat urban runoff from the $48^{th}/52^{nd}$ street stormwater basin prior to it entering Keizer Slough. Design for the new wetland and upstream trash rack are nearly complete.
2) Design and develop a treatment wetland at the confluence of Cedar Creek and the McKenzie River to buffer urban runoff from 72^{nd}, 68^{th}, and 64^{th} street stormwater basins. This wetland project would happen after EWEB purchases the property as part of the Thurston substation expansion project. The wetland project could be used as a wetland mitigation bank that provides a revenue stream to offset expenses.
3) Work with the City of Springfield to route 42^{nd} Street runoff away from Keizer Slough once downstream development allows for more flow through the Q Street channel.
4) Continue to actively participate in the multi-agency group, Lane County Pollution Prevention Coalition, to partner on projects that are of interest to multiple agencies and which reduce pollutants in urban runoff by preventing the use of more toxic chemicals in the first place.

6.3.6 Current and Future Funding

Current Funding

Current funding is going towards EWEB staff time to bring project partners together, apply for outside funding, and manage the contract to develop designs to control urban runoff.

Table 6-5: Summary of EWEB Non-Labor O&M Costs for Urban Runoff Mitigation (2012-2017)

EWEB Costs	2012	2013	2014	2015	2016	2017 Budgeted
O & M	$10,000	$10,000	$10,000	$10,000	$39,000	$35,000

Outside Funding Opportunities

The City of Springfield is a good partner who can provide funding and expertise to projects. Most recently, we worked with Springfield to partner on the above-mentioned wetland enhancement project where they contributed funding toward the design of a trash rack above the proposed wetland enhancement area. They are interested in working together on stormwater improvements as part of their required activities under the MS4 permit.

Grant funding may include Oregon Drinking Water Protection grants (Oregon Health Authority) and Oregon Department of Environmental Quality 319 Grants. In addition, the creation or enhancement of wetland areas might qualify to become wetland mitigation bank credits that EWEB or other agencies/organizations can use for mitigation requirements.

10-Year Funding Projection (2018-2028)

From 2019 to 2028 it is anticipated that annual costs for the urban runoff program will be stable (see Table 6-6).

Table 6-6: Summary of EWEB Future Non-Labor O&M Costs for Urban Runoff (2018-2028)

EWEB Cost	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
O & M	$180,000	$180,000	$90,000	$90,000	$70,000	$50,000	$50,000	$50,000
Revenue						$25,000	$50,000	$50,000

6.4 Chemical Collection

6.4.1 Purpose

EWEB and several local partners have worked together to create opportunities for farmers to get rid of their old, unused, or unwanted pesticides and fertilizers free of charge, with no questions asked. EWEB recognizes the risk of having these chemicals stored within the watershed and potentially within flood-prone areas.

6.4.2 Current Status

EWEB and partners have held two agricultural chemical collection events over the last ten years in (2006 and 2012) that removed 44 tons and 13,000 lbs, respectively, of unwanted chemicals for proper disposal via incineration. EWEB would like to continue to work with partners to hold these chemical collection events every 3-4 years in order to encourage the removal of unnecessary chemicals from the watershed.

6.4.3 Background

Back in 2006, EWEB received a grant from the Governor's Fund for the Environment to create a chemical collection event for area farmers. EWEB worked with Lane County Waste Management, Springfield Utility Board, OSU Extension Service, McKenzie Fire, Region 2 HazMat team and Oregon DEQ to hold a series of events in late 2006/early 2007 for farmers in the McKenzie and Middle Fork Willamette Watersheds. The event was well received and almost 44 tons of chemicals (including pesticides, fertilizers, waste oil, solvents, and other chemicals) were collected during this time, including many that were no longer legal to use.

These same partners conducted another smaller event in 2012 to continue to provide this needed opportunity to farmers.

Agricultural Chemical Collection Event, 2006

6.4.4 Current and Potential Partners

- Lane County Waste Management
- Springfield Utility Board
- Oregon Dept of Environmental Quality
- McKenzie Fire
- Region 2 HazMat Team
- OUS Extension Service
- Upper Willamette SWCD

6.4.5 Recommendations Going Forward

Consider working with local partners to put on chemical collection events every three-four years to address continuing needs to dispose of hazardous chemicals that are no longer being used.

6.4.6 Current and Future Funding

Current Funding

EWEB is not currently engaged in any upcoming collection events, but if a farmer wants to dispose of old chemicals, EWEB will provide funding to cover this on a case-by-case basis.

Outside Funding

Outside funding sources are harder to come by now that agricultural chemical collection events are happening all over the state and are no longer considered 'innovative.' However, EWEB can still work with other local agencies (such as Lane County Waste Management), who can contribute in-kind labor and/or cash to make a collection event happen on a more regular basis. The last event EWEB participated in was in 2012.

10-Year Funding Projection (2018-2028)

EWEB anticipates running a well-coordinated multi-day chemical collection event with key partners for McKenzie farmers every three years. Table 6-7 summarizes anticipated costs for running three chemical collection events over the next ten years (2018 to 2028). It is anticipated that costs for the Chemical Collection Program will be as follows (see Table 6-7).

Table 6-7: Summary of EWEB Future Non-Labor O&M Costs for Chemical Collection Events (2018-2028)

EWEB Cost	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
O & M	$16,000	$0	$0	$16,000	$0	$0	$16,000	$5,300

6.5 Illegal Camping

6.5.1 Purpose

To coordinate with local agencies and organizations around the identification, tracking and cleanup of illegal camps located along waterways and to share resources and expertise for a more effective response to the growing problem.

6.5.2 Current Status

EWEB works with the Willamalane Parks, City of Springfield, Lane County, Willamette Riverkeepers and a host of other partners to schedule, plan, and coordinate volunteer cleanup events of abandoned illegal camps along the McKenzie and Willamette Rivers a couple times a year. In 2016, EWEB funded the development of a web application to better coordinate illegal camping activity and response between volunteer cleanup events (http://laneillegalcampcleanup.org/). The web application was developed and is maintained by LCOG and was recently upgraded to allow email notifications to property owners when camps have been identified on their tax lots. The email notifications only go to those landowners we have email addresses for (all local agencies, large landowners, railroad, etc.). In addition, LCOG sends weekly summaries of illegal camping activity in the area to an email listserve that includes nearly 100 individuals from a large cross-section of agencies, organizations, and businesses. Over 150 illegal camps have been located and tracked from identification to cleanup since the web application went live in April 2016. The City of Eugene has its own illegal camp tracking system that includes 800-900 camps a year. In 2017, EWEB agreed to host two large meetings a year in March and October to bring together all the key partners to coordinate efforts, make adjustments and evolve together to more effectively respond to illegal camping activities.

EWEB Source Protection, Property Management, Security, Vegetation Management, and Facilities groups have developed a process for quickly and efficiently responding to illegal camping activities on EWEB-owned properties. A contractor is used to clean up debris and biohazards after EWEB Security has notified the occupants that camping is not allowed and provided them with an opportunity to remove their personal belongings. Since this coordinated process was established in spring 2016, 172 illegal camps have been identified and cleaned up.

6.5.3 Background

For the last 6-7 years, EWEB actively organized and participated in volunteer abandoned camp cleanup events in the lower McKenzie upstream of our intake. These events happened a couple times a year and yielded over 20 tons of foul smelling garbage and debris that included biohazards and some hazardous materials. However, within weeks of these volunteer events, new illegal camps would show up in the same areas recently cleaned up. In 2015, EWEB began hosting large coordination meetings among all the partners to discuss how to do a better job addressing this growing problem. These efforts lead to the development of the illegal camping web application developed and hosted by LCOG. This has also led to better tracking of illegal camping activity to identify problem areas and help partner agencies and EWEB to take care of illegal camps before they become established. It was determined that if you can respond to the camps shortly after they are identified, it will be much cheaper to clean up the garbage and debris. The problem still continues to be camps located on private lands (International Paper, railroad right-of-ways, etc.). In 2016, EWEB Safety assessed the risks/exposure of EWEB staff participating in these cleanups to biohazards and other safety concerns and determined that the safety risks were too great to allow participation while on EWEB time.

6.5.4 Current and Potential Partners

- Lane County Waste Management
- Lane County Sheriff
- Willamalane Parks
- Oregon State Parks
- Friends of Buford Park
- Willamette Riverkeepers
- City of Springfield
- City of Eugene
- McKenzie Guides
- International Paper
- Upper Willamette SWCD
- Springfield Utility Board
- Oregon Dept. of Fish & Wildlife
- Lane Council of Governments

6.5.5 Recommendations Going Forward

There are a number of things that EWEB could focus looking forward to reduce illegal camp impacts immediately upstream of the Hayden Bridge intake. Willamalane Parks owns a large part of the land immediately upstream of the Hayden Bridge intake that consists of side channels and small islands attracting illegal camping activity. International Paper owns land upstream of the Willamalane property that consists of a strip of land along the McKenzie River where flows enter Keizer Slough, which has also been a problem for reoccurring illegal camping activities (see Figure 6-1). Willamalane does regular sweeps of their property in coordination with Springfield Police to serve notice to illegal camps to move-out flowed by cleanup of trash and debris. International Paper is less proactive in patrolling and cleaning up illegal camps on their property. To address this problem the following actions are recommended:

1. Continue support for and use of the LCOG illegal camp identification web application and annual partner coordination meetings;
2. Continue EWEB's Property Management/Security efforts to efficiently identify and remove illegal camps from EWEB owned land;
3. Use EWEB staff to supplement Willamalane staff in order to increase frequency of patrols. EWEB staff would coordinate with Willamalane to conduct weekly patrols of the Willamalane park area with the use of a drone to assess camping activities on islands that are often missed during vehicle and foot patrols;
4. Provide support to Willamalane for use of boats in cleanup efforts and to bring in hazmat cleanup contractor as needed; and,
5. Work with International Paper (IP) and McKenzie River Trust to acquire the portion of land IP owns along the McKenzie River to allow more proactive management of this area to discourage illegal camping activities.

6.5.6 Current and Future Funding

Current Funding

Current funding is going towards EWEB staff time to coordinate volunteer cleanup events, facilitate meetings, manage contracts, and coordinate cleanups with key partners (Willamalane, Springfield, Lane County, and International Paper) on public and IP lands immediately above EWEB's intake. O & M costs include design, development and maintenance of the illegal camping web application, and cleanup and disposal costs (see Table 6-8).

Table 6-8: Summary of EWEB Non-Labor O&M Costs for Illegal Camping Mitigation (2012-2017)

EWEB Costs	2012	2013	2014	2015	2016	2017 Budgeted
O & M	$5,000	$7,000	$10,000	$10,000	$18,000	$18,000

Outside Funding

Outside funding sources are hard to come by for illegal camp cleanups due to the problem being wide-spread across communities and cities. However, EWEB is working with a number of partners who contribute significant resources (staff time, sheriff prison crews, boats, disposal, and funding). EWEB anticipates increased sharing of resources to fund all aspects of illegal camp tracking and response efforts as the agencies and organizations continue to coordinate and work together.

10-Year Funding Projection (2018-2028)

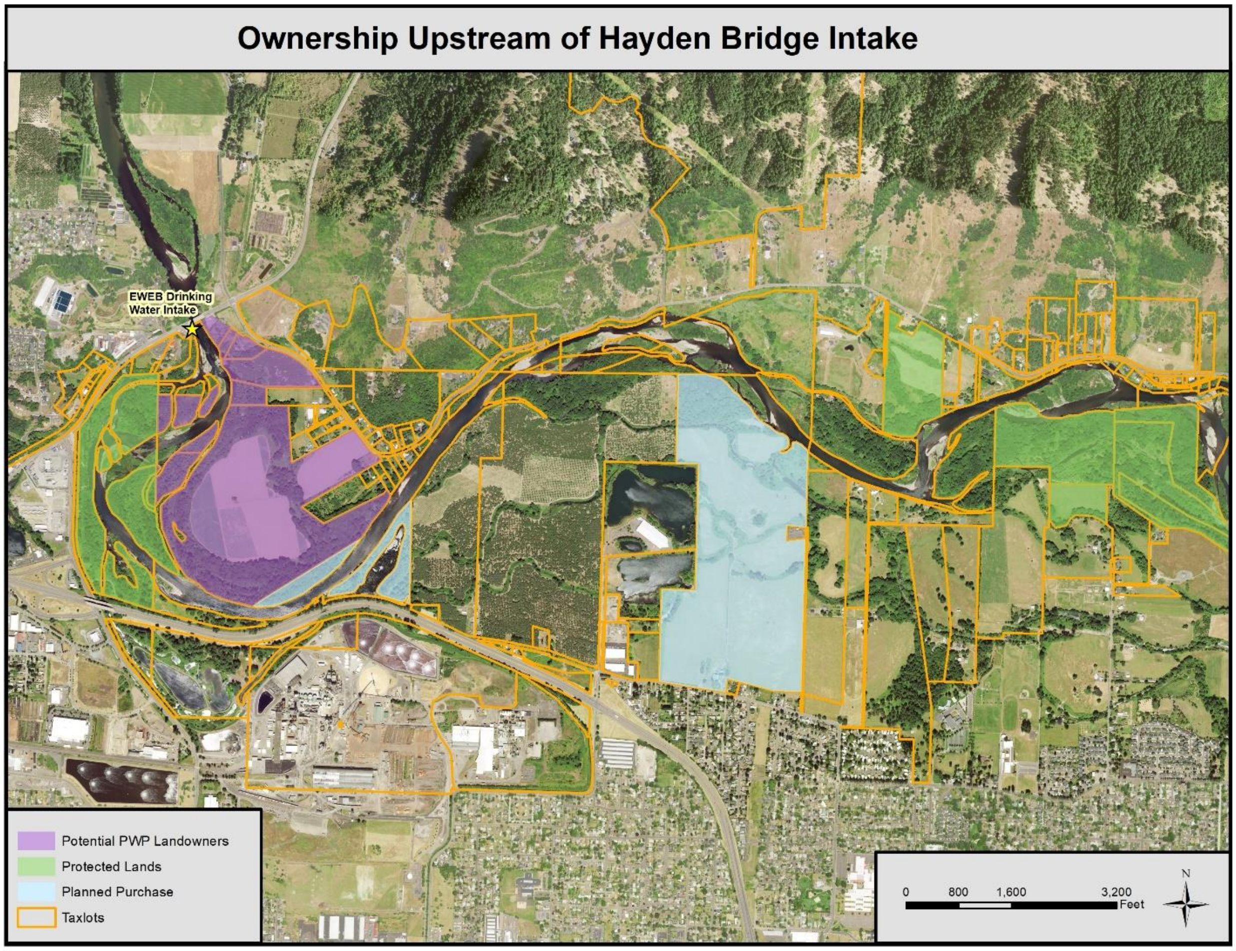
EWEB anticipates continuing to share funding for maintaining and updating the web application, weekly reporting of illegal camping activity, coordinating periodic volunteer cleanup events, and participating in more frequent agency-led cleanup efforts based on illegal camp activity levels. IN addition, more focused efforts will be conducted in close coordination with Willamalane to increase frequency of patrols immediately upstream of the Hayden Bridge intake and to acquire IP property allowing more proactive management of this area (see Figure 6-1). Table 6-9 summarizes anticipated costs for actively participating and supporting regional illegal camping tracking and response efforts with partner agencies and organizations over the next ten years (2018 to 2028).

Table 6-9: Summary of EWEB Future Non-Labor O&M Costs for Illegal Camping Mitigation (2018-2028)

EWEB Cost	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
O & M	$18,000	$18,000	$18,000	$18,000	$20,000	$20,000	$20,000	$20,000
Capital[1]	$100,000							

[1] – Capital funds used to acquire IP property.

Figure 6-1: Focus Area for Illegal Camping Mitigation above Hayden Bridge Intake



7.0 INCENTIVE PROGRAMS

7.1 Septic Systems

7.1.1 Purpose

EWEB's Septic System Assistance Program (SSAP) is meant to encourage homeowners to proactively maintain their septic systems by providing them with financial assistance. Our hope is to both prevent septic systems from failing and releasing untreated wastewater into waterbodies or groundwater as well as to educate homeowners around the importance of proper system maintenance and the connection to water quality.

7.1.2 Current Status

Since EWEB began its Septic System Assistance Program (SSAP) back in 2008, over 650 septic systems have been inspected and pumped. EWEB's program currently consists of two components:

1) ***Cost-share program:*** This program provides a 50% cost-share for McKenzie homeowners to have their septic systems inspected and pumped out, if needed. Since the cost-share program began in 2011, over 230 septic systems have been inspected and pumped with, over 50 needing some type of repair. Under the EWEB SSAP, two-thirds of these systems needing repair were fixed. Minor repairs up to $300 are covered under this effort. Homeowners are eligible for this assistance once every three years. Homeowners have contributed over $50,000 toward their share of program cost and feedback around this program has been extremely positive.

2) ***Zero-interest loan program:*** This program allows homeowners who need to make major repairs or replace their septic tank or drainfield to apply for a zero-interest loan of up to $10,000 from EWEB. We have issued 7 loans through this program. Several inquiries have been made about the program, so we anticipate additional loans in the future. A number of homeowners on fixed income were not able to afford taking out a loan and requested substantial grant or other financial assistance, which EWEB was not able to accommodate.

EWEB tracks and manages participant inspection, pump-out, repair, and collects data via an Access database and in GIS. See www.eweb.org/septic for more information.

7.1.3 Background

Approximately 4,200 homes in the McKenzie River Watershed upstream of EWEB's drinking water intake at Hayden Bridge rely on septic systems to dispose of their wastewater and sewage.

A typical septic system uses a tank to capture solids and a subsurface drainfield where liquid waste is allowed to percolate through the soil, which acts as a natural filter. According to the EPA, approximately 10 to 25% of septic systems fail, often releasing untreated wastewater into the underlying groundwater and/or nearby surface water (EPA, 2004).

Installation of a septic system in the McKenzie Watershed.

While EWEB's water-filtration plant is designed to continually treat the raw water from the McKenzie River, increases in contaminants from failed septic systems could result in increased water treatment costs, reduced drinking water quality and taste, and potentially increased production of disinfection by-products.

2008-2009 Grant Program

EWEB received $88,000 in grant funds from the Oregon Department of Environmental Quality and U.S. Environmental Protection Agency Safe Drinking Water Program to implement a septic system assistance project for McKenzie residents. This project consisted of education and outreach to homeowners regarding septic system maintenance, free septic system inspections and/or pump-outs, water quality monitoring, and strengthening partnerships for future projects.

In the first year, the project targeted those homes that were considered to be high risk: clustered together with other homes in an area, located close to the river, and located in permeable soils. The following year, the project was expanded to homes in Camp Creek Watershed as well as to homeowners directly upstream of EWEB's drinking water intake.

Highlights from the project included inspecting 439 septic systems in the McKenzie Watershed and pumping 108. Fifty-five systems were found to be failing in some capacity and follow up was encouraged. Septic system educational booklets were sent out to over 400 residents in higher risk areas. In addition, staff captured the inspected systems in GIS and we maintain an Access database with records of participation in the program.

Monitoring

Some limited monitoring upstream and downstream of septic system clusters indicated increasing levels of nutrients and *E. coli* in the downstream direction (EWEB, 2006; EWEB, 2009). In addition, limited shallow groundwater monitoring was conducted which uncovered some instances of *E.coli* contamination in well water. More general water quality monitoring over the years has occasionally uncovered low levels of pollutants which are indicators of potential septic system contamination, such as caffeine and pharmaceuticals.

Blue River Community Treatment Project

The community of Blue River is an economically depressed area where development is currently limited by the lack of a community wastewater treatment plant. Over the last several years, members of the community, with financial assistance from EWEB, have conducted an engineering feasibility study to examine alternatives for enhanced wastewater systems that would allow more businesses to open within the community, provide existing residences with a solution to their failing septic systems and preserve the water quality of adjacent river systems. Lane Community College interns have also worked on this project, doing research on the process that might be required as well as holding a public meeting. The effort subsided for a while, but has been picked up by the newly-formed McKenzie River Action Team. There are a number of issues that need to be addressed, mainly revolving around planning/zoning regulations. In addition, community residents have indicated that they cannot afford this system without significant grant assistance.

7.1.4 Septic System Regulations and Recent Legislation

Regulations

Lane County is responsible for implementing DEQ's onsite program. The County is in charge of permitting new septic systems. However, there is really no enforcement or follow-up to ensure that systems are being properly maintained once they are put in. The one exception is for alternative systems, which require signing a contract that includes annual maintenance checks.

New Inspection Form Regulations

In 2013, the Oregon Department of Environmental Quality issued new regulations around septic system inspections and who could perform them, and now requires all companies performing inspections to fill out a standard 8-page document called an *Existing System Evaluation Report*. Homeowners can decline to have companies conduct all portions of the inspection, but blank sections need to be explained and documented. Best Septic, the company that has done over 90% of the inspections/pump-outs in our program (of their own initiative), pushed back against this requirement and wanted to charge homeowners quite a bit more for an inspection due to the extra paperwork. Since our program requires only a subset of items to be inspected, we eventually came to an agreement with Best Septic that they would charge homeowners a nominal $35 fee to fill out the DEQ form if the homeowner wanted to participate in the EWEB cost-share program. Nevertheless, this new regulation really slowed down Best Septic's marketing push in the McKenzie and subsequently did affect the number of participants in our program. We believe this was a contributing factor for the slowdown in the number of people applying for the program since 2013. However, activity has recently picked up again and we continue to receive a constant stream of reimbursement requests.

The septic system assistance program has created a lot of goodwill among participating residents.

Recent Legislation

EWEB has been involved in the Oregon Department of Environmental Quality's efforts to pass legislation requiring time of transfer septic system evaluations. However, a recent constitutional amendment passed in the state that restricted DEQ's ability to require reporting fees. EWEB continues to stay abreast of any septic system legislation proposals and supports rules that would be protective of drinking water quality.

7.1.5 Outreach

We have created a septic system maintenance brochure that explains the basic operation of a septic system, how to properly maintain it, why EWEB developed this program and other resources that are available to homeowners who want more information (http://eweb.org/public/documents/water/septicSystemMaintenance.pdf). These brochures are mailed out to all homeowners who participate in our program. In addition, EWEB continues to advertise the assistance program a couple of times a year in the McKenzie River Reflections, discuss it in presentations around source protection work, and use other methods of contact with landowners (such as the Pure Water Partners Program) as a way to inform people about and promote the program.

For septic system inspections that indicated a failing of the system that was not immediately addressed at the time of the pump out, EWEB follows up with the homeowner to make sure they understand what assistance is available to them ($150 reimbursement for small repairs under the cost-share program; up to $10,000 zero-interest loan program).

7.1.6 Current and Potential Partners

- Department of Environmental Quality
- Lane County Land Management (onsite program)
- Local septic system companies
- Realtors
- Springfield Utility Board (Middle Fork Watershed)

7.1.7 Long Term Vision

Homeowners in the McKenzie Watershed are aware of the importance of septic system maintenance not only to water quality, but also to their health and property values. Homeowners understand how their systems work at a basic level and have them inspected regularly to avoid problems/failures.

7.1.8 Recommendations Going Forward

1) Continue to fund the cost-share program, at an annual rate of at least $20K.
2) Continue to fund the zero-interest loan program, but consider using some of the set aside funding to provide loans to farmers to enable them to conduct projects which protect water quality (see Healthy Farms Clean Water, Section 7.2).
3) Consider some type of small grant program to assist low or fixed income homeowners who cannot afford to make repairs even with the zero-interest loan program.
4) Increase outreach to owners of systems that need repairs.
5) Continue to track and engage with rural unincorporated communities (e.g., Blue River) and their efforts to develop community wastewater treatment systems to eliminate individual septic systems in higher density areas.
6) Continue to track and engage in new legislation that relates to septic system reporting, maintenance and repair and evaluate any opportunity to require inspections at time of sale.

7.1.9 Current and Potential Funding

Current Funding

EWEB staff currently administers the Septic System Assistance Program with an annual budget of $20,000 for the cost-share program and an initial pool of $100,000 from reserves for the zero-interest loan program, established back in 2011 (See Table 7-1).

Table 7-1: Summary of EWEB Non-Labor O&M Costs for Septic System Assistance Cost-Share Program (2012-2017)

EWEB Costs	2012	2013	2014	2015	2016	2017 Budgeted
O & M	$10,000	$10,000	$20,000	$20,000	$20,000	$20,000

Outside Funding

Outside funding sources are harder to come by now that the program is established. Other funding options are not currently available and this program is best suited for the use of EWEB funding.

10-Year Funding Projection (2018-2028)

From 2018 to 2028 it is anticipated that annual costs for the septic system cost-share program will be stable (see Table 7-2). However, we are recommending shifting some of the base funding for the zero-interest loan program to be available to farmers under Healthy Farms Clean Water (see Section 7.2.8 below).

Table 7-2: Summary of EWEB Future Non-Labor O&M Costs for Septic System Assistance Cost-Share Program (2018-2028)

EWEB Cost	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
O & M	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000

7.2 Healthy Farms Clean Water

7.2.1 Purpose

The purpose of the Healthy Farms Clean Water (HFCW) program is to both protect the water quality of the McKenzie River and increase the economic viability of farmers. EWEB recognizes that farms are a critically important resource in the McKenzie Watershed and a preferred floodplain land use to subdivisions and other types of development close to the river.

7.2.2 Current Status

EWEB supports local farms by offering a variety of incentives, including:

- Free soil and leaf sampling
- Free chemical disposal for old or unwanted pesticides or fertilizers
- Reimbursement for organic certification costs
- Technical assistance for developing a nutrient management program through the Upper Willamette SWCD

- Cost share programs for liming and offstream watering projects
- Support for a mating disruption in hazelnut orchards to off-set pesticide use
- Sponsorship of the Local Food Connection

EWEB has worked with two specific groups of farmers within the watershed: blueberry growers and hazelnut growers.

The Northwest Center for Alternatives to Pesticides organized a project with EWEB support to work with farmers to address mummy berry disease without using conventional pesticides.

For the past several years, EWEB has worked with the Oregon Hazelnut Commission and Oregon State University researchers to support a mating disruption project with McKenzie hazelnut growers. This purpose of this project is to reduce the impacts of the filbert worm and reduce chemical use on hazelnut orchards.

7.2.3 Background

EWEB started its Healthy Farms Clean Water Program in 2006 to address potential water quality threats from agriculture, such as pesticide and fertilizer runoff, bacteria, and sediment/erosion concerns. EWEB has received grants to conduct chemical collection events for farmers, as well as couple of grants designed to help farmers reduce their chemical use through a variety of methods.

EWEB assisted in the acquisition of the Berggren Watershed Conservation Area in 2010, which hosted the Berggren Demonstration Farm for several years. This farm was run by a group of partners to better understand the challenge and opportunities faced by agricultural producers in the McKenzie Watershed and demonstrate sustainable farming practices protective of water quality. The farm brought in a number of grants and also hosted education programs and field trips for local schools. This farm partnership was discontinued in late 2014 due to direction from EWEB's Board.

More recently, EWEB has worked with hazelnut growers on a mating disruption research project, as mentioned above. Per agreement, OSU research and testing was jointly funded with the Hazelnut Commission providing over $20,000 and EWEB $19,500 per year for three years. Results indicate a 75% reduction in pesticide use with no significant increase in damage to the nuts. This program relies on frequent trap monitoring of moth activity and hanging of pheromone rings to disrupt mating. This activity is transitioning from OSU doing it as part of research to having the Upper Willamette SWCD trained to conduct weekly monitoring. EWEB shifted its financial support for this project to cover most of the monitoring costs through an IGA with the Upper Willamette SWCD.

EWEB has also worked with a farmer on a project designed to fence cattle out of a creek and provide off-stream watering.

Installation of an off-stream watering system in Camp Creek.

7.2.4 Regulations

There are not a lot of regulations governing agricultural activities; instead various Farm Bill programs provide incentives for voluntary actions. Oregon Senate Bill 1010 directed the Oregon Department of Agriculture to work with local agencies to develop Agricultural Water Quality Management Area Plans to address nonpoint source pollution. The Southern Willamette Valley Water Quality Management Area Plan, which includes the McKenzie, provides recommended practices to address resource concerns associated with agricultural practices in the upper Willamette Basin. These practices include rotational grazing, riparian buffer, off-stream watering and fencing, manure management, and many other practices (ODA, 2017). These practices are voluntary for growers in the plan area. One of the problems with SB1010 water quality plans is that they focus on degraded streams and rivers for use of limited funds for agency engagement and follow-through. The McKenzie (excluding the Mohawk River) does not have degraded streams when compared to other watersheds in the upper Willamette basin. Several federal, state, and local agencies provide education and technical assistance to farmers to help them improve water quality. This bill was non-prescriptive and gave farmers the flexibility to implement solutions that best worked for them.

7.2.5 Outreach

We have publicized our incentives previously through local media: River Reflections, McKenzie Watershed Council, flyers at local stores, and via EWEB's website. A lot of publicity for this program comes from word of mouth. Nearly 70 farmers have participated in some aspect of the HFCW program.

7.2.6 Current and Potential Partners

- McKenzie Watershed Council
- Northwest Center for Alternatives to Pesticides
- Upper Willamette Soil & Water Conservation District
- OSU Extension
- Oregon Hazelnut Commission
- Lane Community College
- Willamette Farm & Food Coalition
- Cascade Pacific Resource Conservation & Development
- Oregon State University
- Natural Resources Conservation Service
- McKenzie River Trust

7.2.7 Long Term Vision

McKenzie farms will be economic viable operations that protect water quality. Farmers will not feel the need to sell their land to developers. Farmers will be willing and able to try new methods/best management practices that are protective of water quality. Technical assistance for farm succession planning will be available and new farmers will be able to find land to lease or buy.

7.2.8 Recommendations Going Forward

1) We would like to see some of the funds currently allocated to the septic system zero-interest loan program be re-allocated to a similar **zero-interest loan fund for McKenzie farmers**. This would enable farmers to consider purchasing equipment or engaging in activities that are protective of water quality but may have large startup costs. In addition, these loans could be used in order to assist farmers in participating in NRCS programs, such as CREP, which encourages restoration in riparian areas. As loans are paid off, that money would be used to make new loans. It is anticipated that about 50%, or $50,000, of the septic system zero-interest loan fund be directed to agricultural water quality loans.

2) We would like to set up a **dedicated cost-share fund for farmers** to engage in smaller projects that are protective of water quality. Currently we have an informal cost-share process that has been operating on a first-come first-serve basis for projects that are protective of water quality. This has worked fine in the past, when there were only a couple of projects happening at a time that were supported by EWEB funds. Recently, there are more requests being made from interested farmers, making it necessary to develop a more formal process for applying for these funds that also requires growers to sign some sort of agreement. Most projects would be either a 50-50 or 75-25 cost-share. We propose having an annual funding cap per landowner.

3) We would like to dedicate a set amount of funding for **free soil and leaf sampling and organic certification** costs at approximately $5,000/year. This makes it easy for farmers to understand nutrient levels and to avoid over application of fertilizer at a small cost to EWEB, and it introduces them to other potential HFCW programs.
4) We would like to set aside funds every 3-4 years to conduct an **agricultural chemical collection event(s**). These have been successful in the past and a great way to reduce the storage of unwanted/unused/obsolete agricultural chemicals in the watershed.
5) Continue to work on the issue of **farm succession planning**. We are working with a graduate student at the UO to explore bringing a farm succession workshop to the McKenzie to address the issue of an aging farmer population and assist growers in exploring various options.
6) We would like to continue to explore the idea of using farmland acquired by our partners (ex. McKenzie River Trust) to give young farmers some low-cost land to farm and learn on while they are launching their careers. This **'incubator farm'** concept is one that has been growing across the US and there are many working models we can learn from. We may engage Cascade Pacific RC&D or an independent consultant to help us evaluate this concept, in partnership with the McKenzie River Trust and Upper Willamette SWCD.
7) Continue to support the **Local Food Connection**, an annual networking event for farmers, buyers and distributors, hosted at LCC by Cascade Pacific Resource Conservation & Development.

7.2.8 Current and Potential Funding

Current Funding

Recent funding has gone to various farmers and partner organizations to decrease impacts to the river from pesticides, nutrients and fecal bacteria while increasing awareness of access to local markets and farm succession planning that can prevent conversion of farms to developed properties with increased impervious surfaces and other impacts.

Table 7-3: Summary of EWEB Non-Labor O&M Costs for Healthy Farms Clean Water Program (2012-2017)

EWEB Costs	2012	2013	2014	2015	2016	2017 Budgeted
O & M	$105,000	$95,000	$80,000	$70,000	$50,000	$35,000

Outside Funding	$168,000	$180,000	$145,000	$140,000	$45,000	$20,000

Outside Funding

Outside funding has significantly decreased recently due to shutting down the Berggren Demonstration Farm and completion of the OSU mating disruption research project. Looking forward, if EWEB redirected a portion of its Septic System Assistance Program 0% interest loan funds to assist McKenzie Farmers with water quality projects, it would leverage NRCS program funds that require farmer match. The Upper Willamette SWCD is currently working to get the McKenzie Watershed into a Conservation Implementation Strategy (CIS) which would provide funding for farmers who implement best practices included within the CIS and designed to improve environmental conditions.

We continue to look for opportunities to work with both the McKenzie Watershed Council and Upper Willamette SWCD on grant projects to accomplish restoration work on the ground, mainly around increasing riparian buffers on farms. Outside grant funding could be available to develop farm succession planning that includes an incubator farm program to help prepare and match new farmers with those retiring and wanting to sell.

10-Year Funding Projection (2018-2028)

The future Healthy Farms Clean Water program will include funding and staff time to support local market development, organic certification, chemical reduction projects, farm succession planning, and an incubator farm program. Existing funds will be shifted from the Septic System Assistance Program loan program to provide approximately $50,000 available for 0% interest loans to farmers engaged in water quality protection work that can leverage NRCS programs. Table 7-4 summarizes the anticipated annual costs for the Healthy Farms Clean Water program over a ten year period (2018-2028). These costs do not include the farm chemical removal efforts described in more detail with costs in Section 6.4.

Table 7-4: Summary of EWEB Future Non-Labor O&M Costs for Healthy Farms Clean Water Program (2018-2028)[1]

EWEB Cost	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
O & M	$15,000	$15,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000

[1] – These costs do not include use of existing 0% interest loan funds ($50,000) being redirected for farm loans that involve water quality protection nor the costs associated with farm chemical collection and removal events (see Section 6.4 for those costs).

7.3 Pure Water Partners Program

7.3.1 Purpose

The Pure Water Partners (PWP) Program is a new initiative designed to reward McKenzie landowners who protect high quality land along the river, assisting EWEB in protecting water quality and helping to avoid future water treatment costs.

The program provides annual payments, technical assistance and/or other incentives to participating landowners. It also helps to connect landowners who wish to engage in restoration projects on their land with technical and financial assistance.

Landowners with small residential lots may participate in the PWP Naturescaping Pathway (see Section 7.4 below)

7.3.2 Current Status

EWEB has completed a 2-year PWP pilot project with $300,000 in grant funds from the Oregon Watershed Enhancement Board (OWEB), which involved working with 15 landowners to develop a riparian assessment and scoring process, conduct landowner assessments, and write assessment reports and management plans that include restoration designs. The two phases of the pilot project provided the opportunity to build and test the programmatic infrastructure with landowners, partners, and others prior to full program roll-out planned for late 2017. The programmatic infrastructure built as part of the pilot project included:

1) *PWP Program Boundary* – used various models to define the PWP program boundary based on likelihood of inundation during flood events (LCOG, 2017).
2) *Riparian Health Assessment Process* – developed, tested, and enhanced a riparian health assessment process and scoring system using The Freshwater Trust's StreamBank software to determine which areas are worthy of protection and which need restoration (and what limiting factors are driving the need for restoration) (TFT, 2017).
3) *Landowner Agreement Templates* – developed and tested with landowners various versions of long-term landowner agreements that grant rights to EWEB to conduct ecological enhancement and stewardship activities associated with riparian forest protection and/or restoration
4) *Business Sponsorship Program* – worked with OSU and the U of O to engage the business community through advisory groups and surveys to develop and refine messaging around PWP and the value proposition for businesses to donate funding and/or products and services to the program. Business sponsorship materials, such as pledge forms and brochures were developed and tested with local businesses, and a list of interested businesses was compiled based on the U of O surveys and focus groups (U of O and OSU, 2012 & 2013).

5) *Marketing Analysis* – EWEB engaged the Bell + Funk marketing firm to develop the Pure Water Partners program name, logo and messaging that were captured in two brochures designed to appeal to landowners and businesses.
6) *Economic Analysis* – grant funds were used to hire Earth Economics and Ecotrust to conduct an economic analysis of the PWP and calculate a return on EWEB's future investment in PWP program infrastructure and protection payments to landowners (ROI is 2.4 years) (Earth Economics, 2017).
7) *Naturescaping Pathway* – developed, tested, and implemented a Naturescaping pathway for small residential lots to provide incentives and technical assistance to homeowners who create a native riparian buffer between their house and the river. Four landowners have signed naturescaping agreements and went through the workshops and landscape design studio put on by the U of O Landscape Architecture graduate student studio class. Small student teams worked with each landowner to design landscape plans that incorporated naturescaping principles (EWEB, 2015).
8) *Fiscal Management System* – used grant funds to acquire advanced accounting software for Cascade Pacific RC&D as the PWP program fiscal agent. All program grant funding and protection/restoration funds from multiple sources (EWEB, USFS, MWMC, business sponsorships, OWEB, etc.) are and will continue to be managed through a Watershed Conservation Fund managed by Cascade Pacific RC&D as a 501c3 (EWEB, 2015). EWEB received two grants in 2017 totaling $175,000 to design and develop the accounting and legal infrastructure of a Watershed Conservation Fund and test the financial and reporting mechanisms by running various funds through the system for actions on the ground.
9) *Funding Intergovernmental Agreements (IGAs)* – EWEB is in the process of drafting funding agreements with the Willamette National Forest and Metropolitan Wastewater Commission to invest in PWP through the Watershed Conservation Fund for riparian restoration actions on private lands that meet their investment goals.
10) *Watershed Health Dashboard* – Designed and developed a watershed health dashboard and PWP website as part of the pilot project (www.purewaterpartners.org). This provides tools for landowners and EWEB customers to track watershed health and the PWP program over time, increasing transparency of watershed conservation investments and trends in watershed conditions.
11) *McKenzie Action Plan* – worked closely with the McKenzie Watershed Council and host of partners to develop a through and detailed action plan that prioritizes watershed conservation actions in specific areas on public and privately-owned lands (MWC, 2016). This plan aligns priorities across federal, state, and local agencies and organizations, allowing the pooling of resources and collaborative approaches to conservation investments over time. The McKenzie Action Plan will be used to help prioritize PWP investments in riparian protection and restoration actions on private property.

12) *Partner Role and Responsibilities* – through the completion of the 2-year pilot project, partner roles and responsibilities were defined and tested. The next step is to memorialize these roles and responsibilities in various IGAs and agreements.

Eleven landowners have agreed to move forward and participate in the PWP program by signing agreements for protection/restoration or naturescaping. Working with landowners has been extremely helpful in developing PWP and fine-tuning some of the details in everything from process to site assessments to landowner agreements. In addition, creating these positive relationships with landowners during the development process will help to engage other watershed landowners down the road. EWEB is now poised to roll out the PWP program to a broader set of landowners.

7.3.3 Background

In the McKenzie watershed, development along the river has resulted in over 200 structures built in the floodway and nearly 1,200 in the 100-year floodplain. Development along the river leads to loss of riparian vegetation, increased nutrient and pesticide use, increased impervious surface and stormwater runoff, and contamination from septic systems.

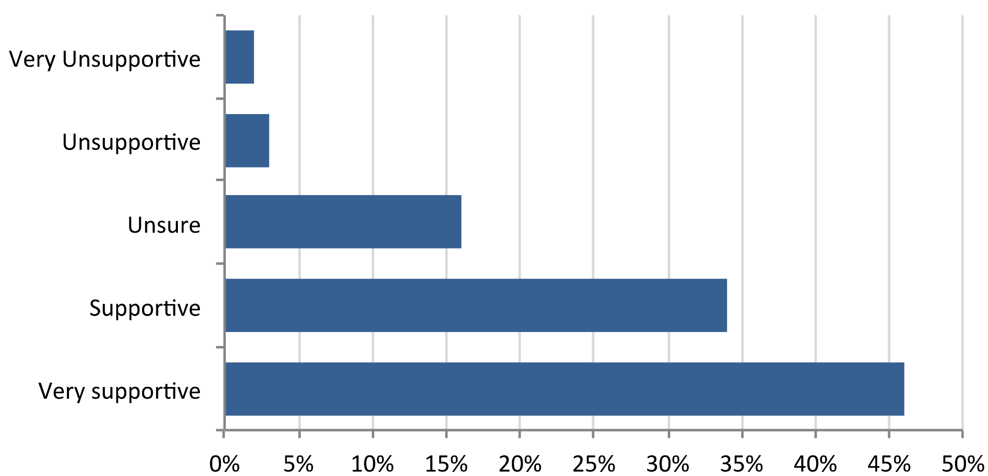
New development right along the McKenzie River

While the current drinking water quality of the McKenzie River remains very high, human activity and development within the watershed poses significant challenges for the long-term protection of this valuable drinking water source. For instance, the number of residential properties in the watershed has doubled from 1,342 to 2,600 since 1970, with over 300 residences being built since 2010 (UO, 2009). Back in 2010, EWEB joined Lane County, local watershed councils, and other organizations in trying to implement a Floodplain Ordinance and Drinking Water Protection ordinance that limited future development in the floodway and riparian area, which subsequently failed and angered many landowners. In response, EWEB source protection staff began to work with landowners on exploring voluntary approaches to limiting development close to the river and maintaining water quality. These efforts created a foundation for EWEB's Pure Water Partners Program (PWP), which capitalizes on existing community interest to protect high quality riparian habitat and reward landowners who engage in positive land stewardship activities. The primary goal of the PWP is to protect relatively intact and healthy riparian areas along the McKenzie River and some of its key tributaries. A secondary goal is to connect landowners who wish to engage in restoration on their land with technical and financial assistance from project partners.

Ratepayer Support for Programs Benefitting Water Quality

In 2012, 411 EWEB ratepayers living in Eugene completed a survey about their perception of the McKenzie Basin. Respondents described their knowledge of water quality, their understanding of risks to water quality, and how much money they would be willing to pay for source water protection. Surveyed ratepayers showed a high level of support for programs to improve and/or maintain water quality in the McKenzie Basin. Among other things, the survey asked "In general, how supportive or unsupportive would you be of establishing programs or activities to maintain the environmental benefits provided by the McKenzie Basin?"

Figure 7-5: EWEB Residential Ratepayer Support for Watershed Protection Programs



Source: University of Oregon and Oregon State University, 2013.

Figure 7-5 shows that 80% of survey respondents indicated that they were supportive or very supportive.

Ratepayers were also asked to indicate how much they would be willing to pay per month to fund water quality improvement projects. Ratepayers showed a high level of support for fees up to $1/month. Ratepayer support drops off at a $3/month fee. Table 7-6 shows EWEB ratepayers willingness to pay for water quality improvement projects.

Table 7-6: EWEB Residential Ratepayer Willingness to Pay for Water Quality Source Protection

Monthly Payment	Yes	Unsure	No
50 cents per month	72%	10%	18%
$1 per month	64%	12%	24%
$3 per month	39%	19%	43%
$5 per month	22%	18%	61%
$10 per month	9%	14%	77%

Source: University of Oregon and Oregon State University. "Protecting the McKenzie River Watershed: A Survey of Eugene Residents."

There are a number of examples of watershed protection fees around the country that appear as line items on utility water bills (see Section 9.1).

Landowner Interest in a voluntary incentive-based program

The second survey, also conducted in 2012, asked landowners in the McKenzie watershed to indicate their personal involvement and interest in programs to protect water quality. The landowner survey was provided to 598 private non-industrial landowners in the basin whose properties were located within one mile of the McKenzie River and/or its tributaries. The research team received 272 total responses yielding a response rate of 45.5%.

Approximately 18% of the respondents had previously participated in a voluntary conservation program, and 44% of respondents reported a high likelihood of enrolling in a voluntary program that would benefit water quality or quantity.

On the other hand, survey responses show that landowners are least likely to enroll in programs that either store carbon through alternative forest management practices or programs that enable the restoration of degraded stream and floodplain areas. Respondents showed the most support for a program benefiting water quality, followed by protecting and maintaining healthy floodplain areas and streamside forests. Responses also showed that these three conservation program types elicited the least amount of uncertainty across all five of the conceptual programs described by the survey (see Table 7-7).

Table 7-7: Likelihood of survey respondents to enroll in a voluntary conservation program within the next five years

Conservation Programs	Extremely Likely	Very Likely	Somewhat Likely	Not Very Likely	Not At All Likely	Don't Know	Total
Benefiting water quality or quantity	**4%**	**17%**	**23%**	12%	22%	22%	100%
Protecting and maintaining healthy flood plain areas (forest and other natural vegetation)	**7%**	**14%**	**21%**	12%	24%	23%	100%
Protecting and maintaining healthy streamside forests	7%	16%	16%	14%	24%	22%	100%
Enabling restoration of degraded stream and floodplain areas	4%	9%	17%	**17%**	**26%**	27%	100%
Storing carbon through alternative forest management practices	4%	7%	15%	**15%**	**28%**	31%	100%

Watershed Protection as a Treatment Cost Avoidance Strategy

The rationale for watershed protection is rooted in the concept of cost avoidance. In short, maintaining healthy natural systems reduces the need for water treatment, which reduces the capital and operations and maintenance costs associated with water treatment facilities. Cleaner raw water entering a treatment plant reduces the need for chemical inputs and formation of disinfection by-products as part of the treatment process.

EWEB staff worked with U of O School of Business to conduct a detailed cost avoidance study that modeled how changes in water quality would impact chemical treatment costs. The results indicate a nearly doubling of daily chemical treatment costs when turbidity levels in the river exceeded approximately 20 NTU (Skov et al., 2013). EWEB assessments and other research indicates that other costs avoided through investments in watershed protection include the need for additional physical treatment associated costs, regulatory triggers and costs (disinfection byproduct formation, plant effluent NPDES, raw and finished water quality, ESA species), restoration costs (riparian forest and wetland restoration), and reduced revenue from loss of public trust in its drinking water quality (WRI, 2013; EPA, 2012; Earth Economics, 2012).

The PWP program is an incentive-based strategy that aims to protect existing healthy riparian areas and restore degraded riparian forests along the McKenzie River through voluntary actions. As such, the PWP provides a more palatable alternative to additional land use regulation.

Acknowledging the value of healthy riparian areas, the PWP program seeks to reward landowners for management practices that benefit water quality. These rewards include financial incentives such as cash payments or vouchers for in-kind services such as developing landscape plans or implementing riparian area plantings. This incentive-based approach not only rewards good land management practices but also incentivizes property owners to restore degraded portions of their land, ultimately improving the ecological health of the watershed (OSU, 2012a).

In 2016, EWEB received grant funds from OWEB to conduct an economic analysis of the PWP and calculate a return on investment (ROI) for EWEB funds used to support the PWP (see Section 2.1). This was a very conservative analysis as it could only accurately model sediment and nutrient avoidance and removal from riparian forests and carbon sequestration value. As indicated earlier, the ROI for EWEB investments in PWP programmatic infrastructure and payments for long-term protection of healthy riparian forests was estimated at 2.4 years (Earth Economics, 2017).

For more information about the PWP program, see the University of Oregon Pilot Project Evaluation (UO, 2015) or visit www.purewaterpartners.org.

7.3.4 Regulations

Lane County riparian regulations include setback requirements for development and restrictions on the amount of vegetation that can be removed, but, as a UO study found, these regulations are not consistently enforced (UO, 2009). In addition, it is not unusual for landowners to get a variance for certain development standards.

Recently, the Federal Emergency Management Agency (FEMA) has been required by the National Oceanic and Atmosphere Administration Fisheries Service (NOAA Fisheries) to identify measures that will reduce negative impacts on salmon, steelhead and other species through its administration of the National Flood Insurance Program (NFIP). This would likely involve implementing new regulations limiting future development in floodplains and within a certain distance of rivers containing salmon. There is much uncertainty about what the new regulations might look like and some Oregon cities and counties are extremely concerned about the effect that this could have on development within their jurisdictions. EWEB source protection staff are hoping that the Pure Water Partners Program might be able to mitigate for some of the regulations and we will be following the implementation of this Biological Opinion closely. There will be interim measures in place by March 2018. If regulations in the future require landowners to protect the riparian areas that are under PWP agreements, EWEB has a clause in the landowner agreement that allows for renegotiation of terms or cancelling the agreement if actions are required under future regulations.

For more information, see the Department of Land Conservation and Development: http://www.oregon.gov/LCD/Pages/NFIP_BiOp.aspx.

7.3.5 Outreach

EWEB has worked with Bell & Funk to design the PWP program logo and produce brochures for both landowners and businesses that we can mail or distribute at local events (see Figure 7-1).

Figure 7-1. Pure Water Partners Program Logo

EWEB plans to do outreach to landowners about the PWP programs in partnership with the McKenzie Watershed Council, McKenzie River Trust, and Upper Willamette SWCD. This will take the form of targeted mailings to landowners, one-on-one contact, and public workshops. In addition, we will be relying partly on our pilot project landowners to be ambassadors for the program and help to recruit other McKenzie landowners. (In fact, this is happening already.) The PWP was successful in being awarded a grant from OWEB in 2017 for $49,000 to fund recruitment of 40 landowners, of which 20 would be projected to sign PWP agreements over the next 2 years.

Landowner outreach will be focused and targeted to achieve the greatest chance for success and best value for EWEB's investments. Outreach will first focus on reaching out to landowners who have already worked with EWEB as part of the Septic System Assistance program, Healthy Farms Clean Water program or other efforts. In addition, inundation modeling, LiDAR analysis, future build-out analysis, and economic ROI calculations on tax lot scale will help us to target landowners whose properties would be most valuable for this program.

In order to recruit business sponsors for the program, EWEB staff (including Communications, Marketing & Research) will make one-on-one contact with area businesses to explain the PWP program and the various options for support. Lists of prospective business sponsors were developed during the pilot project work that engaged businesses as part of OSU/U of O research and business advisory groups (U of O, 2015a). These lists will be used to target businesses who have already expressed interest in PWP and have advanced knowledge of the program to recruit "founding" business partners.

7.3.6 Current and Potential Partners

- Cascade Pacific Resource Conservation & Development
- Lane Council of Governments
- McKenzie River Trust
- McKenzie Watershed Council
- Metropolitan Wastewater Management Commission

- Oregon Watershed Enhancement Board
- Oregon State University
- The Freshwater Trust
- University of Oregon
- Upper Willamette Soil & Water Conservation District
- Willamette National Forest, McKenzie Ranger District

7.3.7 Long Term Vision

Landowners will be educated and informed about the importance of healthy riparian areas to drinking water, recreation, tourism, and fish and wildlife habitat. Landowners will embrace the PWP program and participation will increase over the years. Landowners will also be 'ambassadors' for the program and help to spread the word by talking to their friends and neighbors. New funding sources will be plugged into the Watershed Conservation Fund, increasing the pace and scale of protection and/or restoration in the McKenzie Watershed. Over the next ten years, more than 50% of the acres in the PWP program boundary will be under agreement for long-term protection and/or restoration.

7.3.8 Recommendations Going Forward

The pilot project has been extremely helpful in designing the overall PWP program with landowner buy-in and we are now ready to scale up and enroll additional landowners.

EWEB plans to roll out the PWP program as a "soft" launch in the fall 2017 to not interfere or confuse messaging with McKenzie River Trust's Home Waters fundraising campaign. This will allow completion of programmatic infrastructure development as part of a soft launch and leverage momentum from MRT's campaign to do a full launch in 2018. This coincides with an OWEB technical assistance grant received in spring 2017 to conduct outreach efforts in concert with the McKenzie Watershed Council and UWSWCD and recruit new landowners to the program. It is recommended that the following efforts be conducted over the next 2 years to launch the PWP program:

1. Complete signing long-term agreements with the existing landowners who participated in the PWP pilot project and whose input helped design and develop the program. Many of these landowners have indicated their interest in being ambassadors for recruiting other landowners.
2. Develop and test the Watershed Conservation Fund using grant funds received from the U.S Endowment for Forests and Communities. This is a 2-year grant that funds legal and accounting expertise to design and build the fiscal management infrastructure, allowing for efficient use of outside funding for projects on the ground and reporting back to the funder to satisfy their requirements.
3. Complete development and signing of IGAs with USFS Willamette National Forest and Metropolitan Wastewater Management Commission to allow these funding sources to be used on PWP projects through the Watershed Conservation Fund.

4. Develop and implement a landowner outreach plan that provides strategic focus as part of OWEB grant to engage 40 landowners over a 2-year period with 50% success rate for signing PWP long-term agreements for protection and/or restoration activities.
5. Complete development of LiDAR algorithms that can analyze the 2009 and 2016 LiDAR flights for changes in canopy cover/riparian forests, new building structures and roads, and geomorphic changes in river channel and floodplain. This provides a baseline for future LiDAR flights to measure changes on a watershed scale to assess if the PWP program is having a desired impact on watershed protection over time.
6. Develop and enter into various agreements between PWP partners to memorialize the roles and responsibilities each plays in the PWP program for long-term consistency and efficiency. This allows any partner to promote the PWP and efficiently coordinate and direct incoming inquiries and work to the right place for timely response.
7. Engage the business community and sign-up the first 10-12 sponsors for PWP as founding members whose funds go through the Watershed Conservation Fund, providing tax benefits back to the businesses.

7.3.9 Current and Potential Funding

Current Funding

Recently, EWEB funding was matched with two grants from the Oregon Watershed Enhancement Board (OWEB) totaling $296,000 to conduct a thorough piloting of the PWP program with landowners. The pilot allowed us to build the majority of programmatic infrastructure as discussed in Section 7.3.2. In spring 2017, the PWP program was successful in attracting outside investment from the US Endowment for Forests and Communities ($140,000), The Nature Conservancy ($35,000), and OWEB ($49,000) to complete development of the Watershed Conservation Fund and support landowner outreach as part of PWP roll-out. Table 7-8 summarizes EWEB costs to build and test the PWP program since 2012 and the amounts of outside funding attracted by this innovative approach to watershed protection.

Table 7-8: Summary of EWEB Non-Labor O&M Costs for Pure Water Partners Program (2012-2017)

EWEB Costs	2012	2013	2014	2015	2016	2017 Budgeted
O & M	$94,000	$100,000	$116,000	$125,000	$150,000	$150,000
Outside Funding	$350,000	$130,000	$120,000	$130,000	$150,000	$225,000

Outside Funding

EWEB continues to work with the watershed council, SWCD, Cascade Pacific RC&D, USFS, TFT, and other partners to apply for grants, both for program development and operation, as well as for specific on-the-ground projects with landowners. OWEB will be a likely source of funding, as well as the Metropolitan Wastewater Management Commission, the USFS (via stewardship contracting receipts), business sponsors, and others. The following is a summary of potential outside funding opportunities over the next 10 years:

- MWMC funds for riparian restoration projects that increase shade and provide water quality temperature credits toward compliance with their NPDES permit.
- USFS WNF retained receipts from stewardship contracting timber sales. Portion of retained receipts will be used on PWP riparian restoration projects that benefit Chinook salmon habitat.
- Business sponsorship for watershed protection that maintains clean water for our community.
- OWEB funds for increasing restoration and protection of salmon habitat.
- Trust and foundation funding for programmatic development and transferability for scaling up conservation.
- Mitigation funds from floodplain development, transportation projects, and hydropower impacts to salmon (BPA).
- Upper Willamette Soil & Water Conservation District future tax base with a portion dedicated to watershed conservation through the PWP program.
- Downstream water utility investment in the Upper Willamette as a source protection strategy for Willamette Basin (Corvallis, Tualatin, Hillsboro, Wilsonville, Sherwood, etc.).
- Potential for public-private partnership to package PWP program components for sale to other utilities pursuing watershed protection across the west.
- NRCS funding to increase riparian buffers on farms.

10-Year Funding Projection (2018-2028)

Future costs for all aspects of the PWP program were estimated, including watershed monitoring associated with repeat LiDAR flights every 5 years and funding OSU/U of O SLICES monitoring program every ten years. Table 7-9 summarizes these anticipated costs for PWP over the next ten years (2018-2028) and represents higher end estimates for programmatic infrastructure and protection payments to landowners.

Table 7-9: Summary of EWEB Future Non-Labor O&M Costs for Pure Water Partners Program (2018-2028)

EWEB Cost	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
O & M	$160,000	$170,000	$200,000	$220,000	$230,000	$240,000	$240,000	$240,000

7.4 Naturescaping

7.4.1 Purpose

The purpose of the naturescaping program is to increase landowners' awareness of naturescaping principles, which involve incorporating native plants, reducing water use, enhancing habitat and protecting water quality while producing a landscape that meets landowner needs. We have partners who can help answer questions and facilitate the adoption of these practices on properties throughout the McKenzie Watershed. Employing naturescaping principles is also a 'pathway' under EWEB's Pure Water Partners (PWP) Program.

7.4.2 Current Status

Currently EWEB is offering a Naturescaping Workshop to landowners annually in late winter/early spring. EWEB partners with the McKenzie Watershed Council and Upper Willamette SWCD to put on these workshops. We have received very positive feedback about these workshops from participating landowners.

In spring 2016, EWEB contracted with the UO landscape architecture program to offer a studio class to students that focused around designing naturescaping landscapes for PWP pilot project participants. The class was very well received by both students and the four participating landowners. We hope that this type of studio will be offered again when interested professors are available. All landowners who participated agreed to sign naturescaping agreements with us.

7.4.3 Background

There are many steps homeowners can take in their own homes and yards to safeguard the excellent water quality of the McKenzie River. EWEB partnered with the Upper Willamette Soil & Water Conservation District, Oregon State University Extension Service, the McKenzie Watershed Council and the Northwest Center for Alternatives to Pesticides several years ago to develop a Naturescaping workshop for McKenzie residents.

Naturescaping is a method of landscaping which seeks to incorporate native plants, reduce water use, enhance habitat and protect water quality while producing a landscape that meets landowner needs, is easier to maintain and can save both time and money. This workshop covers a variety of topics including developing a functional and waterwise landscaping plan; planting the "right plant" in the "right place;" addressing invasive species; the importance of riparian buffers to water quality; reducing pesticide and fertilizer use; and enriching soil quality through composting.

The naturescaping workshops will continue to be offered to McKenzie residents as part of EWEB's PWP Program, which is designed to protect riparian forests along the McKenzie River and its tributaries. Residents with small residential lots can enter the PWP through the 'naturescaping' pathway. This involves signing an informal agreement with EWEB to implement naturescaping principles on their property. EWEB will provide financial support through a free initial design consultation through the McKenzie Watershed Council (MWC), a cost-share program to develop an implementable naturescaping design, and other incentives that are available to Pure Water Partners participants.

During the PWP design process, EWEB learned that many McKenzie landowners are very interested in doing 'the right thing' on their riparian properties, but often need some education or technical assistance to help them understand what to do and what practices/techniques to use on their land. EWEB believes that continuing to offer these workshops (which have received very positive feedback from participants) as well as technical assistance through the MWC will help to disseminate this important information to landowners throughout the McKenzie Watershed.

7.4.4 Regulations

There are not many regulations around how a landowner should maintain their landscaping. Lane County riparian regulations do include setback requirements for development and restrictions on the amount of vegetation that can be removed, but, as a UO study found, these regulations are not consistently enforced (UO, 2009b).

7.4.5 Outreach

We publicize the naturescaping workshops primarily through local media: River Reflections, McKenzie Watershed Council, McKenzie Clearwater Coalition, flyers at local stores, and via EWEB's website events calendar.

The Naturescaping Pathway of the PWP program will be publicized through similar venues, as well as through our website, brochures being developed by Bell & Funk, through our list of interested landowners, and most importantly, by word of mouth through other landowners who have participated in the PWP pilot program.

7.4.6 Current and Potential Partners

- McKenzie Watershed Council
- Northwest Center for Alternatives to Pesticides
- Upper Willamette Soil & Water Conservation District
- University of Oregon landscape architecture students
- Oregon State University Extension, Lane County

7.4.7 Long Term Vision

Landowners will be familiar with Naturescaping principles and willing to apply them to their properties to reduce chemical use, increase healthy riparian habitats, use water more efficiently, etc. Landowners will also be 'ambassadors' for the program and help to spread the word by talking to their friends and neighbors.

7.4.8 Recommendations Going Forward

We recommend continuing to hold these workshops. Feedback from participants has been excellent. In addition, these workshops serve two purposes vis-à-vis the PWP Program:

1) Can be used to recruit landowners to the PWP
2) Provide useful information/education to landowners already participating in the Naturescaping pathway of PWP

7.4.8 Current and Potential Funding

Current Funding

In the past, we funded some of the partner hours for the naturescaping workshops out of a DEQ 319 grant, which ended in 2015. Now that we have done these workshops a few more times, the cost to put them on is fairly low and can be covered by EWEB.

For the PWP Naturescaping Pathway, EWEB is currently providing funding for the MWC to work with landowners on an initial consultation, $250 worth of cost-share with landowners towards a naturescaping design, and some technical assistance when implementing their naturescaping plans. EWEB also provides a one-time incentive to landowners by providing them up to half a day of invasive weed removal or planting work done by the Northwest Youth Corps.

Outside Funding

None likely at this point – we already received grant funding to set up and pilot the workshops.

10-Year Funding Projection (2018-2028)

Table 7-10 summarizes the anticipated costs to run the naturescaping workshops and sign-up landowners through the PWP program for implementing naturescaping projects on their property.

Table 7-10: Summary of EWEB Future Non-Labor O&M Costs for the Naturescaping Pathway of the PWP (2018-2028)

EWEB Cost	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
O & M	$16,000	$7,000	$18,000	$18,000	$18,000	$18,000	$21,000	$21,000

9.0 PROGRAM COSTS and FUNDING

9.1 Summary of Watershed Protection Program Cost

Tables 9-1 and 9-2 summarize current and future costs associated with EWEB's Drinking Water Source Protection program. These costs were provided in more detail in previous sections (see Section 5.0, 6.0, and 7.0). The source protection program is currently at 2.5 FTE, which equates to about $350,000-$380,000 per year in labor costs. It is expected that this level of staffing will remain the same for the next ten years with labor costs increasing to approximately $380,000 to $400,000 over that period of time. Labor costs are not included in Tables 9-1 and 9-2.

Table 9-1: Summary of EWEB Non-Labor O&M Costs for Watershed Protection by Program (2012-2017)

Program Name	**2012**	**2013**	**2014**	**2015**	**2016**	**2017 Budgeted**
MWERS	$24,000	$24,000	$25,000	$25,000	$70,000	$195,000
Healthy Forests	$14,000	$30,000	$16,000	$20,000	$29,000	$27,000
Urban Runoff	$10,000	$10,000	$10,000	$10,000	$39,000	$35,000
Illegal Camping	$5,000	$7,000	$10,000	$10,000	$15,000	$18,000
Septic System Assistance	$10,000	$10,000	$20,000	$20,000	$20,000	$20,000
Healthy Farms	$105,000	$95,000	$80,000	$70,000	$50,000	$35,000
Pure Water Partners	$94,000	$100,000	$116,000	$125,000	$150,000	$150,000
Monitoring	$145,000	$148,000	$148,000	$143,000	$138,000	$164,000
TOTAL	**$407,000**	**$424,000**	**$435,000**	**$423,000**	**$511,000**	**$644,000**

Table 9-2: Summary of EWEB Future Non-Labor O&M Costs for Watershed Protection by Program (2018-2028)

Program Name	2018	2019	2020	2021	2022	2023	2024	Average 2025-28
MWERS	$60,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
Healthy Forests	$5,000	$5,000	$10,000	$10,000	$20,000	$20,000	$20,000	$20,000
Urban Runoff	$180,000	$180,000	$90,000	$90,000	$70,000	$50,000	$50,000	$40,000
Chemical Collection	$10,000	$0	$0	$10,000	$0	$0	$10,000	$5,000
Illegal Camping	$15,000	$15,000	$15,000	$15,000	$18,000	$18,000	$18,000	$18,000
Septic Assistance	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Healthy Farms	$15,000	$15,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Pure Water Partners	$160,000	$170,000	$200,000	$220,000	$230,000	$240,000	$240,000	$240,000
Naturescaping	$16,000	$7,000	$18,000	$18,000	$18,000	$18,000	$21,000	$21,000
Monitoring	$160,000	$130,000	$160,000	$140,000	$140,000	$170,000	$140,000	$150,000
TOTAL	**$641,000**	**$582,500**	**$573,500**	**$583,000**	**$576,000**	**$596,000**	**$579,000**	**$574,000**

9.2 Watershed Protection Fee

Water utilities across the country rely on natural capital in the form of forests and clean river systems to supply high quality drinking water and filter out sediment and other pollutants. Utilities have not valued or accounted for these services in the traditional economic sense. One way that utilities can communicate the value of these natural capital assets to customers is through a watershed protection fee that appears on bills and reminds customers that utility staff are working hard to protect their source of drinking water.

EWEB currently funds its Drinking Water Source Protection program through an equivalent of 3% water rates and 0.1% electric rates. Source protection is a long-term program that is designed to leverage EWEB investments with other watershed stakeholder funding to achieve a greater degree of watershed protection in times of a changing climate and more volatile weather patterns. Given the importance of water quality and source protection for EWEB's customers (based on EWEB customer surveys over the last ten years), it may make sense to establish a watershed protection fee as a line item on EWEB's bill and reduce water and electric rates that are currently used to fund the program. This provides transparency as to the amount of funding dedicated to water quality and source protection that are of high importance to customers. This approach also provides an assurance of future funding for long-term planning and partner agreements for shared costs

A University of Oregon survey conducted in 2012 found that the majority of EWEB customers surveyed (~400) were supportive of a monthly fee on their bills for watershed protection. In fact, nearly 65% of surveyed customers would be definitely or probably willing to pay $1/month for watershed protection with another 12% unsure that could possibly be persuaded given the right approach and awareness of what EWEB is doing with these funds (U of O, 2012).

Watershed protection fees are not uncommon on other utility bills. There are numerous examples of watershed protection fees on utilities' bills from around the country, including: Bellingham, WA; Denver, CO; Salt Lake City, UT; Little Rock, AR; Providence, RI, Raleigh, NC; Santa Fe, NM, San Antonio, TX, and others. Common fee structures are 45 cents/month, 1 cent/100 gallons or a set charge per meter. Some fees are also based on meter size. The largest fee we could find was in Bellingham, where they charge $5/month + $0.64/cubic foot volume. EWEB is proposing the $1/month charge based on both needed budget as well as willingness to pay results from the UO study. This would generate sufficient revenue to fund the future program costs as outlined in Section 9.1. It is hard to calculate the value source protection provides to the community, though one study showed that for every $1 spent on source water protection $27 are saved on water treatment (Winecki, 2012). In addition, due to risk associated with climate change, bonding agencies are beginning to ask about how utilities are protecting their source of drinking water as a resilience strategy to reduce future costs that may impact bond repayment (Ceres, 2014).

Examples of Watershed Protection Fees

Raleigh, NC:
https://www.raleighnc.gov/home/content/FinUtilityBilling/Articles/UtilityBillingDepositFees.html

The Watershed Protection Fee is a funding mechanism for the City's water supply protection programs. The City imposes a fee of $0.1122 per CCF (per 100 cubic feet of water) for Raleigh, Garner, Rolesville and Wake Forest water customers. The funds are used to pay for the Upper Neuse Clean Water Initiative, as well as additional drinking water quality improvements to the treatment system, and/or for protective restoration projects.

The Upper Neuse Clean Water Initiative is a land trust partnership created to protect the areas most critical to the long-term health of the drinking water supplies for the communities in the Upper Neuse River Basin. Protection efforts include acquiring parcels of land through conservation agreements, purchases, or donations within the Falls Lake watershed. Funds from the program are also expected to be available to help purchase easements around Lake Benson and possibly around the future Little River Reservoir.

Central Arkansas Water
http://www.carkw.com/customer-service/rates/

A Watershed Protection Fee appears each month as a separate item on the billing statement. The fee funds the Watershed Management Program, which includes land purchases, water quality monitoring, and other measures to protect our drinking water supply lakes from potential sources of pollution. The monthly fee is 45 cents for households with a 5/8 inch-diameter meter. The Watershed Protection Fee by meter size is as follows:

Meter Size	Watershed Protection Fee
5/8″	$0.45
3/4″	$0.45
1″	$0.68
1 1/2″	$1.13
2″	$2.25
3″	$3.60
4″	$6.75
6″	$11.25
8″	$22.50
10″	$36.00

The Watershed Protection Fee appears beside the following line-item on the monthly billing statement: *Watershed Protection.* Discussions with the Central Arkansas utility's source protection staff indicated their customers have been very supportive of the watershed protection fee and have actually asked that it be increased.

For more information

Delgado-Perusquia, Sofi; Kraft, Joanna; Schmidt, Rowan; Stangel, Peter, 2012. Communicating and investing in Natural Capital using Water Rates. Earth Economics, Tacoma, WA & U.S. Endowment for Forestry and Communities.

9.3 Land Acquisition Fund

Over the past several years, there have been several opportunities to acquire land along the mainstem McKenzie River that provides both water quality and habitat benefits. A couple of times, we have been able to take advantage of these opportunities by working with the McKenzie River Trust (ex. Berggren Watershed Conservation Area, Finn Rock). However, these instances have both required quick action and allocation of funds from EWEB reserves. We would like to be able to set aside funds for land acquisition over time so that when opportunities arise, we would have an existing pot of funds to draw from. Clearly we are not going to acquire large swaths of the watershed, but acquiring and/or putting conservation easements on significant riparian areas provides benefits to water quality protection and limits future development in sensitive areas. Otherwise, development will likely continue, as what is currently happening with the McKenzie golf course at Deerhorn. This golf course will now be developed into a 26-residence subdivision, located mostly in the floodway and entirely in the 100-year floodplain.

The concept of a land acquisition fund is to have annual source protection funds ($50,000-$75,000) dedicated to land acquisition and/or conservation easement activities. One option would be to allocate a certain portion of a watershed protection fee to an acquisition fund. Based on the Pure Water Partners pilot project, it is clear that as we engage landowners in riparian protection and restoration, opportunities for acquisitions or conservation easements will increase significantly. These dedicated funds could be deposited under an existing agreement with the McKenzie Watershed Council that currently manages similar annual funding as part of EWEB's Leaburg-Walterville FERC license requirements (Sections 412 and 413). These FERC-mandated funds are used for land acquisitions and conservation easements agreed upon through a technical advisory group, to ensure investment in priority areas in the lower McKenzie River to mitigate for impacts from EWEB's hydroelectric projects. The technical advisory group consists of the McKenzie Watershed Council, McKenzie River Trust, ODF&W and EWEB. This group will be expanding in the future and could also serve an additional role of prioritizing investments for drinking water quality throughout the watershed. This approach uses the McKenzie River Trust to purchase land recommended by the technical advisory group or place conservation easements to protect important riparian areas. In this way, EWEB does not own or manage the land acquired for long-term conservation value.

Land acquisition funds have been implemented across the country at various utilities to help protect land in source water areas. Several of these utilities have set up some type of prioritization/evaluation process for making decisions around where to spend these funds. For instance, Portland Water District in Portland, ME has specific ranking criteria that they use to decide whether or not to contribute, and how much to contribute, to potential land acquisitions. Central Arkansas Water also uses a similar approach. Oftentimes, the utility will help a land trust to acquire the land and put an easement on it, rather than owning and managing the land themselves. We propose to take a similar approach.

Another source of funding for land acquisitions could be revenue from timber harvests on our Leaburg forest. EWEB owns about 500 acres near Leaburg Lake (350 that are forested) that have not been actively managed since the 1970s. EWEB recently hired Trout Mountain Forestry to assess these forested acres and develop a sustainable timber management plan with input from a small team of EWEB staff. The first timber harvest is planned for the summer of 2017. (See Section 6.2 for more information.)

9.4 Green Bonds and other innovative sources

"Large-scale conservation programs should be considered, and funded, like any other major asset that provides long-term benefits. Drought, aging infrastructure, growth, changing standards—these are the issues local water and wastewater agencies deal with all the time. In the past, the response was to sink deeper wells, build dams, or increase the size of pumps and pipes. Those solutions don't always work anymore, however; our groundwater is over drafted and the best dam sites were developed long ago. Even if such solutions were viable, they are no longer the

most efficient way to get the job done. The cheapest and quickest way to provide water security for cities and towns is to use less "grey" infrastructure and concentrate on conservation, efficiency, and green infrastructure. But those solutions can be hard to implement on a large scale. Sometimes it is because engineers are more comfortable knowing what will happen with pumps and pipes. But often it is because we can't figure out ways to fund large investments in things that don't look like the assets we used to build" (Harrington and Koehler, 2016).
-*Ed Harrington, General Manager, San Francisco Public Utilities Commission*

Green bonds are bonds where the proceeds are used for green assets and projects (delivering a range of positive climate and sustainability impacts) and are labelled accordingly. They have emerged as a valuable tool to mobilize global capital to invest in low carbon and climate resilient projects. The global green bond market has reached USD81bn in 2016, with 14% of green bond issuances relating to water infrastructure assets and projects (CBI, 2017).

The Climate Bonds Standard (CBS) Water Criteria focus on both mitigation and adaptation & resilience of water infrastructure assets, in terms of their own resilience to climate change, and their impact on the resilience of the system in which they are part. Under the Water Criteria, the water assets need to go through Mitigation Assessment, which evaluates the GHG emissions of the asset or project to make sure the assets have positive impacts in terms of reduced emissions; and the Adaptation and Resilience Assessment, which checks that the issuer has adequately assessed the climate risks for the assets and the surrounding system, and has prepared and is implementing an appropriate adaptation plan as needed (CBI, 2017).

The CBS Water Criteria are being rolled out in phases: Phase I covers grey water infrastructure for the purposes of water collection, storage, treatment, distribution, or flood and drought defenses. These include water assets in the 'water sector' plus water infrastructure used in the operation, design, and function of other industries, such as mining, manufacturing, power-generation, refinery systems, and general cooling uses. Phase I criteria were released in October 2016. Two bonds issued by San Francisco Public Utilities Commission have been certified under these CBS Water Criteria Phase I, amounting to USD 500m (CBI, 2017).

Phase 2 expands the Water Criteria to incorporate nature-based solutions, which includes green and hybrid water infrastructure for such purposes as water collection, storage, treatment or distribution, flood protection, and drought resilience. This may include the restoration and maintenance of forests and wetlands to filter water, aquifers that store water for drinking or for flood control, and the establishment or restoration of wetlands to attenuate storm surges or process wastewater effluent.

Table 9-3: Examples of Nature-Based Solutions Covered by Green Bonds Water Criteria (CBI, 2017)

Assets	Example Projects	Mitigation	Adaptation & Resilience

Water storage Rainwater harvesting systems Aquatic ecosystems (lakes, wetlands) Aquifer storage Snowpack Runoff Groundwater recharge systems Riparian wetlands Storm water management	Active snowpack management program	●	●
	Using parks, natural areas for storm water management		
	Creating groundwater recharge areas for aquifer storage		
Flood defenses Ecological retention, current force reduction mechanisms Relocation of assets from floodplains / “room for the river”	Restoration of riparian wetlands for flood storage	●	●
	Creation of safe delta flood zones as natural habitat for the river to expand into		
	Altering flow mechanics to reduce the force of flood stage flows		
	Planting trees, other vegetation explicitly to reduce water temperatures, evaporation rates		
Water treatment Natural filtration / recycling systems (e.g. wetlands, watersheds, forests) Grey natural filtration / settling systems Forest for water quality management	Construction of nature-based wetland using native plants for water filtration, nutrient management	●	●
Storm water management	Removal of pavement, creation of new substrate to improve groundwater absorption & reduce runoff	●	●

Permeable surfaces (parks, roads, etc.) and evapotranspiration systems Groundwater recharge Rainwater harvesting Constructed ecological retention ponds Forests for water quality management? Erosion control systems?	Creation of wetland retention ponds			
	Sediment transport to reduce / restore downstream deposition			

EWEB met with members of the Climate Bonds Initiative and learned more about how this process could work to fund green infrastructure associated with source protection. One concept discussed was that as EWEB issues new bonds for hydroelectric projects (Carmen Smith) or drinking water infrastructure (AWS), we could add up to 25% of the value of these grey infrastructure bonds for source protection projects that meet the Water Criteria (examples shown in Table 9-3). The actual grey infrastructure portion of the green bond would also have to meet a set of criteria around carbon emissions, sustainability of materials used, etc. Assuming these criteria could be met, green bonds would be issued with comparable interest rates that EWEB would receive on the bond market, but would appeal to a different set of investors.

The advantages of this approach include: 1) EWEB gets an influx of funds up front for watershed protection work that could be used to quickly scale up programs; 2) investment in upstream green infrastructure solutions, such as wetland and riparian forest protection and restoration, are tied to larger grey infrastructure projects that directly benefit; and 3) issuance of green bonds may appeal to our customer base where sustainable solutions and funding are viewed more favorably than normal business as usual approaches. The downside is that EWEB would end up paying more over the life of the bond for these investments in green infrastructure than the standard annual budgeted approach.

9.4 Water Fund

EWEB applied and was selected by The Nature Conservancy to participate in an innovative workshop with teams from across the western U.S. to learn about developing a water fund. Mentors from across the U.S. and Latin America participated in the workshop to share their experiences in developing such a fund with a variety of partners and funding sources.

A water fund is essentially a tool that enables downstream water users to jointly invest in upstream land protection and restoration to maintain or improve water quality and drinking water resources. Every fund is unique to a place and its individual characteristics. Partners in water funds often consist of utilities, municipalities, businesses that depend on clean water, non-profit organizations, and other stakeholders.

The way a water fund typically works is that a variety of funding sources are combined in a common place to fund agreed-upon conservation activities within a specific watershed boundary. A Board of Directors makes decisions on how much to spend on certain projects and where work should occur, based on recommendations of a technical team. They also make sure that funds spent meet the overall objectives of the fund. Projects funded often include land acquisitions, conservation easements, and restoration work, etc. The overall purpose of most water funds is to strategically protect land that, if degraded, can negatively impact water quality. Many studies have shown that healthy forested land produces the best water quality and there is a direct relationship between amount of forested land cover and water quality (Booth, 2002; Freeman et al., 2008; Jones et al., 2009)).

EWEB received grant funding from the US Endowment for Forests and Communities to build a water fund as part of the Pure Water Partners program for the McKenzie Watershed, and test its transferability to the Santiam Watershed. As part of this effort, EWEB has already used OWEB grant funds to purchase advanced accounting software for Cascade Pacific RC&D, who will provide fiscal management of the water fund. The pilot project has also worked on developing other funding partners (USFS, MWMC, OWEB, business sponsors) that will route their investments through the water fund for actions on the ground that align with the priorities and goals of their funding. The development of the water fund, currently called the McKenzie Watershed Conservation Fund, will provide necessary infrastructure that other future funders can invest in and efficiently and effectively receive credit for the actions on the ground that support their funding requirements.

10.0 STRATEGIC RECOMMENDATIONS

Background

EWEB customers currently value and have access to clear, clean drinking water, and have consistently ranked drinking water quality and watershed protection in the top 5 metrics in customer satisfaction surveys (EWEB Customer Surveys, 2001-2016). This strong customer support for protecting the McKenzie River led the Board to approve, in 2001, the initial source protection goals, objectives, and strategic direction outlined in the program implementation plan, which have guided program development until now. The original goal of EWEB's DWSP program is to measure the balance between watershed health and human use over time and implement actions that maintain exceptional water quality for current and future generations. To accomplish this, the program had two primary objectives: the first was to prevent, minimize and mitigate activities that have known or potentially harmful impacts on source water quality; and the second was to promote public awareness and stewardship of a healthy watershed in partnership with others.

The original strategic direction to accomplish these goals and objectives was for EWEB to accept a leadership role for protection of the McKenzie River by working with partners to develop protection plans and programs that align and share resources.

Based on this direction, EWEB invested in building the programmatic infrastructure for a risk-based watershed protection approach that: a) is collaborative and builds lasting relationships with partners, stakeholders, landowners and communities; b) leverages partner and outside funding/resources; c) is based on best available science; d) addresses multiple economic, social and environmental issues that align with partner efforts for shared investments; and e) is evaluated over time for effectiveness. As the DWSP program was launched based on this approach, it became apparent that this was an effective formula for attracting grant funding. EWEB used grant funds to help build and test collaborative watershed protection programs such as the McKenzie Watershed Emergency Response System, Healthy Farms Clean Water, Septic System Assistance, Pure Water Partners, and others.

The threat of hazardous material spills, urban runoff from east Springfield, and development pressures along the McKenzie River have put these values at risk. In addition to existing watershed spill response and urban runoff mitigation efforts, we are currently in the process of developing a public-private partnership designed to protect and restore critical upstream water sources through a voluntary approach. Investing now in watershed protection helps to avoid higher costs in the future and provides resiliency to the effects of climate change.

10-Year Strategic Plan Summary

This strategic planning period (2018-2028) captures the transition from developing and building (2001-2017) to running, monitoring and adjusting (2018+). The 2017/2018 transition phase will involve establishing long-term interagency collaborative agreements that align and share resources, funding, and responsibilities for watershed protection, allowing EWEB to better predict future budgets and monitor for effectiveness.

The revised goal for EWEB's Drinking Water Source Protection (DWSP) program is to measure the balance between watershed health and human use over time and implement actions that maximize the benefits EWEB receives through its investments in the McKenzie River Watershed.

To accomplish this goal EWEB will:

1. Plan and implement actions that maintain source water quality in a way that balances risks with benefits in partnership with others;

2. Prioritize source protection efforts that provide the greatest benefit to water treatment and electric generation in the McKenzie Watershed; and,

3. Promote public awareness and stewardship of a healthy watershed through targeted actions and programs.

Based on these goals and objectives, our long-term strategic approach is to operationalize source protection efforts in a way that aligns priorities, leverages resources, and integrates with partner actions and leadership through long-term agreements.

There are two elements to operationalizing the DWSP program: one is through greater integration with Hayden Bridge and electric Generation; and the other is through establishing programmatic infrastructure that allows consistent and predictable engagement across the main DWSP elements by EWEB and its partners.

EWEB's source protection staff will work to integrate the DWSP program with Hayden Bridge, provide value to water treatment decisions and increase efficiency of water quality work. Some of these efforts will include spill notification, response, and monitoring; reducing analytical costs through shared use of outside laboratory services and using the Hayden Bridge Water Quality Lab for regular DWSP analysis; using daily operator logs to add source protection observations, trends, and events that add value to treatment decisions; providing seasonal and episodic event information around organic carbon load, characteristics, DBP potential, and taste & odor issues; looking at emerging watershed issues, trends, impacts, changes, timing, and flows; and, exploring efficiencies that can be achieved by working with the water quality lab.

Source protection will also support the McKenzie Hydroelectric Generation facilities through testing and maintaining effective spill response capabilities that could reduce impacts from EWEB hydro-plant releases, providing habitat mitigation opportunities that leverage partner investments and resources to increase scope and impact of Generation efforts, and strengthening relationships with key partners (USFS, DEQ, ACOE, ODFW, MF&R, Lane County, ODOT, USGS, UO, OSU) that add value to Generation operations and FERC license management.

Finally, operationalizing source protection is happening through establishment of: programmatic infrastructure (largely completed) allowing for more efficient, effective, and consistent approaches by EWEB and its partners to watershed protection and restoration actions; and, long-term IGAs and agreements with partners to memorialize roles, responsibilities, funding, and priorities. Staff will continue to report on metrics/measurements of success and engage our customers through the PWP program, website and other venues.

Summary of Programmatic Recommendations

The following are summaries of the more detailed recommendations provided in Sections 5.0, 6.0 and 7.0 and highlight multiple areas of our source protection program where we feel that it is valuable to make investments in maintaining or advancing existing efforts and programmatic infrastructure to address the issues described in this plan. These recommendations are programmatic approaches to protecting the McKenzie Watershed and will be implemented in close partnership with numerous agencies and organizations.

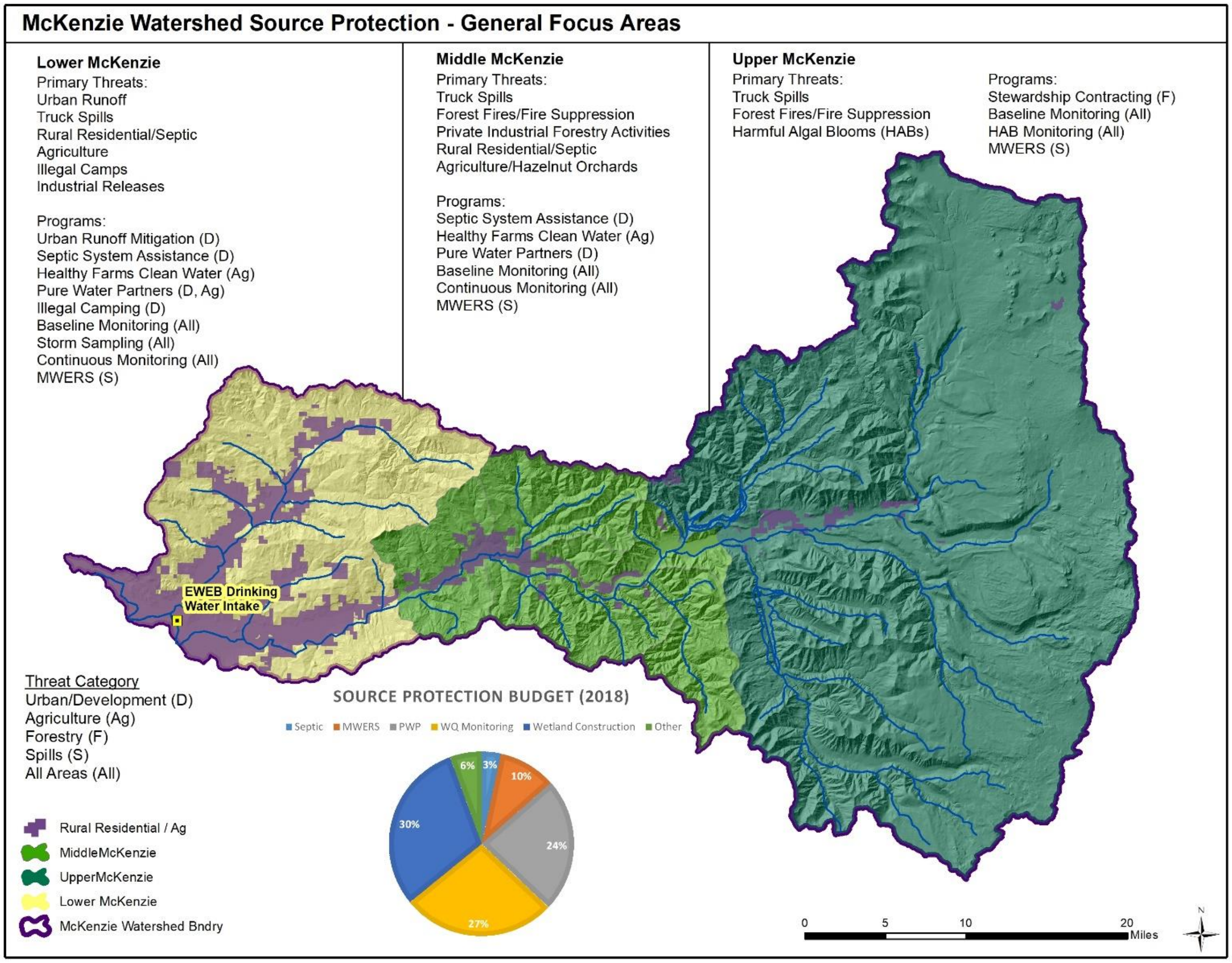
EWEB's drinking water source protection program follows the American Water Works Association (AWWA) G-300 standards for developing, implementing, and measuring effective source protection programs. The following summarizes the main programmatic elements of EWEB's approach to protecting the McKenzie Watershed. Figure 10-1 provides a geographic prioritization of EWEB investments and the main threats addressed by each program.

Water Quality and Watershed Health Monitoring (Entire Watershed)

EWEB will measure and collect information on water quality in the McKenzie Watershed that informs water treatment operations around toxins, emerging contaminants, trends, episodic events that impact the river and treatment, and other changes in watershed health.

1. *Constituent monitoring* consists of quarterly baseline monitoring, storm event monitoring during first flush winter and spring storms, and investigative monitoring that focuses on episodic events.
2. *Harmful algal bloom monitoring* is conducted in the upper watershed between April to September to assess and quantify algal type and production of toxins in reservoirs and at intake.
3. *Continuous monitoring* occurs at various USGS and EWEB operated gaging stations in the lower and middle portion of the watershed to assess changes in general water quality, stream flow, and optical properties (UV and florescence) in real time to identify potential problems and trends that may impact drinking water quality and treatment.
4. *Monitoring data management and analysis* is conducted to interpret water quality trends, identify emerging issues, increase knowledge and understanding of watershed conditions and impacts from climate change, and provide regular reporting to treatment plant, management, Board and public through a variety of outlets.

Figure 10-1: McKenzie Watershed Focus Areas



These monitoring efforts use multiple approaches (i.e., baseline trending, episodic storm event, harmful algal blooms, and continuous monitoring) to track changes in water quality over time, predict episodic events that may impact treatment processes, and understand water quality changes in specific areas of the watershed (see Sections 5.2.11, 5.3.11, 5.4.11, and 7.3.8). This information, combined with periodic watershed scale monitoring using repeat LiDAR flight analysis and OSU/U of O SLICES, will provide a solid foundation for assessing trends, success of programs, adding value to water treatment operations, effects of regulations, return on investment, and impacts of climate change. This information will provide an early warning system to changes in the watershed that may impact treatment and water quality, allowing EWEB and its partners to adjust and adapt source protection programs and approaches over time based on changing conditions. Given that future impacts from climate change are not clearly understood and may play out in ways we have not anticipated, it is important to have this level of long-term monitoring to better understand these changes as soon as possible. This data and information will also be available to our customers and the public through two websites: the watershed health dashboard (www.purewaterpartners.org) that provides trends and information that directly relates to the health of the watershed over time, and the water quality monitoring data website (http://reach.northjacksonco.com/EWEB/) that provides open access to the millions of analytical records collected since 2001.

McKenzie Watershed Emergency Response System (MWERS) (Entire Watershed)

EWEB will maintain a watershed emergency response system in close partnership with first responders that allows for efficient and effective response to hazardous material spills, which will reduce the magnitude and duration of impacts to the McKenzie River. This GIS-based web application provides critical information to first responders by allowing them to search for pre-determined spill response strategies, equipment, critical resources, and personnel; generate reports with travel times based on flow rates; and coordinate and communicate response efforts. Partners conduct interagency annual training and drills using interagency spill response trailers staged throughout the watershed to maintain and hone skills using this equipment and test pre-determined response strategies.

Many partners have been working together on emergency spill response for over 10 years and are committed to maintaining this partnership. The Region 2 HazMat Team has taken more ownership in this effort for maintaining equipment, conducting training and coordinating drills and spill response, allowing EWEB to focus on the GIS/web-application development and maintenance. EWEB plans to leverage the public-private partnership with Mason Bruce & Girard to export the watershed emergency response system web application to other watersheds and receive revenue from royalties (see section 6.1.7 for more details).

Urban Runoff Mitigation (Lower Watershed Focus)

EWEB will implement actions that mitigate, treat, and/or eliminate urban runoff from all five stormwater outfalls upstream of the Hayden Bridge intake. Project work will include constructing wetlands that will treat and buffer urban runoff and capture hazardous material spills for cleanup. These will be located immediately upstream of the Hayden Bridge intake at the 52nd Street outfall and at the confluence of Cedar Creek with the McKenzie River. These two wetland projects will treat/buffer urban runoff from four of the five outfalls above EWEB's intake. The remaining stormwater outfall will be addressed by re-routing stormwater runoff from the 42nd Street stormwater basin to the Q Street channel. This will eliminate outfall discharges to Keizer Slough. This will be a City of Springfield project that leverages EWEB investments in the 52nd Street wetland project.

Pure Water Partners (PWP) (Middle and Lower Watershed Focus)

EWEB will invest in the protection of riparian and floodplain forests as effective natural systems for treatment of pollutants, mitigation of floods, reduction of sediment, and increasing fish habitat that benefits water treatment and electric generation. EWEB's Pure Water Partners program is designed to reward good stewardship through incentives to landowners who maintain healthy riparian areas over the long term while facilitating restoration on degraded portions of their properties. Through this program, partner agencies conduct riparian health assessments to measure and identify riparian conditions on landowner properties that need restoration or which qualify for protection of healthy riparian forests. EWEB (or future Pure Water Partners legal entity) enters into long-term agreements with interested landowners that outline allowable uses in a management plan, provide incentives/compensation to the landowner, and/or assist the landowner in finding funding for restoration work.

Landowners have three pathways available to them if they join the PWP: protection of healthy riparian forests and/or restoration of degraded areas for larger landowners, and naturescaping to create native plant buffers between homes and the river on smaller residential tax lots. Like the Septic System Assistance Program, early indications are that the naturescaping pathway is popular with homeowners and allows EWEB and its partners to engage a large number of landowners living along the river with minimal investment.

The McKenzie Watershed Conservation Fund, managed by Cascade Pacific Resource Conservation & Development (dba Pure Water Partners), manages funding from multiple sources (EWEB, Metropolitan Wastewater Management Commission, USFS Willamette National Forest, Oregon Watershed Enhancement Board, foundations, business sponsors, etc.) for protection and restoration actions on the ground. A governance structure will be developed by 2019 to create the Pure Water Partners as a legal entity that oversees and directs Fund management and could hold landowner agreements.

The PWP program boundary is based on mapped areas in the watershed that have a high likelihood of inundation and where healthy riparian forests would have the greatest benefit to treat pollutants, reduce erosion, mitigate flood impacts, and increase fish habitat.

Acquisition/conservation easement opportunities in high priority areas will become more plentiful as the PWP program engages hundreds of landowners. Establishing a mechanism to take advantage of these opportunities is critical to moving the 15-20 year PWP agreements into permanent protection. The McKenzie Watershed Council currently manages Generation funds (per FERC license Articles 412 and 413) for acquisitions & conservation easements that are then held by the McKenzie River Trust, and this mechanism could be used to leverage future opportunities that arise through PWP (see Section 7.3.8 and 7.4.8 for more details).

Septic System Assistance (Middle and Lower Watershed Focus)

EWEB will work with McKenzie homeowners to reduce the impacts of septic systems on water quality. The septic system financial assistance program provides a 50% cost-share assistance to homeowners to pay for inspection, pump-out, and completion of minor repairs. Homeowners with failing septic systems may apply for zero-interest loans (loan program is currently administered by EMS) to repair or replace these failing systems. This program has received an incredible amount of interest and positive feedback, and helps to make connections with landowners that we can take advantage of in future work (e.g., access to land for spill drills, monitoring locations, naturescaping, PWP, etc.). To date, this program has addressed over 650 septic systems in the watershed (see Section 7.1.8 for more details).

Healthy Farms Clean Water (Middle and Lower Watershed Focus)

EWEB will work with McKenzie farmers to reduce chemical use and increase riparian buffers that benefit water quality. The Healthy Farms Clean Water program focus areas include reducing chemical use and storage on farms by offering cost-share and technical assistance from partners to reduce pesticide use through on-farm projects, agricultural chemical removal events, nutrient management and organic certification. In the future, farmers can access zero-interest loans (administered by EMS) for projects that benefit water quality, allowing them to leverage Federal NRCS funds that require landowner match. Periodically (every three years) coordinate with partners a multi-day chemical collection event to remove old and unwanted chemicals from farms for proper disposal. EWEB has worked with nearly 70 McKenzie farms over the years and sees a lot of potential for getting farmer participation in riparian protection and/or restoration through the PWP program (see Sections 6.4.6 and 7.2.8 for more details). This program recognizes the value of farmland as a preferred floodplain land use to increased development.

Healthy Forests Clean Water (Middle and Upper Watershed Focus)

EWEB will work with partners to increase forest health that reduces wildfire risks, protects water quality, increases fish and wildlife habitat, and generates revenue for watershed restoration that benefits water treatment and electric generation. The Healthy Forests Clean Water program consists of two main components. First, EWEB participates in a stewardship contracting collaborative process with the US Forest Service and other watershed partners. Through this effort, retained receipts generated from timber harvests on federal lands stay in the watershed and can be used to fund restoration projects on the Willamette National Forest and on private land through the Pure Water Partners program (see Section 6.2.8 for more details).

The second part is to manage EWEB's Leaburg Forest to increase habitat that benefits Generation FERC license requirements and protect water quality while generating revenue through small patch cuts and thinning. EWEB has developed a management plan for the Leaburg forest to conduct selected harvests that increase forest health while generating revenue. The idea is to demonstrate this management approach to students and other small woodlot owners.

Illegal Camping Cleanup (Lower Watershed Focus)

Continue working with regional partners to coordinate response and cleanup of illegal camps along area waterways. Provide support, with partner contributions, to maintain and enhance a web application (http://laneillegalcampcleanup.org/) that allows the larger community to identify and track the response to cleanup illegal camps in Lane County. This application notifies landowners and interested agencies when new camps are identified for a more timely and coordinated response to remove camps before they are established and become major problems that are very expensive to cleanup (see Section 6.5 for more details).

Focus staff resources on assisting Willamalane Parks staff to increase frequency of patrols (i.e., weekly) of the area immediately upstream of EWEB's Hayden Bridge intake. Provide funding and other assistance to get boats and Hazmat cleanup contractors to conduct regular cleanup of illegal camps identified and provide access to islands. Work with International Paper and McKenzie River Trust to acquire IP land where illegal camping is common to allow more proactive management of this area (see 6.5.5).

Drinking water source protection programs are increasingly prevalent at utilities all over the country. Although EWEB is by no means the first utility to have such a program, it has gotten national recognition for its forward-thinking approach to protecting drinking water, with multiple awards, including the American Water Works Association Exemplary Source Water Protection Award in 2015. Karl Morgenstern was also selected for national awards from the U.S. Forest Service (Public Awareness Award) and Carpe Diem West (Healthy Headwaters Innovation Award) for work specifically on the Pure Water Partners Program and source protection efforts.

Source protection is a long-term effort that takes years to build, establish good working relationships with partners and gain the trust of upstream landowners. It is a program meant to prevent future risks from increasing development pressures, hazardous material spills, chemical use by rural residential, agriculture and forestry land uses, and climate change impacts. Our program works with multiple partners throughout the watershed and has leveraged nearly $3 million worth of grant funding and partner contributions. Making investments in watershed protection now is much more cost effective than waiting until water quality degrades to a point that requires large investments in treatment technology and loss of public confidence in their drinking water quality. It is critically important to protect the McKenzie River as Eugene's lifeblood due to its excellent water quality and abundant water quantity from large productive springs that power EWEB's hydroelectric projects.

Recommended Funding Approaches

There are a variety of funding approaches that can be implemented to support source water protection activities as discussed in Section 9.0. The following are recommended approaches to funding source protection efforts over the next ten years.

1) **Watershed Protection Fee**: We recommend placing a line item on EWEB customer bills to reflect the cost of watershed protection, which would replace the current funding source from water, and to a lesser degree, electric rates. This would effectively lower water rates, as the entire source protection program would be funded from this fee. Based on survey research conducted by the U of O (UO, 2013), over 70% of customers surveyed supported up to $1/month fee for watershed protection. Program costs are nearly $1 million/year over the next ten years. It is recommended that all water and/or electric customers pay this fee, as this

would include McKenzie residents who benefit from watershed protection efforts. A simple calculation shows that with 86,000 customers paying $1/month would generate over $1 million per year. There are a number of utilities across the country who have successfully adopted this approach and received strong support from their customers. This will not only increase transparency around source protection work, but also provide a more stable source of funding for a program that is designed for the long-term engagement with landowners and watershed stakeholders.

2) **Watershed Conservation Fund or Water Fund:** Establishing a water fund would allow EWEB to combine multiple sources of diverse funding in order to jointly invest in upstream land protection and restoration actions to maintain or improve McKenzie River water quality. EWEB recently received the prestigious Healthy Watersheds Grant from the U.S. Endowment for Forests and Communities in the amount of $140,000 to work on developing such a water fund. The water fund will be initially setup to receive funding from the following sources:

    a. *U.S. Forest Service* through use of retained receipts from stewardship contracting, estimated to generate $1-3 million every 2-4 years until established so stewardship contracts are sequenced over time to provide annual funding.

    b. *Metropolitan Wastewater Management Commission* has secured State Revolving Fund (SRF) funds earmarked for conducting riparian restoration to achieve temperature credits toward its NPDES permit obligations. It is estimated that $1-2 million could be invested in generating shade credits through the water fund.

    c. *Oregon Watershed Enhancement Board* has already invested $350,000 in funding to help build and test the Pure Water Partners programmatic infrastructure and has a vested interest in seeing this program succeed. It is estimated that OWEB could continue investing in McKenzie restoration projects at $100,000 to $200,000 per year.

    d. *Business sponsorships* would likely provide a smaller amount of funding, estimated at $50,000 to $100,000 per year, but would provide good media and customer exposure for EWEB's watershed protection efforts. Business sponsors would also be a good source for volunteer efforts, sponsoring river celebration events, and offering goods and services at discounted rates to PWP participants, which would add incentives to landowners to become better stewards of the watershed.

3) Revenue sources that are currently being developed include **royalties for watershed protection products** developed with private consultants that will be marketed across the West. The first product will include the Oregon Watershed Emergency Response System web application developed by Mason Bruce & Girard, which is estimated to generate $15,000 from each sale of the web application. Additional product lines may include EWEB's unique water quality monitoring data website developed by North Jackson or our water quality database developed by Lane Council of Governments. There are potential opportunities to develop wetland banks from the constructed wetland to treat urban runoff at

the confluence of Cedar creek and the McKenzie River that could generate revenue from third parties in need of offsetting their project impacts to other wetlands. It is anticipated that this would generate between $40,000 to $70,000 over next 10-20 years after the wetland is built and approved for wetland bank mitigation. Revenue from management of Leaburg Forest through selective harvests is estimated to generate $400,000 every 5 years. This revenue could be used for watershed protection, making it a better fit for public acceptance in the use of funds from timber harvests.

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Appendix A: Pesticide List

Appendix B: Watershed Protection Strategic Planning Update (Memo to EWEB Board, February 24, 2017.)