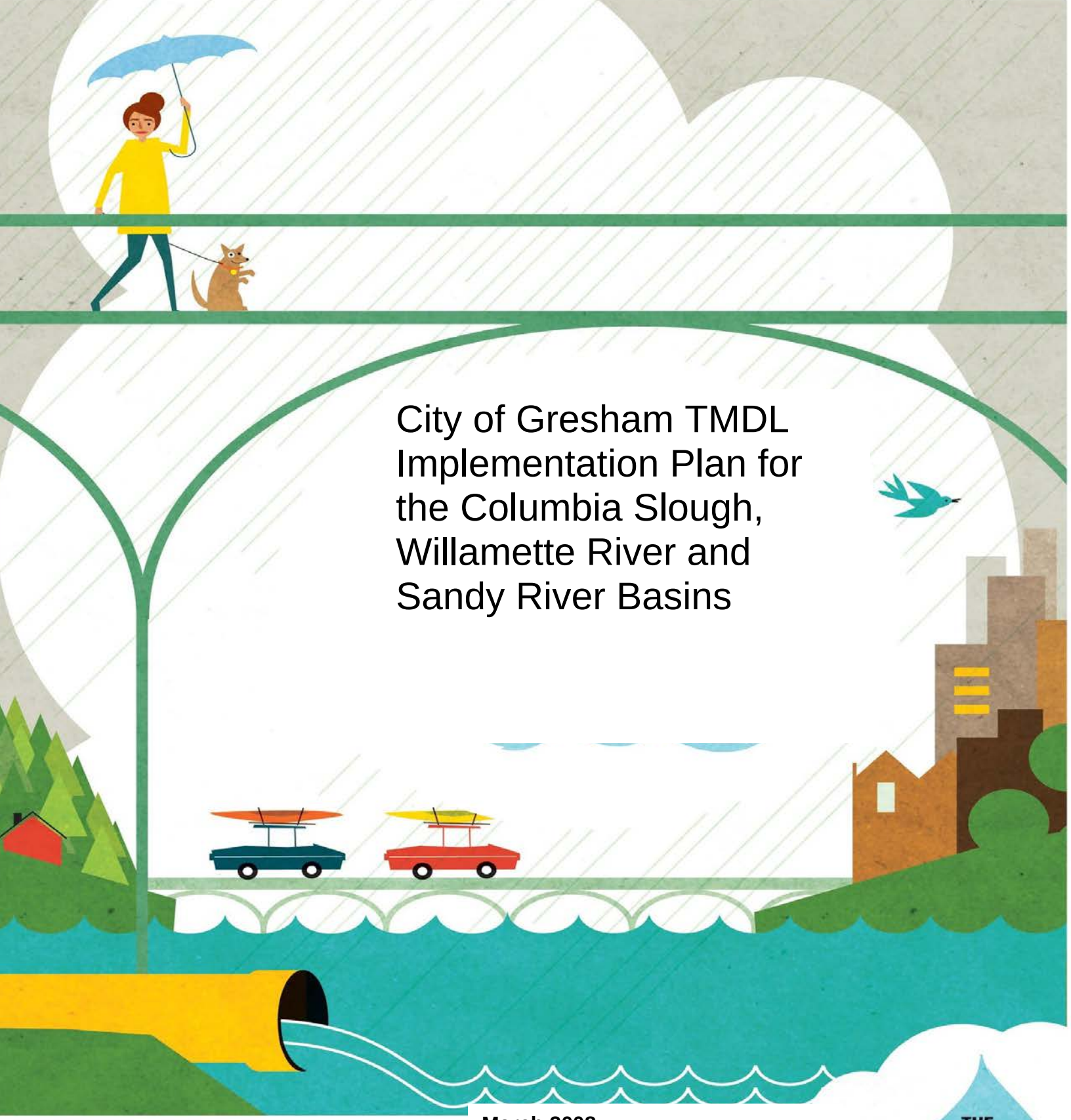


City of Gresham TMDL Implementation Plan for the Columbia Slough, Willamette River and Sandy River Basins

CITY OF GRESHAM

March 2008
5-Yr Update FY 13-14 thru 17-18
5-Yr Update FY 18-19 thru 22-23

Water Resource Division
Dept. of Environmental Services

THE RIVER STARTS HERE

TABLE OF CONTENTS

Section I. Overview
Background 1-1
Overview Scope & Summary of Implementation Plans 1-3
Legal Authority 1.7
Program Priorities 1-7
Fiscal Analysis 1-9
Public Involvement 1-10
Overview of Management Strategies 1-11
Table 1.1 Watershed & TMDL Pollutants 1-3
Table 1.2 Discharge Sources & Relevant Plan 1-6
Table 1.3 Fiscal Analysis (Past & Future) 1-10
Table 1.4: Summarized Commitments 1-12
Section II. Bacteria Plan
Introduction 2-1
Scope of the Problem 2-1
Relevant Requirements 2-2
Management Strategies 2-3
Responsible Parties 2-4
Funding & Prioritization of Projects 2-5
Reporting, Monitoring, and Adaptive Management Strategy 2-5
Section III. Temperature Plan
Background 3-1
Management Strategies 3-2
Proposed Performance Metrics 3-5
Additional Observations 3-7

Appendix A: Water Quality Management Plan Requirement Summary A-1
Appendix B: 2007 Gresham Temperature TMDL Implementation Plan (with March 2008 Addendum) B-1

SECTION I: OVERVIEW

BACKGROUND

The Department of Environmental Quality (DEQ) has set Total Maximum Daily Loads (TMDLs) for several water bodies located in watersheds that are wholly or partly within the City of Gresham to limit the total amount of specific pollutants that may be discharged to a given waterbody. Under Oregon law,[1] TMDLs must include a Water Quality Management Plan (WQMP) that identifies how the TMDLs will be implemented. Management strategies identified in a WQMP must be implemented through water quality permits for those sources subject to permits, and through sector-specific or source-specific implementation plans for other sources.

This document outlines Gresham's compliance plans for the Columbia Slough, Willamette River and Sandy River TMDLs. (See **Table 1.1**) The city's permits, Stormwater Management Plan (SWMP) and other associated documents to reduce TMDL pollutants are implementation plans and are on the city's website: **GreshamOregon.gov** and are included in the Stormwater Plan section of the **Water Resources Division pages**.

The City of Gresham has jurisdiction over both DEQ-permitted and non-permitted activities. The City's responsibilities include compliance with DEQ permits for discharge of stormwater and wastewater, as well as oversight of incidental discharges and thermal warming associated with land uses approved by the City.

Figure 1.1 shows the watersheds within Gresham's boundaries, plus the Columbia River. The watersheds are drained by the Columbia Slough; and Fairview, Kelly/Beaver, and Johnson Creeks. City stormwater drains to all these water bodies, whereas the wastewater treatment plant discharges treated sanitary wastewater to the Columbia River. The shaded areas on the map drain to groundwater via underground injection wells (UICs), rather than discharging to surface waters and are regulated under the City's WPCF permit available on GreshamOregon.gov.

[1] Oregon Administrative Rules, Chapter 340, Division 42

Figure 1.1. Watersheds within Gresham

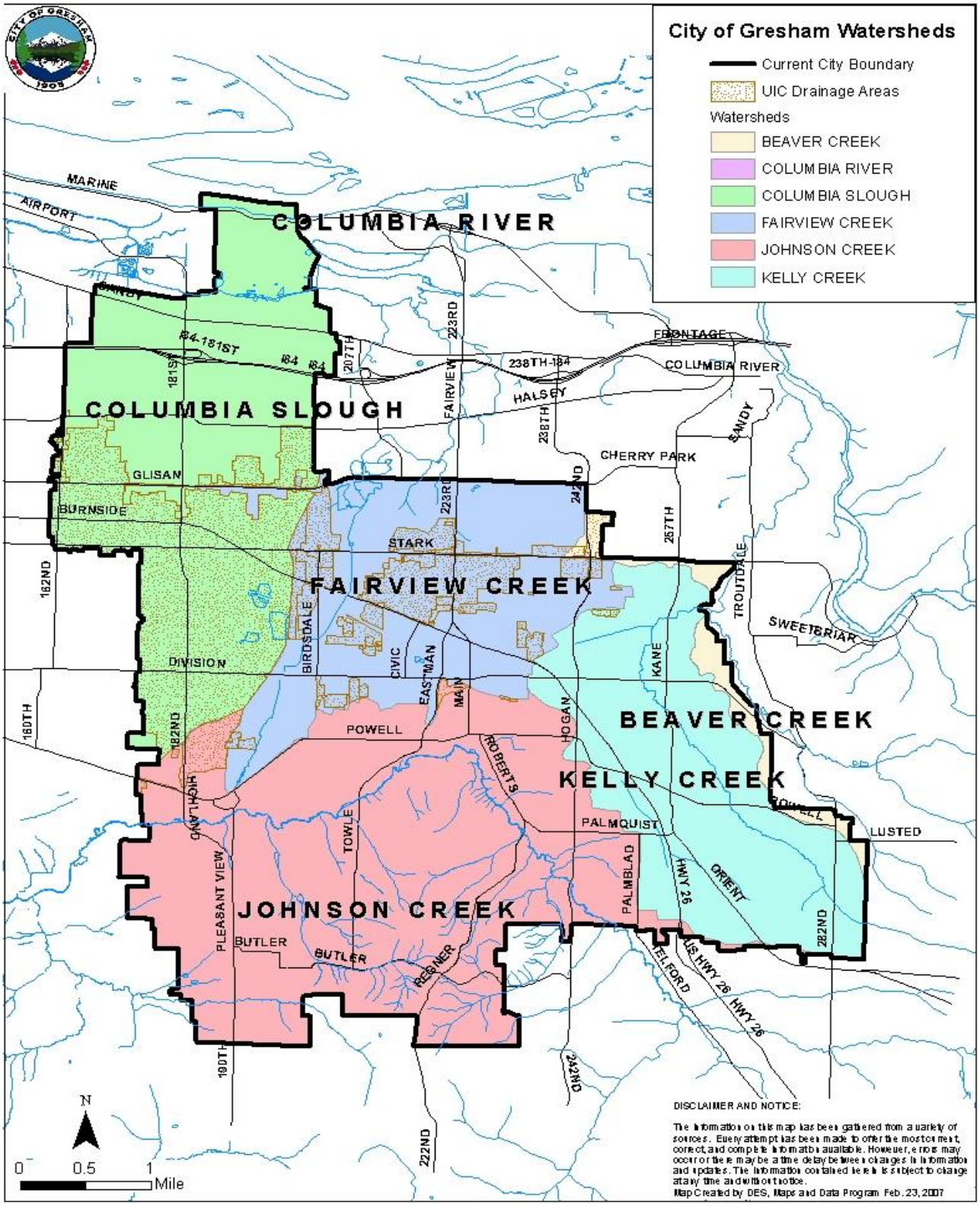


Table 1.1 Watersheds and TMDL Pollutants

Basin Name	Sub-basin(s)	TMDL Pollutants relevant to Gresham	Year TMDL Set
Columbia River	Lower Columbia	Dioxin*	1991
Willamette River	Lower Willamette	Mercury, bacteria, temperature	2006
	Columbia Slough and Fairview Creek	DDT, DDE, dieldrin, dioxin, PCBs, lead, phosphorus, bacteria, dissolved oxygen, pH, chlorophyll a;	1998
	Columbia Slough and Fairview Creek	Temperature	2006
	Fairview Creek	Bacteria	2006
	Johnson Creek & tributaries	DDT, dieldrin, bacteria, temperature	2006
Sandy River	Kelly, Burlingame, and Beaver Creeks	Bacteria, temperature	2005
A portion of Columbia Slough	NA (drains to groundwater ~2,250 acres)	NA (Underground Injection Control permit #112110 and wellhead protection requirements apply)	NA

*A dioxin TMDL was set by EPA for the lower Columbia River. Wastewater treatment plants and stormwater are discussed in that TMDL, but due to lack of data, loads from these sources are considered part of the reserve capacity, and no specific allocation was made.

City of Gresham Jurisdiction and Organization

Typical urban activities that the City oversees to reduce impacts to surface waters include: development, system maintenance & repair, sanitary waste collection and treatment, solid waste recycling and disposal, public health and safety, erosion prevention & sediment control, business inspections, and public outreach (for private land). These activities are under the jurisdiction of different Departments and Divisions within the City. **Figures 1.2 and 1.3** show the organization of the City and the Department of Environmental Services DES), respectively and lists some of the major duties in each DES group.

OVERVIEW SCOPE AND SUMMARY OF IMPLEMENTATION PLANS

This overview addresses discharges of pollutants that come from both “point” and “nonpoint” sources. Point sources enter surface waters via a pipe or other conveyance, whereas nonpoint sources (NPS) discharge to surface waters directly or through overland flow (not via pipes or other conveyances.) The City has obtained point source permits from DEQ under the National Pollutant Discharge Elimination System (NPDES) for its discharges to surface waters from its wastewater treatment plant outfall (#102523) and from over 1,000 stormwater outfalls that enter Gresham’s streams (#101315) and holds a nonpoint source stormwater permit for the property at the wastewater treatment plant.

Figure 1.2 City Organizational Chart

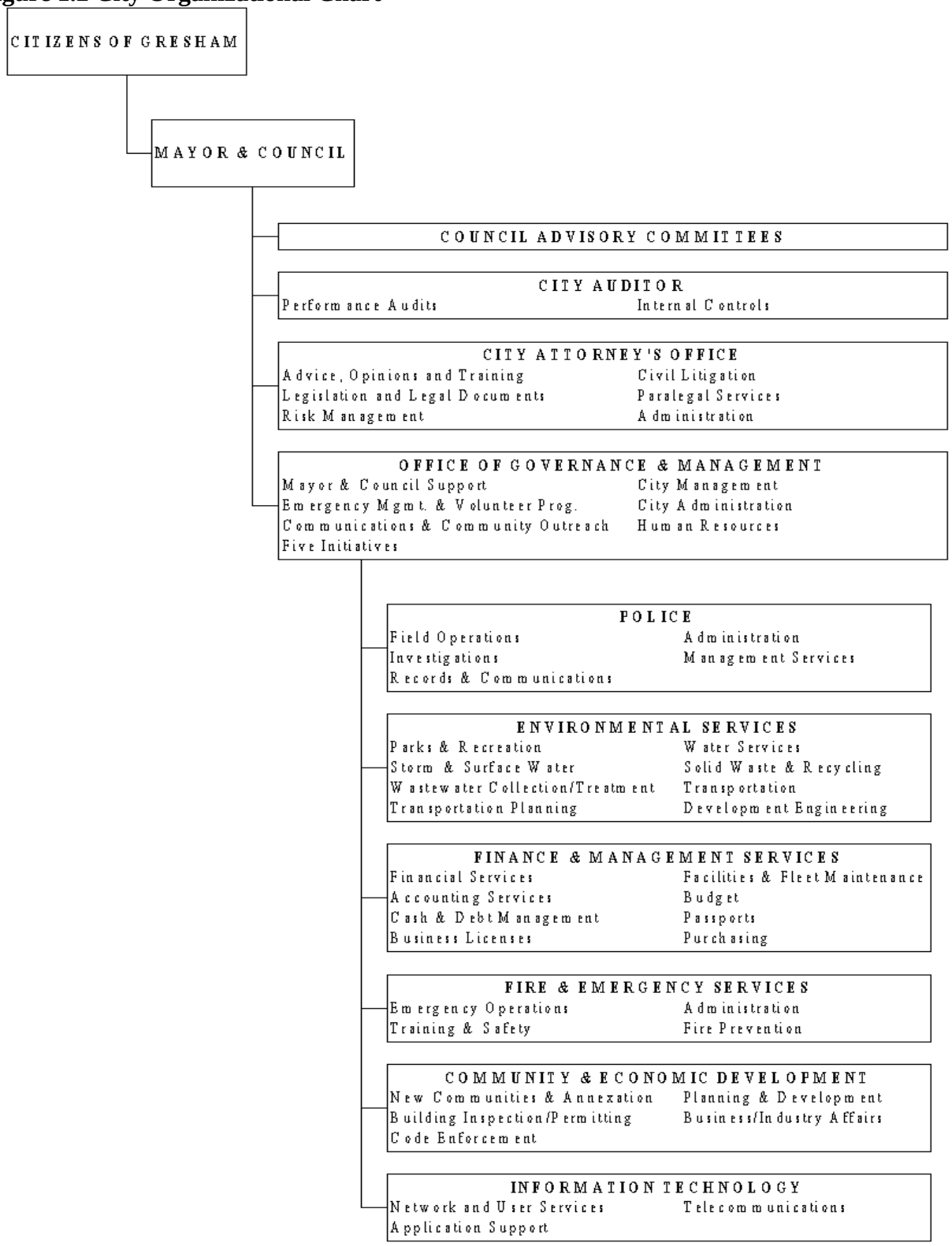


Figure 1.3 Department of Environmental Services Organizational Chart

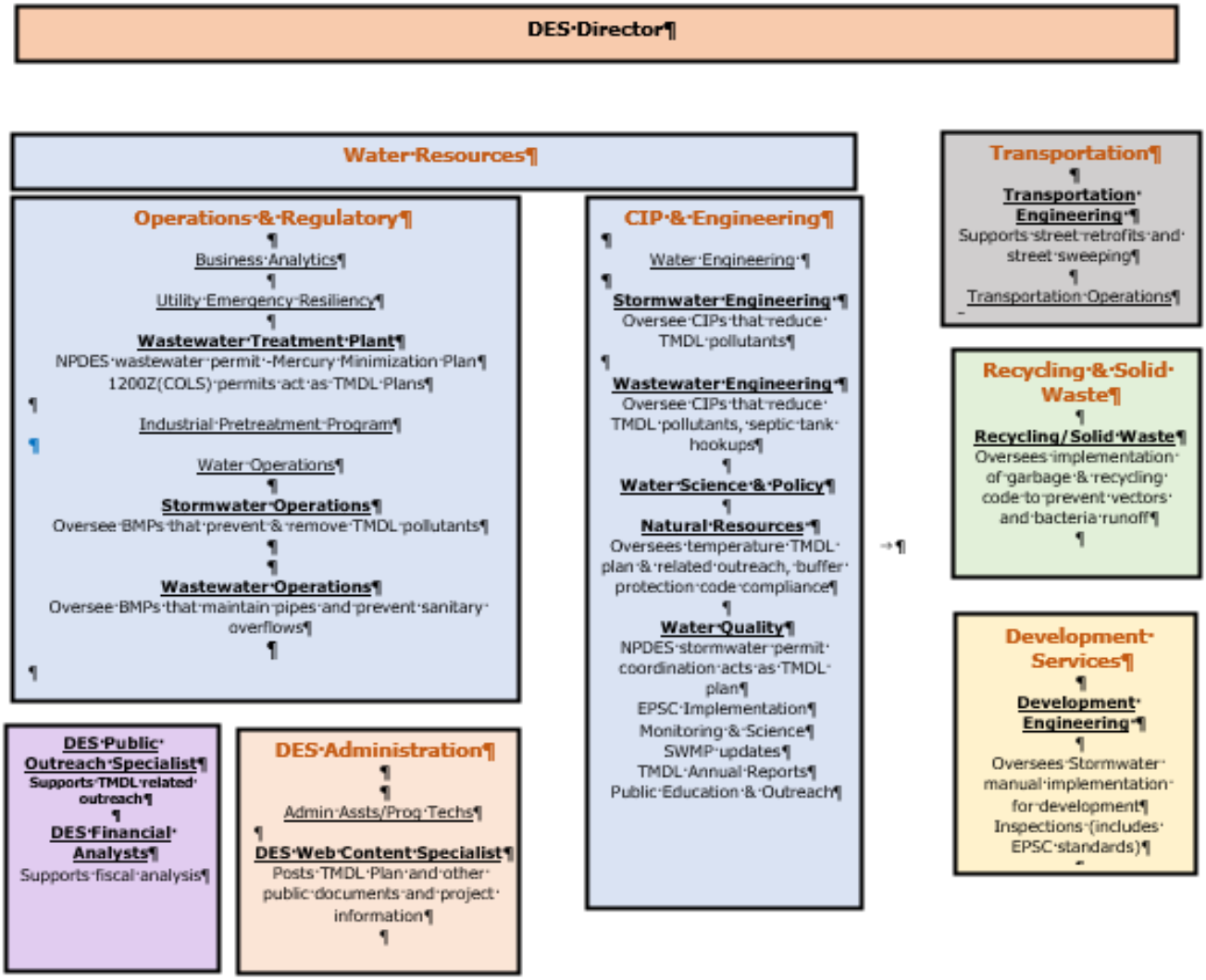


Table 1.2 summarizes the City's various implementation plans for its watersheds and relates them to a comprehensive list of pollutant sources that have potential to affect the quality of surface waters.

Not included in this TMDL package are other regulatory programs that have indirect benefits for TMDL reduction, also available at GreshamOregon.gov:

- WPCF Permit for Underground Injection Controls (UICs) to protect groundwater
- Columbia South Shore Well Field Wellhead Protection practices
- City's Commute Trip Reduction Plan, and Air Contaminant Discharge Permit for the cogeneration facility associated with the Wastewater Treatment Plant

Table 1.2 Discharge Sources and Relevant TMDL Implementation Plan

Pollutant Source or Transport Mechanism	TMDL Parameters of Interest*	Implementation Plan & Lead Dept(s) or Division(s)
Treated and untreated (if there is an upset) sanitary waste discharged from the City's Wastewater Treatment Plant or collection system	*Bacteria, phosphorus, pH, dissolved oxygen, dioxin, mercury*	City's NPDES Wastewater Treatment Plant permit (DES Wastewater Services Division)
Mercury discharges from wastewater (entering Columbia River)	*Mercury*	City's Mercury Minimization Plan (req. by WWTP permit)
Untreated sanitary waste discharged from private system backups or failing septic tanks	*Bacteria, phosphorus, pH, dissolved oxygen, dioxin, mercury*	Nonpoint Source TMDL Implementation Bacteria Plan (DES Wastewater Services Division)
Stormwater runoff from the Wastewater Treatment Plant	*Bacteria, phosphorus, pH, dissolved oxygen*	1200COLS NPDES Permit (DES Wastewater Services Division)
Stormwater runoff and illicit discharges that enter the City's stormwater system (City outfalls to local surface waters)	*Bacteria, phosphorus, pH, dissolved oxygen, dioxin, DDT, DDE, dieldrin, lead, mercury, PAHs, PCBs*	City's NPDES MS4 Permit, SWMP, Environmental Monitoring Plan (DES Water Science & Policy)
Stormwater runoff and illicit discharges that don't enter the City's stormwater system, but are directly discharged to surface waters (e.g. fertilizer and pesticides, animal feces, dumping)	*Bacteria, phosphorus, pH, dissolved oxygen, dioxin, DDT, DDE, dieldrin, lead, mercury, PAHs, PCBs*	City's NPDES MS4 Permit and associated documents** (DES Water Science & Policy)
Atmospheric dry deposition into surface waters	Mercury, *lead*	City's Commute Trip Reduction Plan (Office of the City Manager)
	None known	City's Cogeneration Facility Air Contaminant Discharge Permit (DES Wastewater Services Division)
Contaminated groundwater inflow (known and unknown sites of spills and leaks; excess fertilizers and pesticides)	*PAHs, PCBs, lead, phosphorus, DDT, DDE, dieldrin*	City's NPDES MS4 Permit and associated documents (DES Water Science & Policy) City's Well field Wellhead Protection Program (DES Water Science & Policy) City's Underground Injection Control Program (DES Water Science & Policy)
Solar radiation (lack of shade)	*Temperature, chlorophyll a (dissolved oxygen, pH****)	City's Temperatures TMDL Implementation Plan (DES Water Science & Policy)

Solar radiation (in-line City-owned ponds)	*Temperature, chlorophyll a (dissolved oxygen, pH***)*	City's Temperatures TMDL Implementation Plan (DES Water Science & Policy)

*TMDL parameters that may be affected by the discharge are listed. Those that are reduced through implementation of the plan(s) listed in the right-hand column are shown in italics.
**The City stormwater system is defined in code to include surface waters and the public drainage infrastructure. The City's programs outlined in the SWMP are applied to surface and groundwater areas and private non-point source activities, as applicable.
***TMDL parameters shown in parentheses are indirectly affected by stream temperature.

LEGAL AUTHORITY

The City of Gresham maintains legal authority for implementation of the elements contained with its various TMDL Implementation Plans. Authority is cited in the Gresham Revised Code (GRC) Chapters 1 through 11 as well as the Gresham Community Development Code (GCDC) and available on the City's website.

The primary sections utilized in the TMDL pollution prevention and removal strategies cited within this document include:

- GRC Chapter 3 Stormwater
- GRC Chapter 4 Wastewater
- GRC Chapter 7 Offences and Health
- GRC Chapter 9 Business Licenses and Regulation
- GRC Chapter 11 Administration (System Development Charges)
- GCDC Chapters 4 Land Use and Plan Districts
- GCDC Chapter 5 Overlay Districts

CITY PROGRAM PRIORITIES THAT ADDRESS TMDLS

The City of Gresham will continue to prioritize its emphasis on the implementation of both its NPDES permits for the health of its area water bodies, as well as its Natural Resource program for temperature.

Stormwater

The stormwater program focuses on the implementation of its Stormwater Manual to ensure that infiltration of runoff is conducted to the maximum extent practicable and what cannot be infiltrated is treated primarily with vegetated facilities and secondarily with other methods as needed. The program also focuses on proactive erosion prevention and sediment control for development and the removal of sediment from streets, catch basins, and other stormwater appurtenances. Lastly, the business inspection and technical assistance program and public education & outreach play a key role in driving safe behaviors related to the management of pollutant sources such as hazardous materials, outdoor storage of metals and care for outdoor landscaping and proper disposal of garbage, recycling and pet waste. Detailed in the SWMP on the city's website.

Natural Resources

The Natural Resources program continues to focus on the management of public land with particular attention to sensitive areas such as riparian buffers and wetlands and other key habitat for wildlife, as well as ongoing efforts to partner with community-based organizations and schools to steward land and work with private landowners to conduct enhancement. Public education & outreach focuses on connecting the public to community-based science such as bird and amphibian surveys and workshops to ensure that Gresham residents will work to protect what they love. Lastly, Natural Resources and Stormwater partner with the City of Fairview (via IGA) to fund Portland Audubon and Columbia Land Trust's Backyard Habitat Certification Program to promote native plants and wildlife support at homes, schools, and other properties.

Wastewater

Wastewater continues to plan for future maintenance and expansion of the wastewater treatment plant to meet the demands of a growing population and ensure proper function and compliance with its effluent limits, as well as delivering its Operations & Maintenance program to ensure that a portion of its pipes are replaced or repaired annually in order to prevent and reduce the potential for infiltration & inflow and clogging that could lead to contamination of stormwater or surface water with untreated sanitary waste. Wastewater also works with the county sanitarian to ensure that, when remaining septic tanks fail, homes are connected to the city system. Lastly, wastewater and stormwater partner to deliver a restaurant inspection program to prevent grease backups that could result in sanitary overflows and to ensure proper management of outdoor grease disposal to reduce vectors and stormwater pollution.

FISCAL ANALYSIS

Table 1.3. Previous 5-year update and projected future resources

	FY 13/14	**FY 14/15**	**FY 15/16**	**FY 16/17**	**FY 17/18**
Wastewater Program Resources	$54.1 M	$61.6 M	$54.1 M	$56 M	$57.2 M
Stormwater Program Resources	$16.3M	$17.4 M	$20.5 M	$22.6 M	$22.1 M
Natural Resource Program Resources	$347,000	$273,000	$350,000	$331,000	$441,000
Future*	**FY 18/19**	**FY 19/20**	**FY 20/21**	**FY 21/22**	**FY 22/23**
Wastewater Program Resources	$51.2 M	$52 M	$52.5 M	$53 M	$53.5 M
Stormwater Program Resources	$24.3 M	$24.5 M	$24.75M	$25 M	$25.25 M
Natural Resource Program Resources**	$452,000	$456,000	$460,000	$464,000	$469,000

*Future revenues are estimated at a .01 growth rate to mimic inflation adjustments. Actual rate increases vary by Division and an analysis of overall community priority needs. The City's annual budgeting process includes public involvement and all rate increases are subject to City Council approval.

**The portion of the Natural Resource budget allocated to shade enhancement will be provided in Annual Reports to DEQ.

PUBLIC INVOLVEMENT

The City of Gresham conducts public involvement as required by DEQ for each of its permits. Generally, this includes making the draft compliance plans available via its website and posting notices to the public via print and online internal and external media channels such as the newspaper, emails to stakeholders, and city newsletters. In 2008, the TMDL Implementation Plan was presented to an environmentally focused advisory committee of Gresham residents and business representatives. In other years such as 2013-15 the draft TMDL plans and Stormwater Management Plan updates were also presented. Additionally, SWMP plans are presented and adopted by the City Council. In the future stormwater permit update, the SWMP and TMDL evaluation will be presented to the City Council that includes how the compliance with the WWTP, 1200COLS permit and wastewater programs are all part of the overall compliance effort to reduce bacteria and mercury, in particular.

Table 1.4 provides a condensed version of the NPDES wastewater and stormwater permit general commitments that reduce TMDL pollutants. Both permits require annual reports which provide information on the treatment plant's stormwater, industrial pretreatment, and biosolids management programs, as well as the Stormwater Management Plan (SWMP) implementation, including additional activities conducted for TMDL compliance. The detailed commitments will be found in the original documents, not this table.

Gresham's current SWMP was approved in 2011 and expired in 2015 and is currently on administrative extension. This plan will be updated upon the renewal of the permit. The 2015 permit renewal submittal contains the TMDL evaluation. An analysis of the 303(d) listed pollutants was submitted in 2008.

Table 1.4 also includes the nonpoint sources not covered by DEQ permits because they flow directly to streams without entering the public stormwater system and temperature is not a pollutant associated with stormwater because stormwater occurs during the cold season. As such additional actions that will be taken are described in Sections II and III for the bacteria and temperature TMDLs.

Implementation plans are summarized in **Table 1.4**, those not included but available on GreshamOregon.gov:

- Stormwater Management Plan and Environmental Monitoring Plan required under the National Pollutant Discharge Elimination System (NPDES) Permit for stormwater discharges
- Wastewater Treatment Plant individual wastewater and general stormwater NPDES Permits

OVERVIEW OF MANAGEMENT STRATEGIES

Oregon Administrative Rule (OAR 340-042-0080(3)(a)(A) &(B)**)** requires that a TMDL Implementation Plan:

> *(A) Identify the management strategies the DMA or other responsible person will use to achieve load allocations and reduce pollutant loading;*
> *(B) Provide a timeline for implementing management strategies and a schedule for completing measurable milestones;*
> *(C) Provide for performance monitoring with a plan for periodic review and revision of the implementation plan;*
> *(D) To the extent required by ORS 197.180 and OAR chapter 340, division 18, provide evidence of compliance with applicable statewide land use requirements; and*
> *(E) Provide any other analyses or information specified in the WQMP.*

Each of the City's TMDL Implementation Plans include the required elements. This Overview provides a summary of those elements, as described below, and in **Appendix A**:

<u>Requirements A, B, and C (management strategies, timeline/milestones, and performance monitoring)</u>: Activities are summarized by **Table 1.4** and TMDL Plans will be updated and evaluated on a 5-year basis. Monitoring is described in the City's Environmental Monitoring Plan and a discussion is included in the Temperature TMDL Plan.

In response to the DEQ Mercury Monitoring Order the City of Gresham conducted low-level mercury monitoring, which is described in **Appendix A.**

<u>Requirement D (land use compatibility)</u>:

A land use compatibility statement (LUCS) was provided as part of the application for the NPDES permits. No requirement exists in the Oregon Administrative Rule that a Nonpoint Source TMDL Implementation Plan include a LUCS. However, a general compatibility assessment is included below that addresses all the TMDL-related activities and discharges under the City's jurisdiction. The assessment was conducted by the City's long-range planner, who also provided the formal Land Use Compatibility Statement for the NPDES Stormwater permit.

Findings: Gresham's Comprehensive Plan has five volumes and complies with Statewide Planning Goals, per LCDC (1980s). Most recently, in 2003, an update of the Comprehensive Plan was approved by LCDC through the state periodic review process. The TMDL Implementation Plans are consistent with the City's acknowledged Comprehensive Plan to the extent required by law.

In Comprehensive Plan Volume 2, Chapter 10.232, Water Resources Quality and Chapter 10.333, Stormwater Management System, Public Facilities and Services pertain to TMDLs. These chapters and subsections support the general goals, policies and action measures are written to establish a baseline for protecting the quality of Gresham's ground and surface water. These sections address federal and state regulatory requirements and keeping the City's stormwater standards and practices current with these regulations. For example, Action Measure

#6 of Chapter 10.333 directs the City "to prepare and implement TMDL implementation plans for applicable water bodies".
Subsections describe other actions the city has included in its TMDL Implementation Plans, such as using low impact development practices for handling stormwater runoff, maintaining and cleaning the stormwater system to maximize its efficiency and to meet regulatory requirements, educating the public about the need to protect water quality and enhancing/restoring/acquiring riparian areas and wetlands.

The TMDL Implementation Plans are also compatible with Volume 3 of the Comprehensive Plan Section 5.0417 Water Quality Resource Area Overlay (WQRA), which requires new development to be set back a certain distance, ranging from 15 to 200 ft., from a stream or wetland and related best management practices (BMPs) that support this effort may be found in the City's SWMP and Temperature TMDL Plan.

Conclusion: Gresham's acknowledged Comprehensive Plan has provisions that are relevant to the TMDL Implementation Plans. Based on the above findings, it is found that the TMDL plans are compatible with these provisions.

Requirement E (Additional requirements in the WQMPs):

The TMDLs include requirements that are specific to a given waterbody and to Gresham. These requirements are listed in **Appendix A**. For each requirement, a note is provided that indicates the Implementation Plan in which it is addressed.

Table 1.4. Summarized Commitments for 5 Year TMDL Plan

Key to Pollutant Symbols: An empty circle means the level of effect is unknown, but some effect is likely. A star means the BMP has significant effect if widely and fully implemented (not always the case). A diamond indicates a BMP that has a lesser effect. Blank indicates that the BMP has little direct effect on that pollutant. These designations are based on professional judgment only, based mainly on the ability of the BMP to prevent solids from entering, or to remove solids from stormwater. Program Commitments that have no symbols are integral to other activities that have symbols, or are not expected to have significant effects on the listed pollutants.

Checkmarks in the Watershed column indicate that the BMP is conducted in that basin. A boldfaced checkmark means that the BMP is implemented to a much greater degree in that basin than in other basins.

An "X" in the Regulatory Program columns indicates that the City's compliance efforts for the identified program include that BMP.

"Nonpoint Source" refers here to temperature and bacteria associated with private sector sanitary waste.

Best Management Practice or Activity	Commitment	Performance Measure	Milestones	Adaptive Management	Pollutant										Watershed					Regulatory Program					
					Nutrient Related*	Bacteria	Temperature	DDT/DDE	Dieldrin	Dioxin	PAHs	Mercury	Lead	PCBs	Johnson Creek	Fairview Creek	Columbia Slough	Sandy River	Columbia River	NPDES--MS4	Nonpoint Source	UIC (drywells)	NPDES--WWTP	Limit 10	Goal 5/Title 13
COMPLY WITH MUNICIPAL SEPARATE STORMWATER SEWER SYSTEM (MS4) NPDES PERMIT																									
See complete SWMP for full details on: GreshamOregon.gov																									
Stormwater O&M Program	**Implement O&M activities to prevent or remove sediment and associated pollutants**	▪ Miles cleaned/yr Volume of debris removed/yr	Annual reporting -ongoing; evaluate progress in total city acres treated for each updated stormwater management plan	**Expected 2021-22**	t	t		t	t	t	t	t	t	t	P	P	P	P	P	X					
Stormwater Manual for Development & Erosion Prevent & Sediment Control	**Implement the Development Standards to prevent or reduce pollutants via filtration, plant uptake, degradation, ad-ab-sorption and others.**	Track development, treatment type and acres treated.	Annual reporting -ongoing; evaluate progress in total city acres treated for each updated stormwater management plan	**Expected 2021-22**	ó	ó	ó	ó	ó	ó	ó	ó	ó	ó	**P**	P	P	P	P	X		X			
Private Stormwater Facility Program	**Ensure private facilities are cleaned and maintained on a schedule that is based on best practices**	Track private facilities by type, maintenance education/guidance provided, inspection/owner reporting schedule, and cleaning/repairs conducted as applicable	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	**Expected 2021-22**											P	P	P	P	P	X		X			
Transportation Division O&M program	**Implement O&M activities to prevent or remove sediment and associated pollutants**	▪ Lane miles swept ▪ Water protection O&M procedures utilized	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	**Expected 2021-22**											P	P	P	P	P	X		X			
	Plan stormwater treatment for new road development	Type of stormwater treatment added and acres of area treated	Evaluate progress in total city acres treated (captured above)																						
Water Quality Retrofits and Capital Improvement Projects	**Implement capital and retrofit projects for stormwater and natural resources to prevent or remove pollutants, address temperature, and improve stream resliliency and function**	▪ Track the number, type, watershed location and total drainage area of CIPs or retrofits constructed for water quality and natural resources	Annual reporting-ongoing; evaluate project master lists and funding projections for each updated stormwater management plan	**Expected 2021-22**	□	□		ó	ó	ó	ó	ó	ó	ó	P	P	P	P	P	X		X			
Illicit Discharge/Spill Response Program	**Implement an illicit discharge and spill response program to prevent or reduce impacts to surface water from pollutants**	Document illicit discharge procedures and conduct field investigations, track and respond to spills and document outcomes for activities	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	**Expected 2021-22**	t	t	t			t	t	t	t	t	P	P	P	P	P	X					
Solid Waste & Recycling Program	**Implement programs for the public and businesses that reduce impacts to stormwater from waste storage and disposal**	▪ Report quantities of hazardous materials disposed/yr. ▪ Report number of spill incidents and outcomes/yr.	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	**Expected 2021-22**							t	t	t	t	P	P	P	P	P	X		X			
Business Inspection & Enforcement Program	**Implement inspections at prioritized businesses based on regulatory program needs and potential threats to surface water**	Track number of sites inspected annually by type, issues identified and resolutions.	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	**Expected 2020-2021**	t	t	t			t	t	t	t	t	P	P	P	P	P	X		X			
Construction Site Inspection & Enforcement	**Implement inspections at public and private construction sites**	Track number of sites inspected annually by type, issues identified and resolutions.	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	**Expected 2020-2021**	ó	□	□	ó	ó	ó	ó	ó	ó	ó	P	P	P	P	P	X		X			
Educate Residents	**Program Commitment:** The City will continue to educate residents regarding their personal contributions to stormwater pollutant sources.	▪ Track programs/messages delivered, type of communication piece and where appropriate, number of people affected.	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	**Expected 2020-2021**	□	ó	□			□	□	□	□	□	P	P	P	P	P	X	X	X			
Educate Businesses	**Program Commitment:** The City will continue to educate businesses regarding their contributions to stormwater sources.	▪ Track programs/messages delivered, type of communication piece and where appropriate, number of businesses affected.	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	**Expected 2020-2021**	t	t	t			t	t	t	t	t	P	P	P	P	P	X		X			
Public Involvement	**Program Commitment:** Conduct public involvement related to the updated SWMP and associated TMDLs and present the SWMP and associated documents to City Council each time the Stormwater Permit is renewed	▪ Summarize the public involvement actions taken	Each permit renewal cycle	**Expected 2020-2021**											P	P	P	P	P	X					
COMPLY with WASTEWATER TREATMENT PLANT NPDES PERMIT																									
WWTP O&M and Monitoring	**Implement procedures to ensure proper function of WWTP to prevent overflows and to meet effluent limits**	Train staff, implement procedures and report upsets and sampling exceedance	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated WWTP permit cycle	**Expected date uncertain**	ó	ó				t	t	t	t	t	P	P	P	P					X		

Mercury Minimization Plan	**Implement the plan to prevent or reduce the introduction of mercury into surface waters**	Report on plan implementation	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated WWTP permit cycle	**Expected date uncertain**																				
Wastewater O&M and CIP Program	**Implement O&M procedures and capital projects to prevent inflow and infiltration and clogs leading the introduction of sanitary waste into surface waters**	Track work conducted and capital projects anniually	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated WWTP permit cycle	**Expected date uncertain**	t	t	t			t	t	t	t	t	P	P	P	P	P	X	X		X		
COMPLY with STORMWATER PERMIT (1200-COLS) FOR WASTEWATER TREATMENT PLANT																								
Implement BMPs and Monitoring	**Prevent or reduce impacts to surface water from WWTP activities & landscape management**	Train staff on housekeeping practices, sample per permit	Reporting schedule as defined in the permit--ongoing; evaluate activities for permit compliance as needed	**Expires Aug 2022**	ó	ó				t	t	t	t	t	P	P	P	P	P				X		
NONPOINT SOURCE TMDL IMPLEMENTATION PLANS																								
Bacteria																								
NPB-1 Mid-County Sewerage Project	**Program Commitment:** Report the connection of the final two holdout homes	Report as progress happens	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	Updated 5yr plan	ó	ó									P	P	P		P		X				
NPB-2 Development Code	**Program Commitment:** Ensure that new and redevelopment connect to the public sanitary system, as the city system become available.	Number of new connections to the City system	Annual reporting-ongoing; evaluate frequency and adjustments needed for each updated stormwater management plan	2018-2023	ó	ó									P	P	P	P	P		X				
NPB-3 Utility Billing Survey	**Program Commitment:** Ensure that failing onsite systems are replaced by connection to City system, where City system is available.	List of properties with potential septic tanks QA/QC list Evaluate education options	Summer 2020 Complete and report in year five 2023	Updated 5yr plan	ó	ó									P	P	P	P	P		X				
NPB-4 Private Backups	**Program Commitment:** Determine location of onsite systems within City boundaries as of 2008	Number of failures reported, and outcome	Annual reporting-ongoing;	2018-2023											P	P	P	P	P		X				
NPB-5 Homeless Camps	**Program Commitment:** Address environmental impacts from homeless camps	Summary of procedures and resources to address camp impacts	Annual reporting-ongoing	2018-2023	ó	ó									P	P	P	P	P		X				
Temperature Management																								
NPT-1 Natural Resource CIP Implementation	**Program Commitment:** Pursue implementation of floodplain, wetland, and riparian projects with an identified temperature benefit, as allowed for in the Watershed Division's current Capital Improvement Plan.	By watershed (where applicable as some are city-wide), projects advanced. Includes, by project: (1) scale in stream feet, or riparian acreage (this includes on-the-ground improvements, acquisition, or securing easement rights); (2) $ spent that reporting year; (3) shade class affected (where applicable)	Annual reporting-ongoing	2018-2023			ó								P	P	P	P	P		X				X
NPT-2 Riparian Planting	**Program Commitment:** Work with community, volunteers, and private landowners to install ecosystem potential vegetation within target shade buffer areas	By watershed, projects implemented. Includes, by project area: (1) acreage; (2) $ spent that reporting year; (3) # of stems planted; (4) statement of existing shade classification; (5) outreach/volunteers per site.	Annual reporting-ongoing	2018-2023			ó								P	P	P	P	P		X				X
NPT-3 Monitoring and Reporting	**Program Commitment:** Annually report on implementation of projects; every 5 years report on density, species, and survival statistics; every 10 years provide an analysis of change in shade conditions.	Every 5 years: stems installed; volunteers engaged. Every 10 years: change in shade classification conditions; and metrics related to Natural Resources Master Plan Update. Non-repeating projects like the forest health assessment findings will be reported here, using acreage to denote extent of areas of declining/improving forest health.					ó								P	P	P	P	P		X				X

SECTION II:

BACTERIA IMPLEMENTATION PLAN FOR PRIVATE SECTOR SANITARY WASTE

INTRODUCTION

The Department of Environmental Quality (DEQ) has set Total Maximum Daily Loads (TMDLs) for bacteria that affect all the City's watersheds. The bacterium that serves as the basis for freshwater bacteria TMDLs is *Escherichia coli (E. coli),* which is an indicator of contamination by human or animal waste. E. coli serves as a proxy for other pathogens such as harmful bacteria, viruses, amoebas, etc. Such pathogens may cause infections of the eyes, ears, skin, and gastroenteric systems of those who engage in water-contact recreation.[2]

The City of Gresham is responsible to develop and implement TMDL Implementation Plans to reduce the contribution of bacteria to surface waters from activities and discharges that are under the City's jurisdiction. The City's jurisdiction includes discharges that enter and exit the public sanitary and storm sewer systems. Although onsite systems (e.g. cesspools & septic systems) are regulated by DEQ and its local agent, the City of Portland, rather than the City of Gresham, the City has adopted policies in support of these agencies' missions to minimize the contribution of bacteria from onsite systems. Gresham also responds to sewage spills from public or private collection systems as needed to protect the environment. **Table 2.1** summarizes potential sources of bacteria and lists the relevant TMDL implementation plan that addresses each source. **This Nonpoint Source TMDL Implementation Plan addresses only bacteria associated with discharges that originate from private sanitary sources.**

SCOPE OF THE PROBLEM

There are at least 200 strains of *E. coli,* and more than 100 types can cause human illness, E. *coli 0157:H7* and two major strains producing Shiga toxin (Stx1 and Stx2). Levels exceed DEQ standards in all the City's streams from which samples have been taken, although Gresham's streams (Kelly, Johnson, and Fairview) are not large enough to swim or boat on and the Columbia Slough is not accessible with Gresham's boundaries, the concern is for human contact with water and then touching the eyes, mouth, or nose and contracting an illness or developing a skin rash.

Exceedances occur during both rainy and dry weather, which indicates that waste from pets and wildlife, and sources of human sewage are all potential contributors to the problem. The City of Gresham has not conducted tests to determine the relative contribution of bacteria from various sources. However, the City has few residents or businesses with private sanitary systems. The City also receives few reports of failed systems or sewage spills from plugged private pipes, so private, nonpoint sources of bacteria from human waste are likely to be a small contributor to bacteria exceedances.

[2] Drinking water is assumed to experience chlorination and often filtration prior to use, so the water quality standard and TMDL focus on protection of recreationists.

Table 2.1. Bacteria Sources and TMDL Implementation Plans

Potential Sources of E. coli	Plan that Addresses the Source
Treated sewage from the wastewater treatment plant	National Pollutant Discharge Elimination System (NPDES) permit for wastewater treatment plant
Untreated sewage from overflows from the wastewater treatment plant or the public collection system	
Stormwater contaminated by contact with feces from wildlife or human wastes at the wastewater treatment plant	NPDES 1200COLS permit for stormwater from wastewater treatment plant
Untreated sewage from failures or spills from private systems (onsite systems—e.g. cesspools & septic systems; or blocked private pipes)	Nonpoint Source TMDL Implementation Plan, Bacteria Implementation Plan for Private Sector Sanitary Waste
Stormwater contaminated by contact with pet and wildlife feces	NPDES municipal stormwater permit
Stormwater contaminated by illicit dumping such as from recreational vehicles, or from cross connections with sanitary sewer	
Direct discharge of human or animal wastes into streams[3]	

RELEVANT REQUIREMENTS

The TMDLs for each of the major watersheds within Gresham have slightly different requirements related to bacteria reductions associated with either nonpoint sources or onsite systems. The relevant requirements are listed below.[4]

- For the Upper Slough, the 1998 Columbia Slough TMDL requires sanitary surveys of septic systems and removal of direct discharges of human waste. It also requires a bacteria management plan.
- The TMDL for the Sandy Basin requires an 86 percent reduction in bacteria loads for Beaver Creek and encourages bacteria source tracking as a useful way to focus management efforts.
- The Willamette TMDL requires 78 and 66 percent reductions for Johnson Creek and Fairview Creek, respectively. It also recommends further monitoring to identify bacteria sources, once reasonable steps to reduce bacteria levels have been taken. Neither the Sandy nor Willamette river TMDLs specifically address private systems.

[3] The NPDES municipal stormwater permit does not require the City to address this source, but the activities conducted for stormwater also discourage this type of discharge.

[4] The Columbia River TMDL does not include bacteria, so is not described here.

MANAGEMENT STRATEGIES—Updated for 2019-2023

The City has already taken the most effective steps to reduce bacteria from private sanitary systems. Foremost among these steps are the City's efforts related to onsite systems.

To address the risk of bacteria from onsite systems, the City has made significant efforts. These include:

1. **Mid-County Sewer Project:** Participation in the mid-County sewerage project ordered by DEQ: That project required that any onsite systems within a designated area in Multnomah County be phased out and connected to municipal collection and treatment systems during the period between 1984 and 2005. The City participated fully in the project, and successfully oversaw conversion of approximately 8,000 systems within the requisite timeframe. Two previous holdouts are in the process of connecting.
   Next steps in this process include:
   a. Report on connections during the next five years.

2. **Development Code:** Requiring that new and re-development connect to the public collection and treatment system and prohibition of new septic systems: In previously rural areas that are annexed into the city, properties will be connected when gravity fed systems are within 300 feet and new homes will be connected to the city system.
   Next steps in this process include:
   a. Report on connections during the next five years.

3. **Utility Billing Accounts Survey:** Onsite survey required by the 1998 Columbia Slough TMDL: To meet this requirement, the City uses its utility billing system to identify properties that pay for drinking water but do not have wastewater service and has applied this effort to all waterbodies to monitor potential septic tank removals over time. Utility accounts that have a structure (home or business) but that do not have a wastewater account may have an onsite septic system.[5] In some cases this count is not accurate because it is possible that a neighboring structure that has a wastewater account is providing the service (typically in a business setting). However, as onsite systems fail the responsible party, or their contractor would typically contact the County sanitarian or the City to request a new onsite permit. This typically results in being required to connect the city system as described above. Another method for failing systems to come to our attention include neighbors reporting them government officials, who would enforce health and environmental codes with the same result.

Next steps in this process include:
   a. Update the list of UBA surveys (last completed in 2016): Summer 2020
   b. QA/QC the lots in the list and conduct a phone or written survey to obtain a final updated estimate of onsite systems: Complete by 2023
   c. Evaluate options for septic maintenance best practice education delivery to remaining onsite system owners: Complete by 2023

To address the risk of bacteria entering surface waters from private pipes that connect to the public system, the following applies:

[5]Ground truthing in the form of surveys or smoke or dye testing are needed to confirm.

4. **Private plumbing backups:** these are addressed by Code Enforcement to protect surface water and human health. If a plumbing problem occurs and sewage spills onto the ground, the City's first step is to direct the responsible party (RP) to correct the problem. If no responsible party can be found, or the RP declines to act within an acceptable time frame, the City can fix the problem and seek compensation from the responsible party and use a lien for unpaid repairs or fines. Private sewage spills have been a rare occurrence, with only one or two reports every few years. Private spills are reported in the City's Annual Stormwater Report.

   Next steps in this process include:

   a. Report spills in the Stormwater Permit Annual Report: ongoing

5. **Bacteria from Homeless Camps:** Sadly, houselessness continues to be a significant issue in the Portland-Metro Region. Based on the Multnomah County Point-in-Time Count Report, Gresham's population of people living unsheltered outside has swelled from about 19 in 2007 to almost 200 in 2015. In 2016, the City hired a person dedicated to helping the homeless find living situations through a variety of resources, which contributed to a significant decline to 75 in 2017. The City, in partnership with other agencies continues to clean up camps and provide sanitation and resources to lessen impacts to the environment from houselessness. There is no method of estimating potential bacteria contributions to surface water from this population, but efforts will continue to ensure that all people have access to homes and sanitation.

   Next steps in this process include:

   a. Provide a description of the City's efforts and Point-in-Time Count Report updates in TMDL annual report: ongoing

RESPONSIBLE PARTIES

Staff in several departments within the City (and at the City of Portland) have responsibility to ensure implementation of the management strategies:

- The Wastewater Services Division oversaw implementation of the mid-County sewerage project and has primary responsibility for locating onsite systems and ensuring they have access to the public sanitary system.
- The Building Division, and Development Engineering & Inspection share responsibility to ensure that new and re-development connects to the public sanitary sewer system.
- The Multnomah County Sanitarian ensures that failed onsite systems are not replaced with new private systems, by directing applicants who apply for permits for replacement systems to the City to connect to the public system, where it is available.
- The Water Resource Division staff coordinate to ensure that private plumbing blockages do not result in the flow of human wastes into surface waters by directing responsible parties, ensuring code compliance, and CCTVing connections to the city's system to check for blockages.

FUNDING & PRIORITIZATION OF PROJECTS

See Fiscal Analysis in Section I.

As noted above, the potential for human illness is low and the potential for significant bacterial loads associated with human waste into surface waters due to the clogging of private systems is also low due to its uncommon occurrence. Furthermore, there are relatively few remaining onsite septic systems within the City which are being required to hook up as they fail. **Therefore, the City believes that its current level of effort is adequate to address bacteria from private sector sanitary waste.**

REPORTING, MONITORING OF WATER QUALITY, AND ADAPTIVE MANAGEMENT STRATEGY

General Timelines and Performance Measures are shown in the **Table 1.4 overview, but details will be found in specific permit documents.** An Effectiveness Evaluation will be included in five-year reviews of the effectiveness of the Nonpoint Source Implementation Plan and/or SWMP or other permit updates, as applicable.

Five-year reviews include the relevant annual report, plus an evaluation of the status of the water bodies with respect to bacteria based on available data, and an assessment of whether different or additional efforts are needed by the City to further reduce bacteria levels or to characterize the sources of bacteria.

Once the City has taken all reasonable steps to reduce bacteria levels from the sources under its jurisdiction, it will evaluate whether bacteria source testing is needed to better focus any future efforts.

SECTION III:

Gresham Temperature TMDL Implementation Plan Update (2018/19-2022/23)

BACKGROUND:

Oregon DEQ issued temperature reduction plans for the Sandy Basin in 2005 and the Willamette Basin in 2006. City of Gresham has jurisdiction over waterways draining to both basins and has therefore been assigned a Designated Management Agency role with responsibility for addressing elevated stream temperatures within its current city limits. As such, the City submitted an initial Temperature TMDL Implementation Plan in 2007 based on a GIS model that identified riparian areas which would be targeted for natural resource improvements. A first amendment to that plan was submitted to DEQ in 2008, detailing the management strategies the City would follow to improve stream and riparian conditions. These materials are included in this report as **Appendix B**. Our first five-year update to the Temperature TMDL Implementation Plan was submitted in 2014, and outlined several adaptive management strategies changes we planned to pursue through the 2018 reporting year, including:

1. **Use of fast-growing pioneer tree species to gain faster shade benefits**. Besides the black cottonwood, those species on DEQ's Ecosystem Potential Vegetation list are generally very slow growing and these species would benefit from some on-site shade in their juvenile stages. As such, the City noted in the 2014 update that staff will include smaller deciduous species best suited to thrive following site clearing of invasive monocultures of blackberry, ivy, or morning glory as part of our strategy.

Fast initial growth and nitrogen fixing capabilities of the plant suite chosen as "first phase restoration plantings" will improve site conditions for a second phase of planting that will emphasize the slower growing conifers on the DEQ Ecosystem Potential Vegetation list. This strategy sought to accelerate realization of shade cast on the stream surface as well in treatment areas.

2. **Updated reporting strategies**. Gresham has refined reporting means for macrophyte control and shade classification efforts. 2020 is the year targeted for the updated shade mapping and will be included in the 2020/21 annual report, and will be completed in conjunction with the update to the shade model revisions presented below as an adaptive management strategy revision in this 2018/19-2022/23 update.

These adaptive management strategies were implemented and utilized in the 2013-2018 five-year update. Gresham continues utilizing those revised management strategies moving forward.

MANAGEMENT STRATEGIES FOR 2018/19 - 2022/23

The City of Gresham continues to invest in projects based on the prioritization scores generated through the City's 2010 Natural Resources Master Plan model; progress in implementation of those strategies are reported annually, as well as in our 5-year TMDL progress report, submitted to DEQ in 2018. Current activities include:

NPT 1: Natural Resources Capital Improvement Projects (CIPs):

The Natural Resources CIP funding is nested within the Stormwater CIP budget. Stormwater CIP funding has been obligated and focused for the last few years to the repair and replacement of the Kane Road culvert, a major arterial culvert that collapsed in the December 2015 flood events, and to improvements required as part of a City-wide local road improvement project, ensuring that stormwater infrastructure is repaired concurrent with road improvements. This cost-efficiency strategy is resulting in replacement of failing or near-failing critical infrastructure and is projected to continue through the duration of this next TMDL reporting cycle (through 2022/23). During that same time period Natural Resources CIP funds will be utilized on the following projects:

1. **Updating Gresham's riparian buffer code and mapping.** The City protects riparian vegetation through natural resource inventories and environmental overlays or zones. Gresham currently has 3 separate riparian buffer models from which inventory maps are derived, and 3 separate sections of riparian protection code that all differ depending on the area of the community they were developed for (Gresham Development Code sections 4.1400, 4.1500, and 5.0400).

   These are intended to protect and conserve natural resources, including water quality and fish and wildlife habitat. Gresham embarked on this project to update the underlying natural resource inventories in 2016, using the best available data in terms of resource locations. The effort also includes unifying and simplifying the associated model/maps and protective code language.

   The current complexity of the three disparate models and corresponding code sections has been a challenge for landowners to understand and comply. The new standards will be of similar size, but the mapping and code associated with the standards will be greatly simplified, making administration, compliance, and enforcement much easier for staff and landowners.

   As proposed public projects or private development proceed, the new standards will improve protections for high value resources, including the area defined as the Temperature TMDL shade buffer. Development will be planned to better avoid adverse stream and wetland impacts and enhances options for mitigating unavoidable impacts. This mapping and code update will be a critical tool in implementing and protecting temperature TMDL plantings, and decreasing potential for riparian impacts that can lead to stream widening and similar negative hydromodification. Next steps in this process include:

   a. Spring-Summer 2020: Public Outreach
   b. Summer-Fall 2020: Planning Commission and City Council hearings

c. Winter 2021: City Council approval and effective date

*Note: The management strategies included in this update are consistent with the City's current (as outlined in **Appendix B**) and proposed (as described above) land use plans and requirements.*

2. **Updating Gresham's Natural Resources Master Plan.** With the update of Gresham's riparian buffer model and code, Gresham Natural Resources will be conducting a 10-year update of their 2010 Natural Resources Master Plan, which scopes out and prioritizes stream, wetland, riparian and upland projects, and is informed in part by the geometry of the City's regulated buffers. This will include updated field work and development of enhanced stream and wetland project descriptions. This initiative includes:

   a. Updating Gresham's riparian shade classification mapping. Last completed in 2009/2010, this mapping effort relies on aerial imagery analysis by natural resource professionals to score riparian vegetation conditions as good, moderate, or low, in terms of its shade-producing capacity. Results are used as part of the prioritization model to identify stream reaches with the highest potential for significant improvements.

   b. Working with Gresham's Transportation Division, and private & public stakeholders to identify culvert replacement opportunities that will restore fish passage and stream function, reduce negative hydromodification on streams, and address the need for adjacent riparian improvements.

   c. Coordinating adoption of a 2020/21 Natural Resources Master Plan and adoption of a 2020/21 Gresham Stormwater Master Plan to identify opportunities for prioritized water quality retrofit projects to be incorporated into Natural Resource project implementation.

   d. Update the basis for Stormwater "System Development Charges" (fees collected when new development occurs in the city), to be used to fund a portion of new infrastructure, including green infrastructure, land acquisitions, riparian easement acquisitions, and stream, floodplain, and wetland mitigation. This will increase Gresham's access to high value riparian and stream areas and allow for implementation of riparian and waterway improvements on private land, where easement rights have been negotiated.

   e. Identification of stream and wetland mitigation opportunities as close to the proposed impact sites as possible. By finding opportunities to mitigate close to unavoidable impacts, hydrologic functions will be less likely to be lost to mitigation banks outside the 5th field HUC scale.

   f. Forest Health Canopy Assessment. In the last 5 years, there has been an alarming die-off of multiple native species of trees. The hypothesis for this die-off is presumed to be attributable to the increase in total number of extremely hot days (>90 degrees) during summer months. This is not unique to Gresham. Gresham is working with regional and statewide forestry professionals to develop an assessment

strategy to define the extent of the problem and to identify a prioritized response to removing dying overstory before tree fall negatively impacts slope stability, public infrastructure, public safety, and adjacent streambanks. Critical areas will be identified and used in prioritizing where Gresham will expend restoration dollars from our Operating and CIP funds.

Tasks within this management strategy include:

a. Field work: Summer 2020
b. Shade classification and forest health mapping: Summer 2020
c. Restoration project identification: Winter 2021
d. Mitigation opportunity identification: Spring-Summer 2021
e. CIP development and SDC update: Summer 2021
f. On-the-ground implementation phase: Fall 2021-ongoing

NPT 1&2: Riparian Restoration-Operating and CIP funds. Projects are conducted with annual operating funds that have been allocated to support continuing maintenance at existing restoration project sites, as well as the initiation of new restoration sites. City operating funds are leveraged with grants and watershed partners to complete these projects; current restoration investment averages approximately $125K annually. In addition to ongoing restoration projects described above, the City has utilized CIP funding to prepare and plan for larger scale restoration at two sites:

g. **Butler Creek Corridor.** A high priority restoration project, per Gresham's Natural Resources Master Plan, is riparian restoration and bank stabilization around a primary tributary to Johnson Creek. Natural Resources CIP funding is being utilized to contract professional restoration crews to treat extensive invasive cover that is preventing regeneration of forest canopy, install erosion control and stream aggradation measures, and plant and maintain a diverse native canopy that is incorporates increased diversity of species to increase resiliency of the resulting forest as we experience climate shifts in the Pacific Northwest.

Tasks for this 4-5-acre project include:

a) Initial public outreach: Summer 2020
b) Invasive weed treatment: Fall 2021-ongoing
c) Tree and shrub planting: Winter 2022-Winter 2023
d) Maintenance: Spring 2023-ongoing

h. **Fujitsu Ponds.** Gresham has been exploring financing options on how to address the highest ranking NRMP CIP Project-- the Fujitsu Ponds Improvement Project-- which will remove Fairview Creek from two large in-line relic quarry ponds, restore a discrete Fairview Creek channel connected to an active floodplain, and create adjacent wetland habitat. Significant temperature reduction benefits are expected as a result of this project. The estimated construction & maintenance budget is $9M. Finding a funding source remains the major obstacle for implementation. The City explored creation of a wetland mitigation bank at the site to make the project self-funded, but a risk tolerant funding partner has not yet been found. As part of the 2020 update to the Natural Resources Master Plan, smaller scale phased

improvements at the site will be developed so that portions of the improvements can be realized in phases. Tasks related to identifying implementation of project needs in phases will following the NRMP schedule articulated above.

i. **Encroachment Policy Creation.** Starting in 2018/19, Gresham has partnered with AmeriCorps volunteers, our Code Enforcement staff, and our City Attorney's Office to research anti-encroachment outreach and code enforcement across the country. During this next 5-year period, Gresham will be formulating new official policy and outreach campaigns to reduce encroachment violations, particularly those negatively impacting riparian vegetation, slope stabilization, and riparian function.

Tasks related to improved encroachment prevention and resolution include:

a) School outreach and children's art contest to improve messaging: Spring 2020
b) Neighborhood Association Outreach: Summer 2020
c) Formal policy development (and prioritization of logged encroachment): 2021
d) Encroachment resolution funding request by Code Enforcement: 2021-2022
e) Riparian landowner outreach: 2021

This effort will serve as the final official notice to riparian landowners that the Environmental Overlay Project is complete, and new buffer code and maps are now effective, and will offer technical assistance to ensure compliance with code designed to protect stream banks and riparian vegetation.

3. **Land Acquisition & Easements**: In 2018, the City updated its Stormwater and Natural Resources System Development Charges methodology and its Parks Master Plan. As part of this effort, new emphasis has been added to require privately-owned riparian corridors to be either donated to the City or protected with a natural resource easement as part of the development process. This will enable the City to conduct restoration activities on additional stream reaches in order to improve stream shade and reduce negative influences on stream function, including hydromodification. Significant improvements to this initial effort are slated to occur with the 2020 Stormwater Master Plan update and corresponding update to the Stormwater System Development Charge methodology. Improvements will better ensure City rights to monitor and improve riparian conditions within the easements.

PROPOSED PERFORMANCE MEASURE METRIC CHANGES FOR 2018/19-2022/23 REPORTING PERIOD

Based on our staff review of current restoration BMPs, as they apply to progress on implementing projects and being able to demonstrate forward progress on demonstrable progress in increasing stream shade, the following reporting metrics changes will be followed.

NPT 1: Addresses Channel Modification and Widening as a source of anthropogenic warming:

- Land acquisition and new riparian easement rights will be reported in linear feet of stream affected and associated riparian acreages.
    - Will include information on shade classification at time of acquisition

  This update allows us to demonstrate Gresham's efforts in developing natural resource and open channel easements as part of the private development process in order to gain access for riparian improvements and stream bank improvements on private riparian tracts.

NPT 2: Addresses Removal of Riparian Vegetation as a source of anthropogenic warming:

- Changes in riparian buffer protections and shade buffer geometries resulting from the 2016-2021 Environmental Overlay Project that is resulting in updated riparian buffers and associated code
    - Will discuss levels of protection by acres and how that relates to shade modeling previously completed by the City

NPT 3: Address Reporting Needs

- The addition of a Natural Resources Data Analyst position will enable Gresham to better convey progress on restoration implementation, and articulate investment levels per watershed (Kelly/Burlingame/Beaver which drain to the Sandy, and Johnson, Fairview, and Columbia Slough which drain to the Willamette)
- Updated aerial photo analysis on existing stream shade
    - Reported as acres of Good, Moderate, and Poor Shade Level Classifications.
    - Highlights impacts of drought stress declines in forest health

ADDITIONAL OBSERVATIONS:

1. Gresham's experience over the last 6 years that regional progress towards stream shading goals also would be enhanced if we could better ensure that the various vegetation management agencies are all considering our stream shade goals and vegetation needs. A multitude of mature trees along the banks of Johnson Creek were removed along the Springwater Trail, when a local power company was required to clear vegetation from under its power lines as part of their FERC relicensing requirements. The City had previously worked with PGE to develop a list of suitable, shorter tree species to plant under the power lines, those previously approved species were required to be removed due to the federal requirements the utility company faced. If Gresham and other stakeholders could have a coordinated regional approach, such as developing a plan with even shorter preferred species, better future outcomes may be realized to minimize loss of existing stream cover. **Gresham supports the concept of a DEQ led effort to convene utility corridor managers, drainage districts, and affected DMAs to collaboratively brainstorm planting strategies that may better reflect the shared concerns of all parties involved**.

2. A significant decline in forest health has occurred regionally due to increasing summer temperatures and decreasing precipitation during the growing season. These climate affected forest stands are potentially negatively impacting stream shade and stream bank stability. Regionally, restoration experts are analyzing these trends and incorporating their

findings in their planting plans. Increasing the diversity of tree species utilized is the primary strategy recommended at this point. It's important to note that the Willamette and Sandy Basin Water Quality Management Plans require the planting of 5 "Ecosystem Potential Vegetation" species. DEQ and their partners at EPA will need to anticipate that DMAs will be utilizing a much wider planting palette in the coming years in order to increase the forest's climate resiliency in the future. The City's next 5-year update will contain more analysis on this issue, as we are just in the beginning stages. **If DEQ is privy to similar discussions by other DMAs and wishes to bring restoration partners together for discussions on future planting palettes, Gresham would be very interested in participating.**

Gresham looks forward to continued collaboration with DEQ and other stakeholders within the Lower Willamette and Sandy watersheds on the above initiatives as we seek to demonstrate progress addressing the anthropogenic sources of stream warming identified by DEQ in their development of the Water Quality Management Plans for these watersheds as described in **Appendix A**.

APPENDIX A: WATER QUALITY MANAGEMENT PLAN MEASURES FOR CITY OF GRESHAM

INTRODUCTION

Water Quality Management Plans (WQMPs), found in Chapter 14 of the Willamette Basin TMDL, and Chapter 6 of the Sandy Basin TMDL, include several requirements that are specific to Gresham or to individual waters or pollutants relevant to Gresham. Those specific requirements are excerpted here.[6] Requirements that are repeated in several different places or with slightly different wording are listed only once. Wasteload and load allocations, and requirements that are listed in OAR 340-042 as major elements of an implementation plan are summarized in Section I. Overview. For each of the specific requirements, or set of requirements listed below, the relevant TMDL Implementation Plans that address the requirement(s) are noted.

COLUMBIA SLOUGH (1998 TMDL)

Background

The Columbia Slough TMDL was adopted in 1998 after years of modeling and discussion. It was among the early TMDLs adopted by DEQ, and the mechanism by which many of the requirements in the TMDL were to be implemented was Memoranda of Agreements between DEQ and local governments. The agreements were to detail the steps and timelines to be followed to implement the management measures. An agreement between DEQ and Gresham was never created, although Gresham did sign an agreement with the City of Portland to conduct the required water quality sampling.

With the adoption of the TMDL rules in OAR 340-042, it became clear that NPDES permits are the implementing mechanism for the point source component of TMDLs, and implementation plans would be created for nonpoint sources like bacteria and temperature.

The hydrology of the Columbia Slough is complicated, and the TMDL divided the Slough into five reaches. Management measures required in the WQMP are tied to specific reaches, which are indicated in the TMDL by a number. **The numbers relevant to Gresham are Reach 3, which is the Upper Slough, and Reach 5, which is Fairview Creek.** Reach numbers are shown in the excerpts below in parentheses to indicate the reach(es) within Gresham to which each requirement applies.

[6] Although the text is not shown in quotes, the requirements are drawn verbatim from the TMDLs.

Dissolved Oxygen (Biological Oxygen Demand (BOD_5))
Requirements:

The DMAs will conduct monitoring of stormwater BOD_5 loads and the instream response to those loads. Previous monitoring under the MS4 permits has measured BOD_5 levels from urban runoff that do not correlate with the few instream BOD_5 samples taken during storm events. The discrepancy between loads and instream concentration is likely due to processes such as deposition and decay during the transport to the receiving water. The monitoring data was used to calibrate a dynamic water quality model to simulate the Slough's response to storm water and deicing fluid. The DMA WLA will not be included as an effluent limit. Achievement of the WLA will be through implementation of BMPs. Municipal discharges will be required to implement BMPs and demonstrate that the BMPs achieve the WLAs established. Previous monitoring used continuous hydrolabs to characterize DO, temperature, conductivity, and pH of the system. The DMAs are required to:

- Provide DEQ with a description of the program designed to reduce BOD_5 loads to the Slough. (3,5)
- Implement a program of BMPs that will reduce overall BOD_5 load to achieve the DMA WLAs. (3,5)
- Implement coordinated monitoring to define stormwater loads to the Slough and the influence of storm water BOD_5 on receiving water quality. (3)
- Implement monitoring to demonstrate compliance with BOD_5 WLA targets. Instream monitoring includes grab samples of BOD_5 and DO (3)

- Relevant Implementation Plan: NPDES Stormwater Permit, SWMP and Environmental Monitoring Plan

Eutrophication (pH and nutrients)
Requirements:

- Identify at least three representative sites for the Lower (Reach 1), Middle (Reach 2) and Upper (Reach 3) Slough for long-term monitoring of water quality in the slough to determine the effectiveness of the implementation strategy
- Identify a representative site in Fairview Lake (Reach 4) and Fairview Creek (Reach 5) to characterize water quality in these waterbodies and determine effectiveness of control strategies. Water quality parameters will include DO, pH, temperature, chlorophyll *a*, dissolved ortho phosphate, total phosphate and bacteria
- Maintain the grab samples of pH, dissolved ortho-phosphate, chlorophyll *a*, DO and temperature (3)
- Identify BMPs in MS4 permits which may reduce contributions of phosphate via stormwater (3,5)
- Include PO_4 in assessment of BMP effectiveness by measurement of influent and effluent dissolved orthophosphate concentrations and total phosphate concentrations (3,5)

Relevant Implementation Plan: NPDES Stormwater Permit and associated documents

Bacteria
Requirements and Relevant Plans**:**

- *Requirement*: Sanitary surveys of septic systems, removal of direct discharges of human waste to the Slough (3)

  Relevant Plan: Nonpoint Source Implementation Plan—Volume II: Bacteria Implementation Plan for Private Sector Sanitary Waste

- *Requirement*: Detect and eliminate illicit discharges to the Slough (3,5)

  Relevant Plan: NPDES Stormwater Permit and associated documents

- *Requirement*: Establish adequate monitoring to demonstrate compliance with *E. coli* criteria, including measuring E. coli concentrations and distributions (3,5)

  Relevant Plan: NPDES Stormwater Permit and associated documents

- *Requirement*: Implement BMPs to control anthropogenic sources of bacteria in stormwater (3,5)

  Relevant Plans: NPDES MS4 Stormwater and Wastewater Treatment Plant 1200COLS Permits

Toxics—Lead
Requirements:

- Conduct instream dry and storm event monitoring for total lead, dissolved lead and hardness. Conduct lead analysis using detection levels which are lower than the water quality chronic criterion. (3)
- Conduct monitoring at outfalls to Slough, outfalls selected based on land uses known to have high lead levels or other metals (3)
- Identify and implement BMPs in the municipal NPDES permits that will be effective in controlling lead stormwater inputs (3,5)
- Monitor to determine effectiveness of BMPs to remove total and dissolved lead from stormwater (3)
- Estimate the load reduction of lead achieved for stormwater at the end of Phase I (3)
- Estimate effectiveness of BMPs to remove TSS (3,5)

Relevant Plan: NPDES Stormwater Permit and associated documents

Toxics—Organics
Requirements:

- Identify and implement BMPs as listed in the municipal NPDES permits, for erosion control based on limited data suggesting stormwater sediment as a current source of organics (3,5)
- Monitor the effectiveness of BMPs at TSS removal (3)
- Estimate the load reduction of TSS achieved for stormwater at the end of Phase I (3)

Relevant Plan: NPDES Stormwater Permit and associated documents

SANDY RIVER (2005 TMDL)

Background

The Sandy TMDL post-dates the adoption of OAR 340-042, which identifies the mechanism for TMDL implementation by responsible parties as a permit or a nonpoint source implementation plan. The implementation requirements in the Sandy TMDL are therefore different in focus from those in the 1998 Columbia Slough TMDL. The Sandy requirements are comparatively general: they presume that responsible parties will identify the management practices and monitoring that are needed to meet goals articulated in the TMDL. The Sandy TMDL focuses on listing the topics that must be addressed in an implementation plan, and on the objectives of the plan which are instrumental to meeting the TMDL goals. The topics are both broader and deeper in scope than the list of management strategies provided in OAR 340-042.

Required Elements:

Contents of a Plan:

Requirements: ODEQ expects that identified responsible participants will develop, submit to ODEQ, and implement plans that will achieve the load allocations within 18 months of TMDL adoption. These activities will be accomplished by the responsible participants in accordance with the Schedule in Section 6.6 of this WQMP. The DMA specific water quality implementation plans must address the following items:

Proposed management measures tied to attainment of the load allocations and/or established surrogates of the TMDLs, such as vegetative system potential or percent reductions.

- Timeline for implementation.
- Timeline for attainment of load allocations.
- Identification of responsible participants demonstrating who is responsible for implementing the various measures.
- Reasonable assurance of implementation.
- Monitoring and evaluation, including identification of participants responsible for implementation of monitoring, and a plan and schedule for revision of implementation plan.
- Public involvement.
- Maintenance effort over time.
- Discussion of cost and funding.

- Citation of legal authority under which the implementation will be conducted.

Relevant Plans: The City's MS4 Stormwater permit and associated documents, and the Temperature and Bacteria TMDL Plans include the information required by the Sandy TMDL. The Wastewater permits are not relevant to the Sandy Basin, as the permitted discharges outfall to the Columbia River or Columbia Slough.

Monitoring:

Requirements: Monitoring and evaluation has two basic components: 1) implementation of DMA specific implementation plans identified in this document, and 2) monitoring of physical, chemical and biological parameters for water quality and specific management measures. This information will provide information on progress being made toward achieving TMDL allocations and achieving water quality standards.

The objectives of this monitoring effort are to demonstrate long-term recovery, better understand natural variability, track implementation of projects and BMPs, and track effectiveness of TMDL implementation. This monitoring effort and feedback mechanism are major components of the "reasonable assurance of implementation" for the Sandy Basin TMDL WQMP.

This WQMP and the DMA-specific Implementation Plans will be tracked by accounting for the numbers, types, and locations of projects, BMPs, educational activities, or other actions taken to improve or protect water quality. The mechanism for tracking DMA implementation efforts will be annual reports to be submitted to ODEQ.

The City of Gresham monitors two instream locations in Kelly Creek and an additional two in Beaver Creek through an agreement with Multnomah County. The monitoring is described in the Environmental Monitoring Plan and covers all the TMDL constituents.

Relevant Plans: The NPDES Stormwater Permit and associated documents, and the Temperature and Bacteria TMDL Plans identify monitoring adequate to meet the monitoring requirements. The only water quality monitoring that is needed in addition to that currently described in the Stormwater Monitoring Plan is for temperature (with a focus on shade as a proxy for temperature).

Adaptive Management:

- *Requirement:* Each DMA will also monitor and document its progress in implementing its plan and this information will be provided to ODEQ.

  Relevant Plans: Each of the City's implementation plans describe monitoring and reporting.

- *Requirement:* DMAs will develop benchmarks for attainment of TMDL surrogates, which can then be used to measure progress.

Relevant Plans: The NPDES Stormwater permit and associated documents include benchmarks for the Columbia Slough basin (except temperature). (See 2015 Permit Renewal Submittal). No benchmarks are required for the individual Wastewater permit since there is no relevant TMDL for the Columbia River. The 1200COLS permit for stormwater from the Wastewater Treatment Plant includes pollutant limit benchmarks that if exceeded, corrective actions will be required by DEQ. The Temperature and Bacteria TMDL Plans include information relevant to milestones either developed or under development for activities that have discrete steps leading to completion.

- *Requirement:* Where the Implementation Plans or management techniques are found to be inadequate, DMAs will revise the components of their Implementation Plan to address these deficiencies.

  Relevant Plans: Each of the City's implementation plans allows for a process to modify practices should the existing commitments/activities prove inadequate.

Funding:

Requirement: Designated Management Agencies will be expected to provide a fiscal analysis of the resources needed to develop, execute and maintain the programs described in their Implementation Plans. The purpose of this element is to describe estimated costs and demonstrate there is sufficient funding available to begin implementation of the WQMP. Another purpose is to identify potential future funding sources for project implementation.

Relevant Plans: The NPDES Stormwater Permit and associated documents describe the fiscal resources available for the main Stormwater BMPs. The Wastewater permits are already being implemented through existing resources.

WILLAMETTE RIVER AND TRIBUTARIES (2006 TMDL)

Background:

Like the TMDL for the Sandy Basin, the Willamette TMDL post-dates the adoption of OAR 340-042, and therefore presumes that the mechanism for TMDL implementation is either a DEQ permit or a nonpoint source plan. The specific requirements listed in the Willamette TMDL regarding the topics to be addressed by the implementation plans are slightly different from those listed in the Sandy TMDL. The table below shows the topics that are required to be addressed in an implementation plan by the two TMDLs.

Table A.1: Summary of Requirements for Sandy and Willamette TMDLs

Required Management Measures:	Sandy Basin	Willamette TMDL
Identification of management strategies	X	X
Identification of Responsible Parties	X	
Timeline for Implementation of strategies & schedule for completing milestones	X	X
Timeline for attainment of load allocations, including benchmarks for attainment	X	X
Track Implementation of Commitments	X	X
Submittal of Annual Reports to DEQ	X	
Adaptive Management	X	X
Compliance with applicable statewide land use requirements	X	X
Include effectiveness evaluations every five years		X
Reasonable Assurance of Implementation	X	
Monitoring of physical, chemical and biological parameters to ensure water quality goals are being met and demonstrate long-term recovery	X	X
Monitor to better understand natural variability	X	X
Characterize Mercury levels in stormwater		X
Address Runoff from nonpoint sources not covered under an NPDES permit	X	X
Public Involvement	X	
Maintenance Effort over Time	X	
Discussion of Cost and Funding	X	X
Citation of Legal Authority	X	X

Grey shading indicates requirements that match or elaborate on those listed in OAR 340-042-0080. Requirements that closely match the OAR are addressed in the "Overview of Management Strategies" in Section I. rather than in Appendix A.

Summary of Requirements and Identification of Relevant Management Plans:

The exact wording of the requirements in the Sandy and Willamette TMDLs is not identical for a given management measure, but it is reasonable to assume that the intent is the same, given the similar goals of the TMDLs. In the interest of efficiency, the analysis below addresses only measures that are required in the Willamette TMDL, which are not included in the Sandy TMDL.

Five-Year Effectiveness Reviews:

Requirement: For point sources of pollution, ODEQ will issue permits that include specific discharge limitations and compliance schedules that ensure water quality standards are met or will be attained within a reasonable timeline. Permits are reviewed and renewed on a 5-year cycle.

For nonpoint source pollution, sector-or source-specific TMDL implementation plans will include specific management strategies and timelines. DMAs will be expected to prepare an annual report and undertake an evaluation of the effectiveness of their plans every five years to gage progress toward attaining water quality standards.

Relevant Plans: The City's NPDES permits all require renewal applications each five years. The renewal requirements constitute the five-year review required in the TMDL. The Nonpoint Source TMDL Implementation Plan includes commitments for the requisite five-year effectiveness reviews.

Mercury:

Requirements: Permitted municipal storm water dischargers (MS4 Phase 1 and 2 permittees): Intent: Ensure MS4 communities are addressing mercury through implementation of their MS4 permit and require MS4 Phase I permittees to collect data on mercury levels in urban storm water runoff in order to characterize these sources so they may be appropriately considered in the 2011 update of the mercury TMDL.

In September 2006, EPA approved DEQ's mercury TMDL for the entire Willamette Basin. Because the 2006 TMDL does not establish source-specific WLAs for mercury, mercury is not considered to be a TMDL pollutant under the Phase-I MS4 permit provisions. However, mercury is a 303(d) listed pollutant in the Willamette Basin and is therefore subject to requirements found in Schedule D of the MS4 permit, and as such, the City submitted the 2008 303(d) Pollutant Evaluation Report to comply.

Northwest Environmental Advocates filed a lawsuit in 2012, which argued the validity of the 2006 mercury TMDL and EPA's approval. In April 2017, the US District Court issued a ruling requiring EPA to revise the TMDL by April 2019 and allowing the 2006 TMDL to remain in effect until EPA issues or approves the revised TMDL.

The City of Gresham and other stakeholders joined a DEQ advisory committee in 2017 to provide input regarding the sources, contributions and modeling for the updated TMDL. During this time, there was a collective acknowledgement that the largest source of mercury in Oregon is atmospheric deposition caused by global scale manufacturing and energy production and weather patterns that disperse the compound making it difficult for any Oregon stakeholder to significantly reduce sources of mercury compared to the overall total. Nonetheless, Stormwater and Wastewater permittees will be charged with significant reductions in mercury over time.

Since 2004, the City of Gresham has monitored total mercury in all instream, stormwater, and stormwater facility performance sampling with a method detection limit of 2 ng/L.

Additionally, in response to DEQ's Mercury Monitoring Order, the City of Gresham conducted low-level monitoring for total and dissolved phases of mercury and methyl mercury in stormwater at 8 locations in 2011-2013. The method detection limits were 0.5 ng/L for total and dissolved mercury and 0.05 ng/L for total and dissolved methyl mercury. The City received DEQ approval in 2014 to discontinue low-level monitoring and continues to sample for total mercury. With each consecutive SWMP, the city will continue to focus on controlling sediment-laden runoff to the maximum extent practicable to reduce mercury movement to our waterways.

The following analysis were required relative to the Mercury TMDL (not yet final as of 2018 updated five-year plan):

- Determine whether there is a reasonable likelihood for storm water from the MS4 to add or contribute to water quality degradation of receiving waters through the discharge of mercury. Provide the rationale for the conclusion, including the results of an evaluation.
- If the discharges from the MS4 are a contributor for mercury, determine and describe the relationship between mercury and the MS4 discharges.
- Determine whether the BMPs in the existing Stormwater Management Plan (SWMP) are effective to address mercury. If not, describe how the plan could be adapted to more appropriately address mercury. A summary of the rationale for this determination must also be included in the report.
- If sufficient information is not available to make the determinations required above, the co-permittee must compile the additional pertinent information necessary to adequately complete these determinations.

These components were undertaken with the acknowledgement that a benchmark analysis could not be completed without a finalized TMDL and provided to DEQ in the City's 2015 Permit Renewal Submittal package. Available on the City's website at: GreshamOregon.gov. This evaluation will be finalized when the City receives its next updated stormwater permit and is able to finalize its SWMP to comply with that permit.

Relevant Plan: The City's MS4 Stormwater Permit, SWMP, and Environmental Monitoring Plan.

APPENDIX B: 2007 GRESHAM TEMPERATURE TMDL PLAN
(with March 2008 Addendum)

City of Gresham, Oregon

TMDL Implementation Plan

VOLUME III:

TEMPERATURE TMDL IMPLEMENTATION PLAN

Initial Submittal - April 2007
Addendum 1 Submittal - March 2008

Department of Environmental Services
City of Gresham, OR

TABLE OF CONTENTS

Volume III: Temperature TMDL Implementation Plan

Executive Summary 3-1

BACKGROUND

Introduction 3-3
Gresham's Tree Canopy and Surface Water Resources 3-3
TMDL Background 3-5
Temperature TMDLs Affecting Gresham Streams 3-5
Gresham as a Designated Management Agency for the Temperature TMDL 3-7
"Surrogate Measures" for Meeting Temperature Criteria 3-8
Gresham's Shade Targets 3-8
System Potential Vegetation 3-9
Targets for Other Factors Influencing Temperature 3-10
Overview of Gresham's Watersheds 3-11
Sandy River Tributaries 3-11
Kelly, Burlingame, and Beaver Creeks 3-11
Lower Willamette Tributaries 3-12
Johnson Creek 3-12
Columbia Slough 3-14

FRAMING AN APPROACH

Establishing Management Strategies 3-18
Influence of Riparian Buffer Ordinances on System Potential Vegetation 3-19
Reasonable Timeline for Implementing a Temperature TMDL Response 3-22
Determining the Buffer Needed to Meet Shade Targets 3-22
Defining Gresham's System Potential Vegetation 3-28
Analysis Needed for the Final Temperature TMDL Implementation Plan 3-30

MARCH 2008 ADDENDUM TO TEMPERATURE TMDL IMPLEMENTATION PLAN

Background 3-31
Management Strategies 3-32
Mitigation Opportunities 3-33
Implementation of Proposed Management Strategies 3-33
Timeline for Project Implementation 3-34
Prioritizing Volunteer of landowner Involvement Efforts 3-34
Overview of the Existing Shade Analysis Process 3-34
Capital Improvement Projects (CIPs) 3-36
Riparian Planting Strategy 3-37
Maintaining Management Strategies over Time 3-39
Macrophyte Control Projects 3-39
Monitoring, Evaluation, and Reporting 3-40
Public Involvement Process 3-40
Adaptive Management Strategy 3-40

Fiscal Analysis 3-42
Consistency with Land Use Requirement 3-42
Citation of Legal Authority 3-42
Conclusion 3-42

NOTE

This Temperature TMDL[7] Implementation Plan is being submitted to the Oregon Department of Environmental Quality (DEQ) by the City of Gresham in response to requirements contained in the Willamette and Sandy Basin TMDLs. This document presents: (1) background information on the temperature standard applicable to Gresham's surface water infrastructure, (2) an assessment of existing stream conditions throughout the City's watersheds, (3) research and modeling results that will guide the development of on-the-ground activities ('management strategies') necessary to meet the City's temperature TMDL obligations, and in the March 2008 addendum at the end of this volume (4) a description of the management strategies the City will commit to implementing in order to work toward meeting DEQ-established shade targets.

The actual list of prioritized on-the-ground projects to be implemented as temperature TMDL management strategies will be developed in concert with interested stakeholders. City Council approval of any resource commitments related to proposed management strategies will be required.

[7] TMDL: "Total Maximum Daily Load." See "TMDL Background" on page

Executive Summary

The quality of Oregon's streams, lakes, estuaries and groundwater is monitored by the Oregon Department of Environmental Quality (DEQ) and other agencies. This information is used to determine whether water quality standards are being violated and, consequently, whether the *beneficial uses* of the waters are *impaired*. Section 303(d) of the Federal Clean Water Act (CWA) requires that a list be developed of all impaired or threatened waters within each state. This list is called the 303(d) list after the section of the CWA that requires it. DEQ is responsible for assessing data, compiling the 303(d) list, and submitting the 303(d) list to the Environmental Protection Agency (EPA) for federal approval. Section 303(d) also requires that the state establish a Total Maximum Daily Load (TMDL) for any waterbody designated as water quality limited. TMDLs are written plans with analysis that determine the total amount of a pollutant (from all sources) that can be present in a specific waterbody and still meet water quality standards.[8]

Total Maximum Daily Loads (TMDLs) were issued by DEQ for the Sandy Basin in 2005 (to address impaired water quality in the areas of temperature, dissolved oxygen, and bacteria), and for the Lower Willamette Sub-basin in 2006 (to address water quality exceedances of temperature, bacteria, mercury, and organochlorine pesticides). Gresham has 18 months from September 2006 to submit to DEQ a TMDL Implementation Plan that addresses the City's strategy to improve water quality standards within the Sandy and Lower Willamette basins, including a list of projects that will be implemented to improve water quality, a timeline for implementation of projects, evaluation methods, and reporting protocols.

What follows is the City of Gresham's plan for responding specifically to the water quality violations of **temperature**, as required by the Willamette and Sandy Basin TMDLs. The goal of the approach is to make defensible and reasonable progress towards compliance with in-stream temperature standards as they pertain to: Johnson Creek, Fairview Creek, and the Columbia Slough (through the Willamette River TMDL); and Kelly/Burlingame Creek (through the Sandy River TMDL). Included here are the rationale for the City's approach, background info on temperature TMDLs as well as Gresham's surface water infrastructure and human-generated temperature impacts on those waters, and the process that the City will follow to scope, prioritize, and implement temperature-reduction projects. An addendum to the April 2007 version of the Temperature TMDL Implementation Plan is included at the end of this volume. This addendum includes a list of management strategies, maintenance and monitoring protocols, and reporting and adaptive management efforts that will be utilized in the City's Temperature TMDL response.

[8] Sandy Basin TMDL, Chapter 1: Executive Summary. 2005. Oregon Department of Environmental Quality. Pg. 1.

BACKGROUND

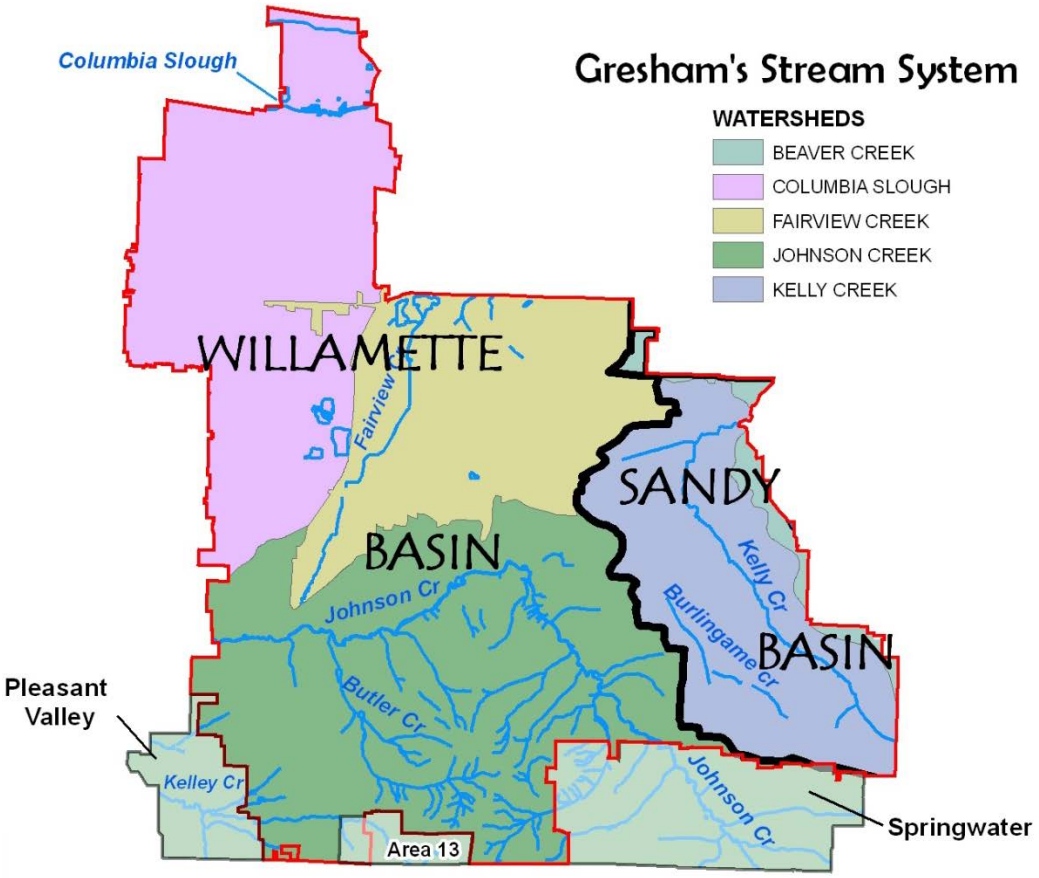
Introduction

Gresham's Tree Canopy and Surface Water Resources

The City of Gresham is located within the Portland Metropolitan area—Oregon's largest urban center, with over 2 million people and nearly 600 square miles of developed land. Roughly 25 square miles of the eastern Portland Metropolitan area is within Gresham's current jurisdictional boundaries. With a population that has ballooned from 4,000 residents in 1960 to roughly 100,000 people in 2006, Gresham is now Oregon's fourth most populous city.

Once an extensively forested area miles from the heart of Portland, the Gresham region was long referred to as "Campground" by the local population, as this wooded area provided a convenient stopover for those traveling to Portland. From the mid-1800s to the mid-1900s, the area transitioned to an agricultural community—spurring extensive clearing of forests and manipulation of water resources to accommodate the needs of what would become a productive berry farming area. Around 1960, there was an increase in the rate and extent of urbanization, eventually leading to complete replacement of farmland with high- and low-density residential and commercial land uses. As this move to a more urban community began, the area's forest resources had already largely disappeared.

Similarly, the effect of these historic land use changes on the city's surface water features was a sharp decrease in quantity and quality of resources. Prior to the passage of federal, state, and local resource protection rules, the vast majority of the City's wetlands were filled, and total stream miles were decreased by straightening and filling. Still, over 70 miles of creeks currently lay within the city limits. These creeks represent small portions of two major Oregon watersheds: the Willamette Basin and the Sandy Basin. Johnson Creek, Fairview Creek, and the Columbia Slough are tributaries to the Willamette River, and the City's most eastern creeks—Kelly, Burlingame, and Beaver Creek—drain to the Sandy River. Future expansion of Gresham is anticipated in the new community areas of Springwater, Pleasant Valley, and Area 13, which will result in an increase of roughly 25 stream miles in the City's surface water features. These additional stream miles are all within the Johnson Creek basin and therefore are part of the Willamette watershed.



Throughout these stream systems, Gresham's water quality and aquatic habitat have been impacted negatively by the reduction in tree canopy, wetlands, and stream miles. The negative environmental, aesthetic, and economic impacts resulting from these losses are now widely recognized as primary causes of: faster and more intense stormwater flows to local creeks, stream channel and water quality degradation, loss of stream bank and associated damage to public and private property, and declines in native plant and animal species populations. Reduction in tree canopy also results in lower air quality, loss of an effective "sink" for carbon emissions, and increased summer energy demand as sparsely treed areas absorb and emit heat from the summer sun. The loss of riparian (streamside) trees specifically is a primary cause of degraded stream conditions and water quality, marked increases in stream temperatures, and associated loss of habitat for species dependent on cold water.

Many communities are now working to regain the "ecosystem services" provided by healthy urban forests and streams by focusing regulatory efforts on protecting and expanding tree canopies—particularly in riparian areas where dense stands of trees were historically present. Gresham is among those communities working to enhance its forest resources in order to improve local air, water, and habitat quality. New tree protection standards are in development within the Metro region and within the City, local funds have been dedicated for increased volunteer planting efforts, streamside capital improvement projects now include significant tree planting efforts, and public outreach and education continues to be developed to encourage tree planting and protection throughout the city. These efforts are being done in part to increase the livability and aesthetics of the Gresham community. Policymakers and citizens also have come

to realize the cost efficiency of enhancing riparian forests to augment the City's flood control infrastructure, as some mature native trees can uptake as much as 400 gallons of water per day. Of equal importance is the City's obligation to respond to regional, state, and federal water quality and habitat protection laws. A significant portion of the City's reforestation efforts are directly tied to its obligations under the federal Clean Water Act.

TMDL Background

In Oregon, the US Environmental Protection Agency has delegated responsibility for implementing the Clean Water Act to the Department of Environmental Quality (DEQ). One of DEQ's responsibilities is to ensure all surface waters are of adequate quality to protect beneficial uses for humans, fish, and wildlife. DEQ determines the maximum amount of a pollutant that can be present in a waterbody before the beneficial use known to be most sensitive to a pollutant is negatively impacted. Beneficial uses (e.g., support of aquatic species, recreation, fisheries, drinking water supply, etc.) have been designated for every watershed in the state and DEQ has adopted hundreds of standards for pollutants to protect these beneficial uses.

DEQ, municipalities, watershed councils, federal and state agencies, and other entities routinely monitor water quality throughout their jurisdictional ranges to determine whether the state water quality standards are being exceeded. When monitoring results verify that a waterbody is failing to meet standards set for one or more pollutants, DEQ includes the waterbody on the state's 303(d) list—a regularly updated list of "impaired" surface waters. The Clean Water Act requires that DEQ then develop "Total Maximum Daily Loads" (TMDLs) for waterbodies on the 303(d) list. A TMDL *identifies sources of a specific pollutant, defines the maximum load of the pollutant* that a particular waterbody can assimilate without causing violations of water quality standards, *and then allocates shares of the pollutant load* between industry, municipalities and other entities known to be contributing the pollutant to the waterbody. DEQ uses best available science to calculate pollutant loads that can be present without jeopardizing the ability of the waterbody to continue providing the identified beneficial uses.

Among the pollutants DEQ monitors and for which it develops TMDLs are: toxins (such as pesticides), bacteria (i.e., from septic fields, sewer overflows, and pet/wildlife waste), metals (entering waterways from air pollution, stormwater runoff, and street debris), and temperature. More precisely, ***temperature*** is the water quality parameter of concern, but ***heat***—in particular, *heat from anthropogenic (human-generated) sources*—is the pollutant of concern when establishing a temperature TMDL.

Temperature TMDLs Affecting Gresham Streams

DEQ has established *temperature TMDLs* for both the Willamette River and Sandy River Basins. These temperature TMDLs essentially affect all stream resources within Gresham, as the temperature criteria set for a watershed is equally applicable to all tributaries within the basin. This applicability is irrespective of ownership, location in the watershed, or size of stream. Meaning, the temperature of a small headwater stream on a private butte property in south Gresham is as important as the temperature of the Johnson Creek mainstem. In fact, smaller headwater streams and groundwater inputs are typically the most important contributors of cool

water to an overall stream system. It should be recognized by those dealing with obligations under the TMDL program that all waterways within a watershed are connected, and that the level of a pollutant in one stream impacts the water quality of the downstream receiving waters. As such, DEQ has established TMDLs on a watershed-wide basis, looking at the overall water quality of surface water features throughout large-scale watersheds.

DEQ set allowable stream temperatures to reflect conditions needed to support the most sensitive beneficial uses of each watershed. For both the Lower Willamette and Sandy Basins (and therefore for all of Gresham's creeks), DEQ has determined that rearing and migration needs of native salmonids (salmon and steelhead trout) represents the most sensitive beneficial use, and has therefore set the stream temperature standard for these basins to be 18° C (64.4° F). Stream temperatures throughout Gresham regularly exceed this standard.

DEQ has called out the following non-point, anthropogenic activities as primary sources of stream warming throughout the Willamette and Sandy Basins: "urban and rural development, agricultural practices, forest management, and associated developments such as transportation systems that cause or contribute to the removal of streamside vegetation or detrimental changes in stream channel form. Dam, reservoir, and hydroelectric project management operations are also identified as relevant non-point sources because these activities have substantial impact on stream temperatures…".[9] In short, DEQ has identified practices and land use leading to in-stream impounding or diversion of water, channel modifications, removal of shade-producing streamside vegetation, and development of large areas (that previously received, stored, and then discharged rainfall as groundwater in drier seasons) as the primary factors leading to the higher stream temperatures seen in our region and throughout the state. An additional non-point source of stream warming identified in the Fairview Creek/Columbia Slough basin is the growth of macrophytes (aquatic weeds) that proliferate in the channels to the point of significantly slowing the flow of water.

Less obvious factors of stream warming include changes in watershed processes and channel morphology. Activities that interrupt groundwater flows and the critically important exchange of groundwater with surface waters will reduce summer base flows as well as the availability of cool water refugia that are necessary for salmonids throughout their life cycle. Channel modification such as downcutting (deepening of channels as a result of "flashy" stormwater flows), bank armoring, dike construction, aggregate mining (i.e., gravel quarries in close proximity of streams), and wetland and floodplain filling contribute to the loss of channel complexity, which reduces or eliminates cool water refugia and fish habitat. Although the impacts of such watershed and channel modifications on stream temperature are not quantified in the temperature TMDL language, protection of diverse temperature environments and refugia is an important element of Oregon's temperature standards.[10]

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[9] Willamette Basin TMDL, Chapter 4: Temperature-Mainstem TMDL and Subbasin Summary. 2006. Oregon Department of Environmental Quality. Pg. 4-35.
[10] Ibid, Pg. 4-30.

Gresham as a Designated Management Agency for the Temperature TMDL

The City of Gresham has been identified as a Designated Management Agency (DMA) (i.e., those entities with a known, demonstrable impact on water quality) responsible for meeting the Willamette and Sandy Basin standard of 18°C for all streams and contributing tributaries within the City's jurisdictional boundaries. A Temperature TMDL Implementation Plan is due by March 2008 from each DMA within the Willamette and Sandy Basins that addresses the lands and activities that impact stream segments in the watershed within their boundaries to the extent of the DMA's authority. For reasons outlined below, Gresham's primary response to temperature TMDLs will be the installation of native tree cover in all stream-side areas where installation of trees is possible. Though installation and retention of stream-side tree canopy is the only activity required to be implemented, monitored, and reported to DEQ, there are many opportunities for the City, through its everyday functions, to improve water quality and stream temperatures within its jurisdiction. Relevant areas of responsibility include:

Through the Department of Environmental Services:

- **Public land acquisition** for: preserving riparian buffers, wetlands, and high value tree groves; utility, recreational trail, and right-of-way infrastructure; floodplain reconnection projects; and community park areas.
- **Watershed planning** through the Watershed Management Division, in partnership with local watershed councils
- **Capital project construction** to enhance streams and wetlands
- **Public education**, including **streamside technical assistance to property owners**, **community outreach events** focused on pollution prevention, and follow up on investigation of water quality violation complaints.
- **Stormwater infrastructure planning, construction, investment, and maintenance**
- Development and application of **Low Impact Development standards**
- **Mitigation of utility impacts to riparian corridors**
- Development and application of **Standard Operating Practices for operating in and near waterways and wetlands**

Through Community and Economic Development Department:

- Development and application of **Low Impact Development standards**
- **New community planning** focused on **green development** practices
- Ensuring accurate **mapping of protected stream and wetland resources**
- **Development, enforcement, and inspection of riparian, wetland, natural resource, and tree protection ordinances**
- **Community outreach and education** regarding natural resource code implications
- **Comprehensive planning** to protect the environment by reducing impacts on natural features and resources

“Surrogate Measures” for Meeting Temperature Criteria

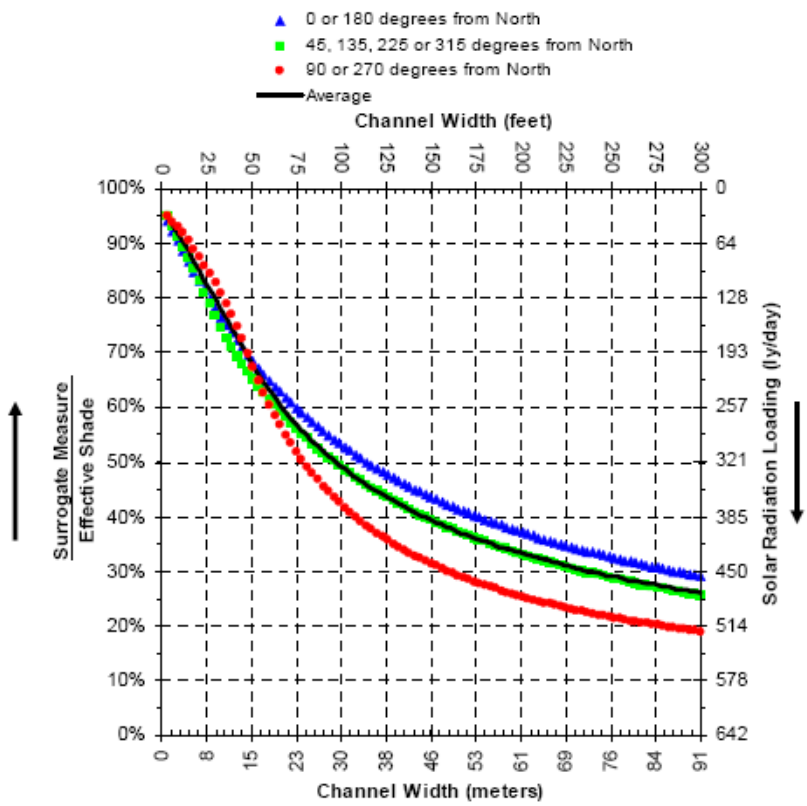
As discussed above, DEQ has concluded that a significant cause of stream temperature warming is a result of increased solar radiation loads on streams due to human-generated disturbances to near-stream vegetation. Similarly, the predominance of scientific literature indicates that the most important human-caused effects on stream temperatures include increased direct sun exposure on a waterbody and streamside heating as a result of the removal or thinning of streamside vegetation. Because of the known, direct connection between riparian forests and stream temperature, DEQ established “shading targets” and “effective shade curves” that will need to be met or retained by DMAs. These concepts represent the relationship between vegetation height and density, stream orientation, stream channel width, and resulting solar radiation that a stream would receive. Under the Willamette and Sandy TMDLs, shade targets and effective shade curves are applied as “surrogate measures” for temperature, allowing DMAs to address, monitor, and report on shade levels over a stream, rather than monitoring actual stream temperatures.

Gresham’s Shade Targets

Because of the DEQ-established surrogate measures for temperature, Gresham will not be monitoring stream temperatures to assess whether the 18°C temperature criteria is being reached. DEQ expects that DMAs will focus initial temperature TMDL implementation efforts on “improving shade conditions through establishing and/or enhancing riparian vegetation conditions and in ensuring that existing and future development practices allow the attainment of shade targets.”[11] Gresham will therefore monitor its progress in installing and retaining shade-producing vegetation along its stream corridors, in order to block solar loading during the summer months when stream temperatures have the greatest impact on salmon and trout.

[11] Willamette Basin TMDL, Chapter 5: Lower Willamette Subbasin TMDL. 2006. Oregon Department of Environmental Quality. Pg. 5-74.

Shade is more effective on narrow streams than on wider streams given the same flow of water at a given point because shadows cast by trees cover a greater percentage of the stream surface in narrow streams. On smaller streams, shade can effectively screen the water's surface from direct rays of the sun. As Gresham's streams all have an average summer width of 25 feet or less, it is the expectation of DEQ that Gresham can meet a very high level of shade through installation of streamside vegetation. The chart at right was extracted from Chapter 5 (Table 5.73) of the Willamette TMDL. It shows the potential effective shade curve for varying stream widths of varying orientations. This curve is specific to the Portland basin where we know that western redcedar, Douglas fir, and black cottonwood were historically the dominant trees along our river systems. On the shade curve, Gresham's small-width streams show effective shade curve goals of between 85-95%, meaning that historically prevalent streamside vegetation should be able to block most of the direct solar loading from reaching these smaller streams. One can clearly see from the curve that streamside trees would produce much less of a beneficial effect on very large rivers such as the mainstem of the Willamette. This provides more evidence of the importance of small tributaries as cool water inputs to the overall system.



System Potential Vegetation

To meet the ambitious shade goals established by DEQ and reflected in the above graph, Gresham and the other affected DMAs will need to install and/or retain the "system potential vegetation" capable of providing significant shade benefit to surface waters. System potential vegetation is considered by DEQ to be necessary to achieve "system potential effective shade," and is defined for purpose of the TMDL as "the potential near-stream vegetation that can grow and reproduce on a site, given the climate, elevation, soil properties, plant biology, and hydrologic processes."[12] This definition considers the vegetation types historically known to be present throughout the Portland basin eco-region. These vegetation types would include those species still found in remnant patches of forest throughout Gresham's natural areas, such as: red alder, western redcedar, Douglas fir, black cottonwood, and big leaf maple. System potential does not consider management or land use as limiting factors; it is an estimate of the vegetated condition where the human-generated impacts to riparian vegetation that cause stream warming

[12] Sandy Basin TMDL, Chapter 3: TMDL for Stream Temperature. 2005. Oregon Department of Environmental Quality. Pg. 21

are minimized. System potential is **not** an estimate of pre-settlement conditions. Although it is helpful to consider historic land cover patterns, channel conditions, and hydrology, many areas have been altered to the point that the historic condition is no longer attainable given drastic changes in stream location and hydrology (channel armoring, wetland draining, urbanization, etc.).

Again, per the language of the Willamette TMDL, DEQ expects that DMAs will focus initial temperature TMDL implementation efforts on improving shade conditions through establishing and/or enhancing riparian vegetation conditions and in ensuring that existing and future development practices allow the attainment of shade targets. While it is recognized in the Willamette and Sandy TMDL that it may take several years to several decades after full implementation of shade-producing measures to achieve the shade targets identified by DEQ, consistent progress toward achievement of the shade target is expected.

Targets for Other Factors Influencing Temperature

It is expected that factors and efforts associated with achieving effective shade targets will promote channel recovery and improvement. That is, DEQ believes that by meeting the effective shade allocations associated with this TMDL, resulting vegetated riparian conditions will also lead eventually to realization of system potential channel width conditions. Areas with serious channel alteration will likely require active reconfiguration to achieve desired channel conditions. DEQ did not establish specific targets in the Willamette or Sandy Basin TMDL for improving channel morphology or base flow conditions, but the Water Quality Management Plans for the Willamette and Sandy Basin TMDL state DEQ anticipates projects that address known sources of stream warming (such as changes in channel morphology) within a DMA's jurisdiction will be identified in Temperature TMDL Implementation Plans.

Overview of Gresham's Watersheds

Pavement, intensive (~80% impervious area coverage on a tax lot) commercial and industrial uses are located primarily in the Columbia Slough and Fairview Creek watersheds with somewhat portions of Johnson and Kelly Creeks being made up of these land uses. There are, however, significant portions of Johnson, Fairview, Kelly, and Burlingame Creeks comprised of low-density residential areas, parks and open spaces. City-wide, total impervious surface is estimated around 30%. The historic trend in increasing impervious surface area has led to a decrease in infiltration of rain into subsurface systems, however groundwater continues to be a major source of stream flow during summer months.

Sandy River Tributaries

The Sandy River includes the main channel and numerous relic slough channels meandering through the floodplain. The major contributors to the Sandy River include Beaver Creek, Big Creek, Buck Creek, Gordon Creek, Trout Creek, and the Bull Run River. Within Gresham's jurisdictional limits, Kelly and Burlingame Creeks are second-order tributaries to Beaver Creek.

Kelly, Burlingame, and Beaver Creeks

Temperature conditions

The mainstem Sandy River and several of its major tributaries are on the 303(d) list for exceeding temperature standards. One major tributary, Beaver Creek, flows briefly through the City of Gresham. Another minor tributary, Kelly Creek, enters Beaver Creek near the northeast corner of Gresham. DEQ monitoring data found that summer temperatures in both streams frequently exceeded 18° C—the maximum allowable temperature as established by DEQ to support salmonid rearing and migration. In Beaver Creek, the 7-day average daily maximum temperature was 22.8° C and the stream temperature exceeded 18° C on 71 days.[13] In addition, DEQ monitoring data indicates that summer temperatures in Beaver Creek frequently exceed temperatures in the mainstem Sandy River, which is listed on the 303(d) for temperature. In-stream impoundments on Kelly and Beaver Creeks and provide significant areas of stream warming.

Population density and land use

Unlike most of the Sandy basin, land uses within the Sandy tributary basins in Gresham are residential (high and low density) and commercial along Kelly and Burlingame. Upper portions of these creek systems still contain pockets of agricultural land use—the predominant land se in these basins until the early 1970s.

Channel condition

Kelly and Burlingame are low gradient (roughly 1-10%), moderately narrow, and produce low baseflows. Channels typically consist of a cobbled sandy bottom with undercut banks and frequent channel incision.

[13] Sandy Basin TMDL, Chapter 3: TMDL for Stream Temperature. 2005. Oregon Department of Environmental Quality. Pg. 27.

Riparian condition
Along Burlingame, Kelly Creek, and the lower reaches of Beaver Creek, urban development impacts have led to a diminished riparian forest. Channel incision and predominance of invasive vegetation such as Himalayan blackberry are major factors impacting riparian condition. The most severely impacted habitat within the Sandy basin has been identified on tributaries where agricultural and development impacts have caused the banks to be undercut, large woody material is lacking, illegal trash dumping is problematic, and agricultural practices are not adequately buffered.

Flow regime
Urban development and stormwater impacts have led to a flashy flow regime on Burlingame and Kelly Creeks and on the lower reaches of Beaver Creek. In-stream impoundments have led to heat sinks and alterations of sediment distribution.

Water quality
Inadequate riparian buffers between agricultural and residential development adjacent to Sandy River tributaries have impacted water quality of the watershed. Moderately high levels of total phosphates and increased biochemical oxygen demand impact water quality in the Sandy River during high flows, likely due to inorganic and organic pollutants entering through runoff from fields, ditches, and storm drains.

Biota
The Sandy River has productive runs of Lower Columbia River Steelhead Trout and the Lower Columbia River Chinook Salmon. The lower Sandy River is also the only location within Multnomah County known to have historically provided spawning habitat for the Columbia River Chum Salmon. Burlingame and Kelly Creeks are inaccessible to anadromous species because of the impassable pond at Mt. Hood Community College and a series of fish impassible culverts on Lower Kelly Creek.

Lower Willamette Tributaries

Johnson Creek

Johnson Creek flows for 25 miles westward from its headwaters in the Boring Hills east of Gresham, through the Cities of Gresham and Portland, emptying into the Willamette River in the City of Milwaukee. The Johnson Creek watershed is approximately 54 square miles and intersects several political jurisdictions, including the Cities of Gresham, Portland, Happy Valley and Milwaukee; and Clackamas and Multnomah Counties. Major tributaries to Johnson Creek within current Gresham city limits include all of Hogan Creek and significant portions of Kelley and Butler Creeks. As Gresham’s city boundaries expand into the Springwater new community area, significant portions of Sunshine, Badger, and North Fork Johnson Creek will be within the city’s jurisdiction.

Temperature Conditions

Johnson Creek is on the 303(d) list for temperature, and in 2006, Oregon DEQ established a temperature TMDL for Johnson Creek, which is represented in the Willamette TMDL. According to DEQ monitoring data, the 7-day average stream temperatures at two sites on Johnson Creek—92nd Avenue and the mouth of Crystal Springs Creek—exceeded the lethal limits for salmonids throughout the summer months. In Gresham, the 7-day average daily maximum temperatures in Johnson Creek ranged from 19° C to 22° C.[14]

Population density and land use

A variety of land uses currently exists in the Johnson Creek watershed, including dense industrial and residential areas near downtown Portland and Milwaukee; high-density residential and commercial development in Gresham; and rural residential and agricultural areas in the upper portion of the watershed. Over 50% of the watershed has been urbanized and impervious surfaces make up an estimated 43% of the land cover. The percentage of effective impervious area is highly variable across the watershed, with the highest percentage EIA in the lower reaches, and percentages nearing 10-15% in upper watershed.

Channel condition

The channel gradient is steep from the headwaters to just upstream of Gresham. Here, the slope flattens substantially, current slows, and the channel meanders. The gradient increases again downstream from Gresham through Portland to the confluence with the Willamette River. Residential development, bank hardening, and channelization have resulted in a disconnection from the floodplain along most of Johnson Creek, leading to channel incision and scouring of spawning gravels from the creek bottom. The floodplain connection is still intact in portions of the upper reaches, particularly in the Springwater area currently slated for urban development, and within the reach located in east Gresham.

Riparian condition

Riparian vegetation cover is highly variable along the mainstem of Johnson Creek. Some sections in the lower watershed and more developed reaches in the middle watershed lack any significant riparian cover, while some mainstem sections in the upper watershed have native riparian vegetation buffers of 200 feet or more. Forested riparian corridors in the upper watershed, particularly tributaries such as Sunshine Creek and Badger Creek, at times exceed 600 feet. Significant efforts are being made by the Johnson Creek Watershed Council and the Cities of Gresham and Portland to improve the riparian buffers along Johnson Creek. Gresham is currently partnering with the City of Portland to conduct several riparian and wetland restoration projects within the existing city limits of Gresham, where some 40% of the riparian land is under public ownership.

Flow regime

In the dry summer months, baseflows in the middle and upper Johnson Creek watershed can drop below ODFW minimum flow targets for protecting salmonids. There are many seasonal tributaries to Johnson Creek in the upper watershed that are nearly 100% dry during the summer months. There is no historical data on baseflows in the upper watershed, so it is unclear whether low summer baseflows are a result of development activities or are a natural occurrence due to

[14] Willamette Basin TMDL, Chapter 5: Lower Willamette Subbasin TMDL. 2006. Oregon Department of Environmental Quality. Pg. 5-75.

the unique geomorphic conditions in the upper watershed (the upper portion of the watershed is dominated by largely impervious soils and basalt domes).

Water quality
Water quality in Johnson Creek is currently 303(d)-listed by DEQ for summer temperature, bacteria, and toxics (PCBs, PAHs, DDT and Dieldrin). Jurisdictions are working through the Interjurisdictional Committee of the Johnson Creek Watershed Council to complete comprehensive monitoring related to toxics and sediment.

Biota
Johnson Creek provides habitat for several fish species, primarily those species tolerant of more degraded habitat conditions such as redside shiners, reticulate sculpin, and speckled dace. In smaller numbers there are also pacific lamprey, cutthroat trout and ESA-listed populations of Coho and Chinook salmon, steelhead, and pacific lamprey. Salmonid populations are significantly reduced from historic levels as a result of urbanization and associated habitat. A 2001 ODFW biological monitoring study showed that fish assemblages were severely impaired in 21 out of 23 reaches of Johnson Creek. In addition, benthic invertebrate and diatom assemblages are moderately or severely impaired throughout the Johnson Creek watershed.

Columbia Slough

The Columbia Slough drains a 50 square mile watershed that encompasses portions of Portland, Maywood Park, Gresham, Fairview, Wood Village, and unincorporated Multnomah County. The Slough is usually divided into four reaches for management purposes: Fairview Creek, Fairview Lake/Upper Slough, Middle Slough, and Lower Slough. Fairview Creek begins as a series of springs and wetlands near Grant Butte in Gresham, flowing north for five miles before emptying into Fairview Lake. The Upper Columbia Slough begins at Fairview Lake in the City of Fairview and ends at the Mid-Dike levee west of NE 142nd Avenue. The Middle and Lower Sloughs flow below the Mid-Dike levee, through Portland, to the mouth at the Willamette River near Kelly Point State Park.

Temperature conditions
The Columbia Slough is on the 303(d) list for temperature. Portions of the mainstem Columbia Slough and its tributary Fairview Creek regularly exceed the criteria for salmonid rearing and migration (18° C) during the summer months. According to data cited in the DEQ TMDL report for the Lower Willamette subbasin, the 7-day average daily maximum temperature in the mainstem Columbia Slough (at NE 21st in Portland) ranged between 18° C to 23° C during June, July and August, 2002.[15] In Fairview Creek, the 7-day average ranged from 19° C to 22° C during July and August, 2002.[16]

Population density and land use

[15] Willamette Basin TMDL, Chapter 5: Lower Willamette Subbasin TMDL. 2006. Oregon Department of Environmental Quality. Pg. 5-43.
[16] Ibid, Pg. 5-44.

Land use within the upper Columbia Slough watershed is mainly industrial north of Sandy Boulevard and residential south of Columbia Boulevard. The Fairview Creek and Fairview Lake/Upper Slough subwatersheds are largely urban residential, with a few remaining agricultural parcels slated for urban development in the near future. The population within the Columbia Slough watershed is currently around 158,000.

Channel condition

The Columbia Slough is a low gradient, moderately confined stream with little or no floodplain connection. Channel alterations are the most important factor causing aquatic habitat loss in the Columbia Slough watershed. A series of dams, levees, and pump stations built over the past 85 years have disconnected the main channel of the Slough from the Columbia River floodplain and from off-channel wetlands. In addition, channel structure and function has been impaired as a result of extensive industrial and urban development in the watershed. Floodplain alterations have also impacted Fairview Lake, Fairview Creek, and its tributaries, which historically were inundated during spring floods from the Columbia River. Much of the mainstem Fairview Creek stream channel has been straightened and a significant percentage of banks have been hardened to protect residential developments. Channel restoration projects have been undertaken at the Fairview Creek headwaters area and approximately 1.5 miles downstream. Planning for additional channel work is being conducted by the Columbia Slough Watershed Council, and the Cities of Gresham, Fairview, and Portland.

Riparian condition

Lack of riparian canopy contributes to high summer and fall temperatures in the Columbia Slough. The riparian buffer has been greatly disturbed in areas adjacent to private industrial lands along the banks of the Slough, where native plant species have largely been replaced by invasive monocultures of reed canary grass, non-native blackberry and scotch broom. Still, remnant patches of native species including cottonwoods, willows, Oregon ash, and red osier dogwood, exist in places and efforts are being made to improve canopy cover across the Columbia Slough watershed in order to meet TMDL guidelines developed by Oregon Department of Environmental Quality.

Riparian canopy vegetation in the Fairview Creek subwatershed is patchy and consists mostly of hardwood species such as cottonwood and alder. Understory vegetation is lacking, and invasive species make up the majority of vegetation cover along several reaches. Riparian restoration activities have been conducted by the Cities of Gresham, Fairview, and Portland as well as the Columbia Slough Watershed Council. Additional riparian restoration will be conducted in the near future as Capital Improvement Projects and Watershed Action Plans are implemented

Flow regime

The Columbia Slough is part of the Columbia River floodplain and was historically a series of wetlands, lakes, and side channels that were seasonally inundated by flooding from the Columbia River. Now most of the flow in the entire Columbia Slough has been diverted, diked and channelized for flood control, with pump stations to manage drainage and flow. These activities have resulted in extensive loss of off-channel habitat and degradation of existing aquatic habitat. Flows are highly controlled throughout the year in the Upper Columbia Slough. Water surface elevations are kept at 7.5 feet NGVD to meet irrigation water rights. During winter months,

most of the flows in the upper watershed come from stormwater flows and from Fairview Lake. From May to October, nearly all the flow is held in the lake for recreational purposes. Groundwater is therefore the primary flow source in the Upper Slough during the summer.

Water quality
Water quality in the Columbia Slough is impaired; the stream is on the 303(d) list for ten different parameters, including several toxins and organic compounds, temperature, pH, dissolved oxygen and bacteria. Major sources of chemical contamination include runoff from industrial areas in the middle and upper watershed, and from Portland International Airport. In the Upper Slough, flow stagnation and elevated temperatures lead to excess algal growth during the summer, which in turn contributes to high levels of pH, chlorophyll a and phosphorus. Fairview Lake has high levels of suspended sediments. Fairview Creek is listed on the 303(d) list for pH, nutrients and bacteria. Many reaches are impaired by the accumulation of fine sediments, despite historical data indicating that gravel was once the dominant natural substrate in Fairview Creek.

Biota
Aquatic and terrestrial species in the Columbia Slough watershed are impacted by degraded habitat conditions, including insufficient flows, off-channel habitat loss, and impaired water quality. Fish communities are dominated by nonnative warm water species like carp and bluegill. Salmon, lamprey and other native cold-water fish species are generally absent from the Columbia Slough, although juvenile Chinook and Coho salmon have been observed in the Lower Slough. A pump station at NE 33rd Avenue in Portland completely blocks fish passage to the upper watershed, barring the presence of anadromous fish in the Upper Slough and Fairview Creek. Resident cutthroat trout are present in the Fairview Creek watershed, along with pacific lamprey, sculpins, perch, largemouth bass and mosquito fish. The Columbia Slough has populations of some sensitive aquatic and terrestrial species, such as bald eagles, western painted turtles, osprey and northern river otters. The Springwater Corridor near the Fairview Creek headwaters supports populations of great horned owls, red-legged frogs, Pacific tree frogs, several hawk species, several deer species, and coyotes. Benthic invertebrate populations in the Columbia Slough consist of species that are tolerant of silt, unconsolidated mud substrates, high temperatures and poor water quality. Midges, cladocerans, rotifers and oligochaetes are the dominant species; current physical habitat conditions make it unlikely that the Columbia Slough has any sensitive invertebrate species like stoneflies, mayflies or caddisflies. In 2001, an index of biotic integrity (B-IBI) study using benthic invertebrates was conducted at four sites on Fairview Creek. All four sites were found to have low biological integrity (B-IBI less than 24; 50 maximum possible score) with samples dominated by one species of mayfly (*Baetis tricaudatus*), various species of midges, a tolerant blackfly (*Simulium*) and a tolerant beetle (*Optioservus*).

FRAMING AN APPROACH

Establishing Management Strategies

DEQ does not prescribe the actions a DMA must take to meet an allocation.[17] Though the Willamette and Sandy TMDLs clearly state it is DEQ's expectation that DMAs will work toward achievement of effective shade targets by means of installing and retaining "system potential vegetation," specific directives that would frame a DMA's response to the temperature TMDLs are not included. For instance, DEQ has not mandated implementation of shade measures within a specific timeframe, nor do the TMDL documents provide guidance on how wide of a treed buffer might be necessary to achieve the DEQ-established shade targets. Instead of specific directives, the Willamette and Sandy TMDLs provide shade goals that need to be considered in the context of a DMA's specific eco-region and stream sizes.

Given the challenge of developing specific management strategies in the absence of more prescriptive language, City staff realized the need to: (1) assess the extent of treed buffer necessary to meet the shade targets established for Gresham's stream sizes and eco-region, and (2) develop a reasonable timeframe for implementing the system potential vegetation projects. Responses to these questions would be needed to scope temperature TMDL projects, and to determine the level of resources that would be needed to implement any new management strategies. This analysis is also needed to create a defensible proposal that can be presented to policymakers and stakeholders to gain support for directing municipal funding to the installation, maintenance, monitoring, and reporting that any new projects will require. As municipal policymakers can not approve a regulatory response plan without a full appreciation of costs and implications to their community, an analysis of the time and resources required to implement the proposed response measures is needed. Towards that end, Gresham staff worked with natural resource consultants from Pacific Habitat Services to determine the scope of the effort needed to meet the intent of the TMDL and eventually to meet the DEQ-established shade targets for Gresham's watersheds. Initial steps in this process have included answering the following questions:

1) How do existing and anticipated riparian buffer ordinances support the goals of the temperature TMDL?
2) What is a reasonable timeline for carrying out activities identified as necessary within a Temperature TMDL Implementation Plan?
3) How wide of a buffer is needed to realize the shade targets established by DEQ?
4) How do utility corridors, the roadway network, and existing land uses impact the City's ability to install system potential vegetation?
5) What exactly is Gresham's "System Potential Vegetation"? How do we relate that concept to an actual planting plan?
6) What specifically is required in a temperature TMDL implementation plan, according to DEQ and the Willamette and Sandy Basin TMDLs?

Overviews of the responses developed for these questions by City staff and consultants are provided below. Details for actual project locations, timelines, maintenance, and monitoring protocols, etc., are included in the addendum at the end of this volume.

[17] Willamette Basin TMDL, Chapter 14: Water Quality Management Plan. 2006. Oregon Department of Environmental Quality. Pg. 14-9.

Influence of Riparian Buffer Ordinances on System Potential Vegetation

The City currently has in place riparian buffer ordinances focused on stream, wetland, and vegetated corridor areas identified as needing regulatory protection to preserve water quality and floodplain function. Current riparian buffer ordinances protect "Water Quality Resource Areas" (WQRA) and serve in part to help meet the City's regulatory obligations under Oregon state land use planning Goal 6 (Air, Water, and Land Resources Quality) and Goal 7 (Areas Subject to Natural Disasters and Hazards), as well as fulfilling regulatory obligations for water quality protection required by Title 3 of the Portland Metro Regional Government's Urban Growth Management Functional Plan. Generally, throughout the Metro area, riparian protection ordinances framed under Title 3 that were clearly tied to Clean Water Act requirements, and ordinances providing protection of health and property through flood prevention have won out over claims under Measure 37 and its update, Measure 49. Gresham's WQRAs were mapped to generally include stream channels, known and mapped wetlands of at least 0.5 acres in size, and riparian corridors. 'Riparian areas' were generally defined as 50 feet from the top of bank of streams for areas of less than 25% slope, and up to 200 feet from top of bank on either side of the stream for areas greater than 25% slope, and 50 feet from the edge of a wetland. The WQRA consists of the protected water feature and the adjacent vegetated buffer. More detail on existing corridors is found on the chart below, or in section 5.0600 of the Gresham's Development Code, accessible on the web at:
http://www.ci.gresham.or.us/departments/cedd/dp/code/article5/section506.pdf.

GRESHAM'S CURRENT RIPARIAN BUFFER PROTECTIONS
WATER QUALITY RESOURCE AREAS

Protected Water Feature Type (see definitions below)	**Slope Adjacent to Protected Water Feature**	**Starting Point for Measurements from Water Feature**	**Width of Vegetated Corridor (Required Setback)**
Primary Protected Water Features[1]	< 25%	Edge of bankfull stage ("top of bank")[6] or 2-year storm level; Delineated edge of Title 3 wetland	50 feet
Primary Protected Water Features[1]	≥ 25% for 150 feet or more[5]	Edge of Bankfull stage[6] or 2-year storm level; Delineated edge of Title 3 wetland	200 feet
Primary Protected Water Features[1]	≥ 25% for less than 150 feet[5]	Edge of bankfull stage[6] or 2-year storm level; Delineated edge of Title 3 wetland	Distance from starting point of measurement to top of ravine (break in >25% slope)[3], plus 50 feet.[4]
Secondary Protected Water Features[2]	< 25%	Edge of bankfull stage[6] or 2-year storm level; Delineated edge of Title 3 wetland	15 feet
Secondary Protected Water Features[2]	≥ 25%[5]	Edge of bankfull stage[6] or 2-year storm level; Delineated edge of Title 3 wetland	50 feet

1 Primary Protected Water Features include: all perennial streams and streams draining greater than 100 acres, Title 3 wetlands, natural lakes and springs.

2 Secondary Protected Water Features include intermittent streams draining 50-100 acres.

3 Where the Protected Water Feature is confined by a ravine or gully, the top of ravine is the break in the > 25% slope.

4 A maximum reduction of 25 feet may be permitted in the width of vegetated corridor beyond the slope break if a geotechnical report demonstrates that slope is stable. To establish the width of the vegetated corridor, slope should be measured in 25-foot increments away from the water feature until slope is less than 25% (top of ravine).

5 Vegetated corridors in excess of 50 feet for primary protected features, or in excess of 15 feet for secondary protected features, apply on steep slopes only in the uphill direction from the protected water feature.

6 "Bankfull Stage" (top of bank) is defined in OAR 141-85-010 (definitions for Removal/Fill Permits) as the stage or elevation at which water overflows the natural banks of a stream or other waters of the state and begins to inundate upland areas. In the absence of physical evidence, the two-year recurrent flood elevation may be used to approximate the bankfull stage.

By December 2008, the City will adopt new riparian buffer ordinances as required by the Portland Metro Regional Government (Metro). These "Title 13" buffers are designed to apply regionally consistent buffers to state-specified Goal 5 and Goal 6 resources. Like Gresham's existing WQRA buffers, Title 13 buffers will not preclude development, but will require mitigation of necessary impacts within those natural resource areas determined to have high value regarding environmental benefits. Protection of these buffers will be needed to help maintain and improve water resources of the state and are necessary to support Endangered Species Act-listed salmonids as well as other native aquatic species found in the Willamette and Sandy basins. These buffers, which meet or exceed the extent of current WQRA buffers, are based on extensive field inventory and evaluation of on-the-ground natural resource features, and on a robust scientific inquiry that analyzed the extent of vegetated buffer generally needed for realization of critical water quality and habitat functions that occur within healthy streams, wetlands, and riparian areas. For the most part, these buffers range from 50 to 200 feet in width. More information on the Title 13 buffers Gresham will soon adopt can be found on page 27 of the Metro's model Title 13 ordinance at:
http://www.metro-region.org/library_docs/nature/092305-4_ord_05-1077c_ex_c_t13.pdf.

Both current and future buffer programs were developed to ensure jurisdictions within the Metro Urban Growth Boundary have riparian protection ordinances that comply with state land use planning and Metro urban growth planning goals for protection of water quality, habitat, safe drinking water withdrawals, and safe recreational contact. Though these buffers offer protection from unmitigated impacts that could otherwise by associated with development or land use, these regulations do NOT mandate property owners improve or maintain native vegetation or bank stability within the designated riparian buffer. The only planting or maintenance required in regulated areas is that required as mitigation for new development impacts. As no state or regional regulation requires active restoration or improvement of streams, wetlands, or riparian areas, there is no regulatory program in place within Gresham that mandates property owners or public entities, in the absence of a development-related trigger, install native riparian vegetation. This is typical of other Oregon jurisdictions with land use rules in place to protect riparian buffers. Incentive programs do exist to increase tree canopy on public and private properties, but the impact of these programs on improving stream shade remains limited in comparison to the riparian improvements needed to meet shade targets.

Given the current insufficiency of native tree canopy as well as the degrading influence of: invasive plant and animal species; hydrology regimes altered from system-wide drainage manipulations; active timber and agricultural activities at the urban-rural edge; and human and domestic animal activity within riparian areas, it is clear that implementation of land use regulations will not likely result in "passive restoration" of riparian areas within urban/suburban areas such as Gresham. Staff would be unable to demonstrate shade targets would eventually be met without the benefit of active weed management and/or planting strategies within riparian areas, given historical evidence in our area that even regulation-protected areas experience a multitude of impacts that lead to declines in native tree cover and stream bank stability. As such, it was recognized during Gresham's TMDL planning that some level of active management would be needed to improve existing riparian conditions to address the fact that DEQ has determined that existing canopy is currently insufficient throughout most of Gresham's surface water system. Planting will be required to realize system potential vegetation, and newly improved areas will require periodic maintenance to address ongoing impacts we can realistically

expect from invasive species, recreational impacts, and various types of encroachment. The implementation, monitoring, and enforcement of regulatory protections for buffers will be important for ensuring protection of newly vegetated areas.

Reasonable Timeline for Implementing a Temperature TMDL Response

As DMAs must demonstrate progress towards meeting the shade targets, and as DEQ expects DMAs to specify the management strategies they will employ to meet shade targets as well as a timeline they will follow in implementing those management strategies, staff found a planning horizon was needed to frame the City's temperature TMDL response. A short-term planning horizon of 5 years is used for the City's funded Capital Improvement Plan (CIP), and therefore was chosen as the timeline for implementing the highest priority shade projects. The City's standard long-term Capital Improvement Project (CIP) planning horizon of 20 years seemed a logical choice for overall Temperature TMDL project implementation planning. This is consistent with more traditional infrastructure master planning horizons. Staff also found the 20-year timeframe to be consistent with temperature management programs presented by Washington County and Clean Water Services.

The 20-year planning horizon will be used to determine the long-term implementation schedule for proposed temperature TMDL projects that have been prioritized based on a number of criteria, such as expected shade benefit. Once projects are scoped and prioritized, resulting projects will be included both on Watershed Management's CIP project lists for the short term (i.e. highest priority project will be included on the 5-year list of funded projects) and long term (i.e. lower priority projects will be included on a 20-year list of unfunded projects and will cycle onto the revolving 5-year funded CIP list according to priority rank).

This long-term horizon will also frame the development of the City's long-term effectiveness evaluation process. The impacts of these planting projects may take decades before significant increases in shade are realized. The 20-year timeline represents the target timeline for installation of system potential vegetation, not an expected timeline for meeting the shade targets established by DEQ.

Determining the Buffer Needed to Meet Shade Targets

To determine the extent of active restoration that would be needed to show progress toward meeting shade targets, given existing riparian conditions, staff and consultants considered the following issues:

- What amount of direct shade benefit is realized as the distance of planted system potential vegetation is extended perpendicularly from a creek edge?
- To what extent do stream orientation and slope of banks affect the amount of shade a stand of trees can provide?
- Is there a temperature benefit from planting the north bank of a creek where the direct shade benefit is clearly less than on a south bank? (This was an important consideration as some stream segments have the predominance of publicly owned property located on

the north side while the south side consists of small private residences. Planting would have a greater impact on the south bank, but it would be logistically more difficult to plant and maintain continual stretches of private streamside property.)

Staff reviewed regional jurisdictional temperature management plans and current research related to impacts of riparian vegetation on stream temperatures. Much of the literature explored impacts of riparian forest on stream temperature not just from direct shade, but also by maintenance of cooler soil temperatures, reducing exposure to wind, and preservation of insolating microclimate. (It should be noted that most literature sources based their findings on vegetated buffers in forestry and agricultural areas; very little information on urban buffer impacts were found. No contradictions in information were found between the urban and non-urban research, however.) This literature review showed two predominant stream temperature benefits provided by riparian tree cover: (1) creation of direct shade over the adjacent surface waters, and (2) protection of an insulating microclimate which minimizes temperature fluctuations throughout the day.

Pacific Habitat Services consultants created a model appropriate for Gresham's smaller stream sizes (i.e. less than 25-feet wide) that compared summer condition radiation loading for streams without a vegetated buffer to summer condition radiation loading for streams with vegetated buffers. The model utilized direct normal radiation data recorded for the Portland region through the National Solar Radiation Database (1961-1990). Stream loading ratios were developed as a function of stream orientation, slope angles and buffer widths. The effect of opposite bank vegetation on the stream loading ratios was also considered.

Results of the literature review and the Pacific Habitat Services model provided similar conclusions in terms of minimum necessary buffers and optimal extents of vegetated buffers, when looking specifically at the impacts of buffers on stream temperatures. (It should be noted that there are multiple natural resource functions dependent on healthy vegetated riparian areas; the extent of buffer area needed to support those functions were not considered in this stream temperature-specific effort).

The literature review supported the conclusion that to realize **direct shade** through installation of system potential vegetation, a minimum of 35 feet of vegetated buffer was needed on streams sizes typical of that found in Gresham. Increasing the buffer widths from 35 to 55 feet resulted in significant increases in direct shade on the stream, and little additional benefit was realized from planting buffer vegetation beyond 55 feet (when results were averaged for varying stream orientation and surrounding slope). This is consistent with the results one regional modeling expert found in manipulating variables within the Shade-A-Lator model; he found that on streams comparable in size to Gresham's (i.e. less than 25 feet wide) around 98% of the direct shade benefit that can be gained will result from planting roughly the first 50 feet of riparian area (when results are averaged across all variations for stream orientation, surrounding slope, and maturity and density of vegetation)[18].

Literature review results suggested the **microclimate** under riparian forest cover is as important of a factor as direct shade in moderating stream temperatures on hot summer days. Under the

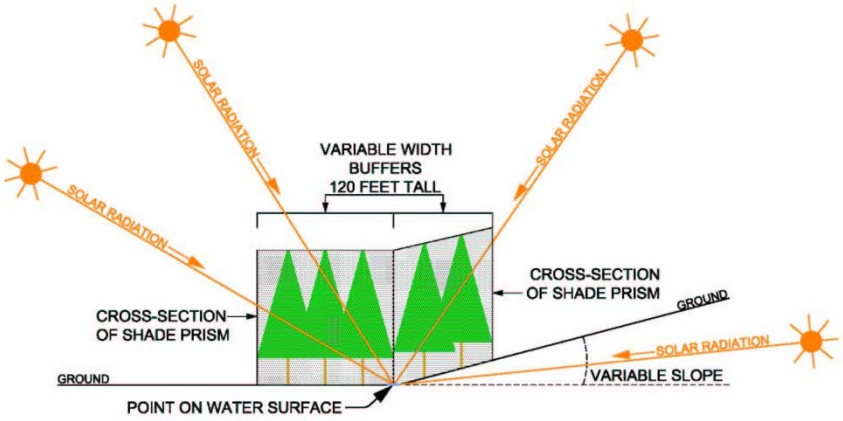
[18] Personal communication with Raj Kapur, Clean Water Services, Hillsboro, OR. April 2007.

canopy, the air temperature is lower during the day (though higher at night) and the relative humidity is higher, moderating the impacts of high air temperatures outside the canopy. Staff looked for research related to buffer sizes and relative microclimate benefit. Researchers from the USDA Forest Service, Bureau of Land Management, and Oregon State University, looking at headwater streams in western Oregon recently found that within buffers of unthinned stands of Douglas fir, there exists a noticeable microclimate gradient extending 5 to 100 meters perpendicular from the stream center, with the first 10m of gradient showing significantly lower air temperatures and higher relative humidity. These unthinned buffers appeared to mitigate microclimate impacts from the removal or thinning of trees outside the buffer area.[19]

Given the evidence from our modeling efforts and literature review that significant direct shade and microclimate benefits are realized within roughly the first 35 feet of buffer, the Gresham TMDL team chose this as the minimum buffer width that would be used as the goal for planting. To determine the maximum buffer width needed to make reasonable progress in meeting shade goals, Gresham contracted Pacific Habitat Services to create a model that would show the shade benefit that could be realized by planting various buffer widths with system potential vegetation.

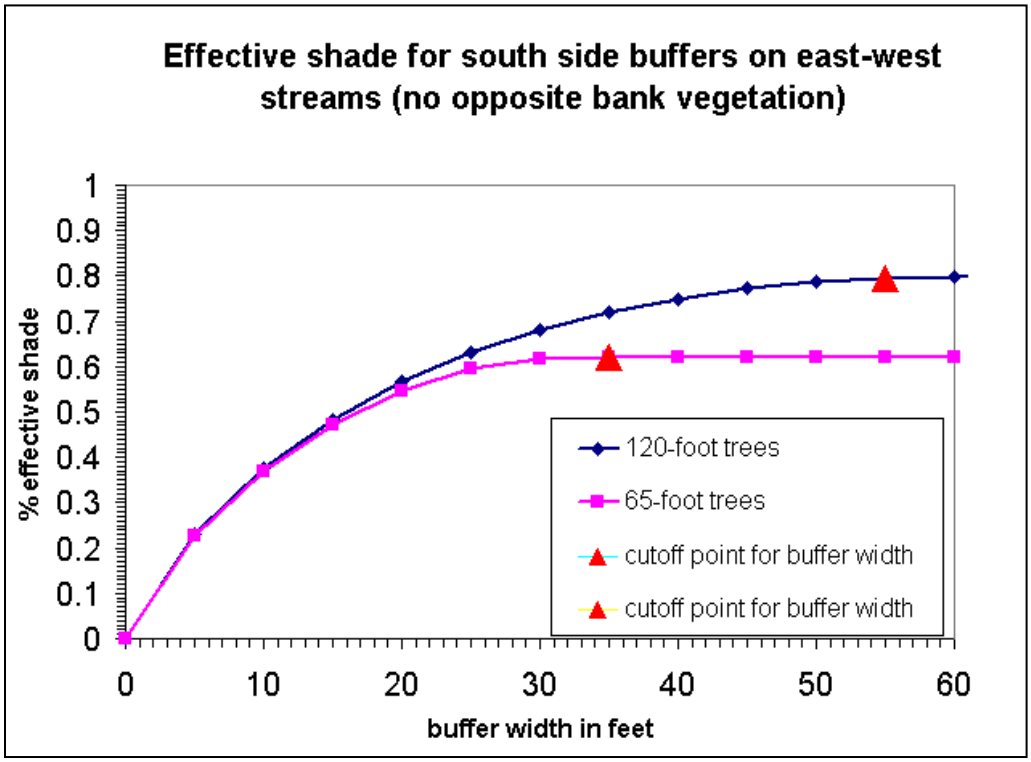
Modeling Buffer Sizes for Gresham Streams

Pacific Habitat Services utilized a national database that provides direct solar radiation readings taken at stations scattered throughout Oregon. Data is generally available for the time period 1961 to 1990, and data specific to the Portland area was used for this effort. Using GIS, all of Gresham's streams were divided according to changes in stream orientation. Within each resulting reach, the riparian zone was modeled as two prisms, with the dimensions of the prisms dictated by the fixed buffer width of 200' and fixed tree height of 120'. The buffer width of 200' was chosen as a conservative estimate for the maximum extent of vegetation that could have a direct shade benefit. The fixed tree height of 120' was chosen as representative of the average system potential vegetation tree height for the Portland basin eco-region. Direct shade benefit was determined along each stream reach by comparing the riparian areas with and without vegetation using the sum of the July solar radiation taken from the database. The results were a function of stream aspect, slope angles, buffer width, tree height, and presence of opposite bank vegetation. Curves were generated that demonstrated the functional shade benefit realized as the extent of vegetation was extended from



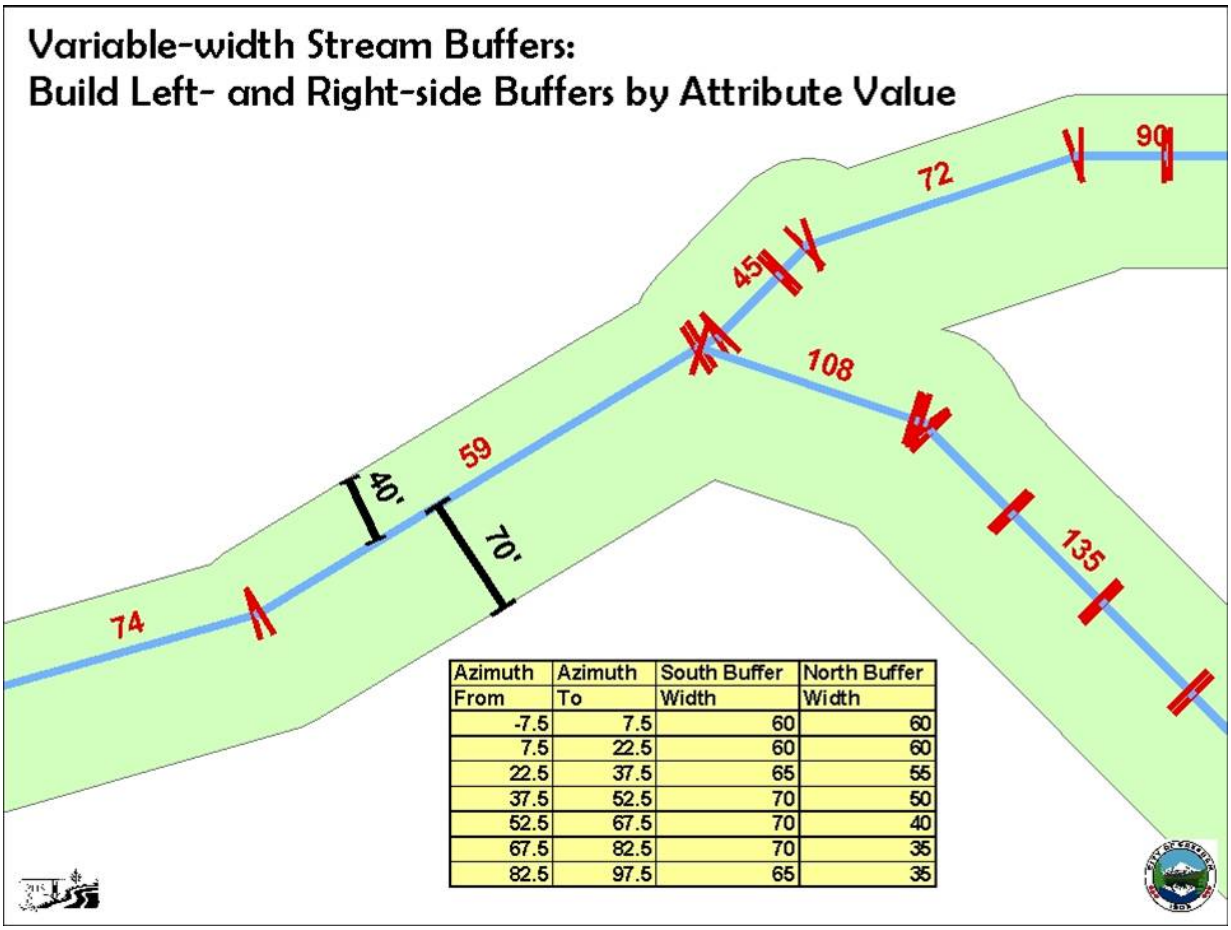
[19] Paul D. Anderson, David J. Larson, Samuel S. Chan, "Riparian Buffer and Density Management Influences on Microclimate of Young Headwater Forests of Western Oregon." Forest Science, vol. 53, issue 2. April 2007. Pgs. 254-269.

a buffer width of 0' to 200'. Regardless of slope, stream orientation, or presence of opposite bank vegetation, there was a similar diminishing shade benefit as the vegetative buffer width was extended perpendicularly from the edge of bank. It was determined by the Gresham TMDL team that the outer extent of buffer would be set at the point on the curve where an additional 5' of vegetation would result in less than 1% additional direct shade benefit. Changes in stream orientation had the greatest impact on varying this point of diminishing returns, whereas changes in slope (with other factors remaining equal) had a negligible impact on the buffer width. A representative curve (for an east-west oriented stream segment), highlighting the cutoff point for buffer width, is shown in the graph below. (Note, a curve showing a tree height of 65' is included just to demonstrate the effective shade benefit that will likely be realized by less mature trees within 25 years in contrast to the longer term effective shade these plantings will be expected eventually to provide.



According to the model, there was a significant increase in effective shade when the opposite bank was vegetated. Mostly this is attributable to the overhang of opposite bank vegetation over the stream, which doesn't necessitate a large buffer on the opposite side. This supported the decision of the Gresham TMDL team to set a goal of a minimum 35-foot buffer along all stream segments.

Gresham GIS staff established a variable-width buffer along all streams in Gresham by first creating an attribute table of buffer widths developed using the minimum buffer width of 35 feet, and the maximum buffer width appropriate for specific stream orientations (buffers ranged from 35-70'). A representative ArcMap image is included below, showing sample reaches where variable buffers of 40' and 70' (marked in black) were generated based on the stream orientation. The red marks are stream orientation reach breaks, as defined by GIS, and the red numbers represent the angle of orientation for that reach.

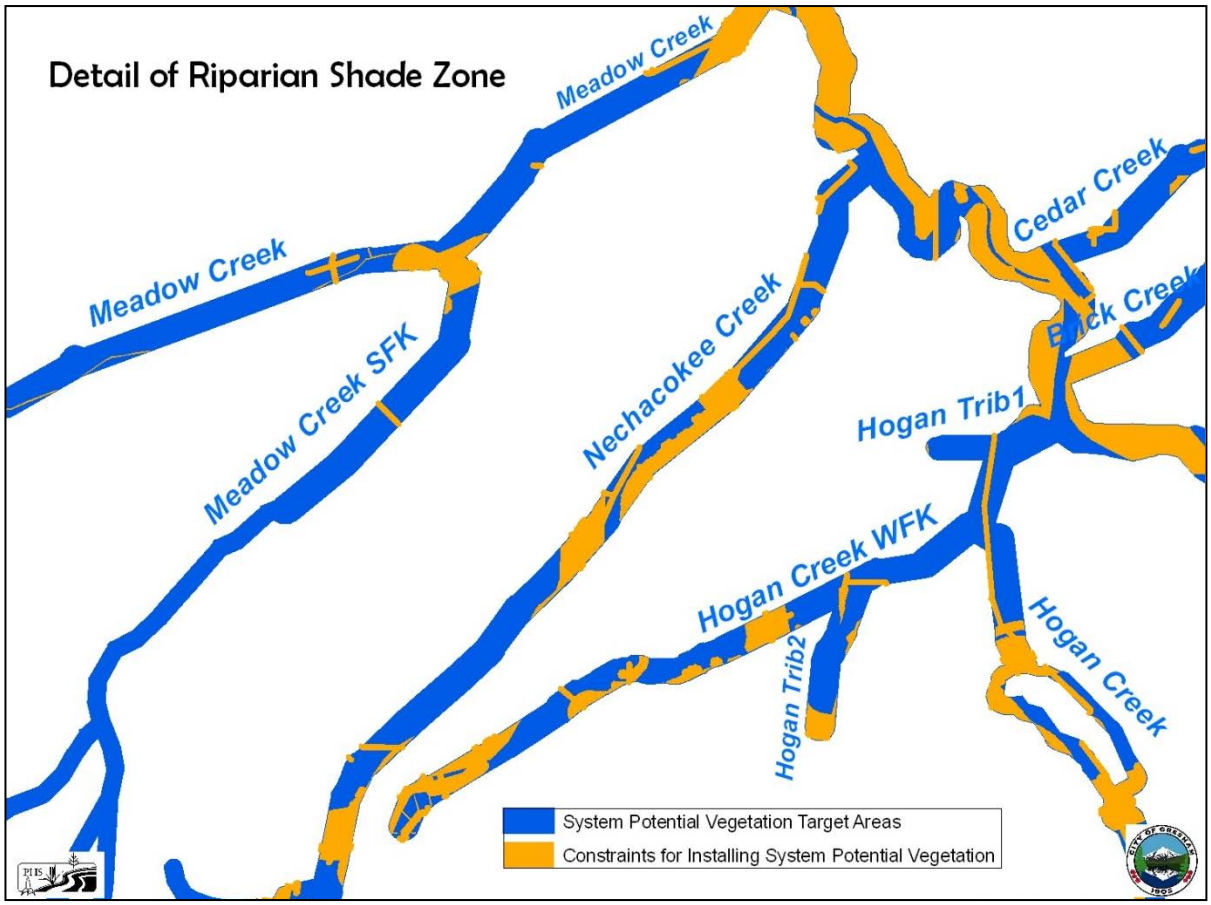


Azimuth From	Azimuth To	South Buffer Width	North Buffer Width
-7.5	7.5	60	60
7.5	22.5	60	60
22.5	37.5	65	55
37.5	52.5	70	50
52.5	67.5	70	40
67.5	82.5	70	35
82.5	97.5	65	35

This methodology was applied city-wide and generated a map layer that represents the "Functional Shade Buffer"—the riparian area throughout the city where system potential vegetation plantings will have the most effect on reducing stream temperatures.

It was recognized by the Gresham TMDL team that numerous constraints existed throughout this buffer area that would not allow for system potential vegetation establishment. Constraints were identified and broken into two types: hard constraints (areas that logistically cannot be planted) and soft constraints (areas where plant communities OTHER than system potential vegetation communities are more appropriate). Hard constraints within the Functional Shade Area included utility corridors (e.g., gas, water, stormwater, and wastewater pipe corridors), transportation corridors (including future right-of-ways and setbacks for visual site distance), established formal trails, building footprints, and paved areas). Soft constraints included areas that should be vegetated but due to habitat, safety, or human use considerations, system potential vegetation cannot be installed but other plant communities would be appropriate. Examples of soft constraints include wetlands, constructed water quality facilities, areas within power line easements (due to height restrictions), and developed park areas. Constraint areas were mapped (see image below) and subtracted from the Functional Shade Area to provide the final plantable area. This plantable area was called the Riparian Shade Zone. Less than half of the area within the Functional Shade Buffer contained constraints to installing system potential vegetation. Of

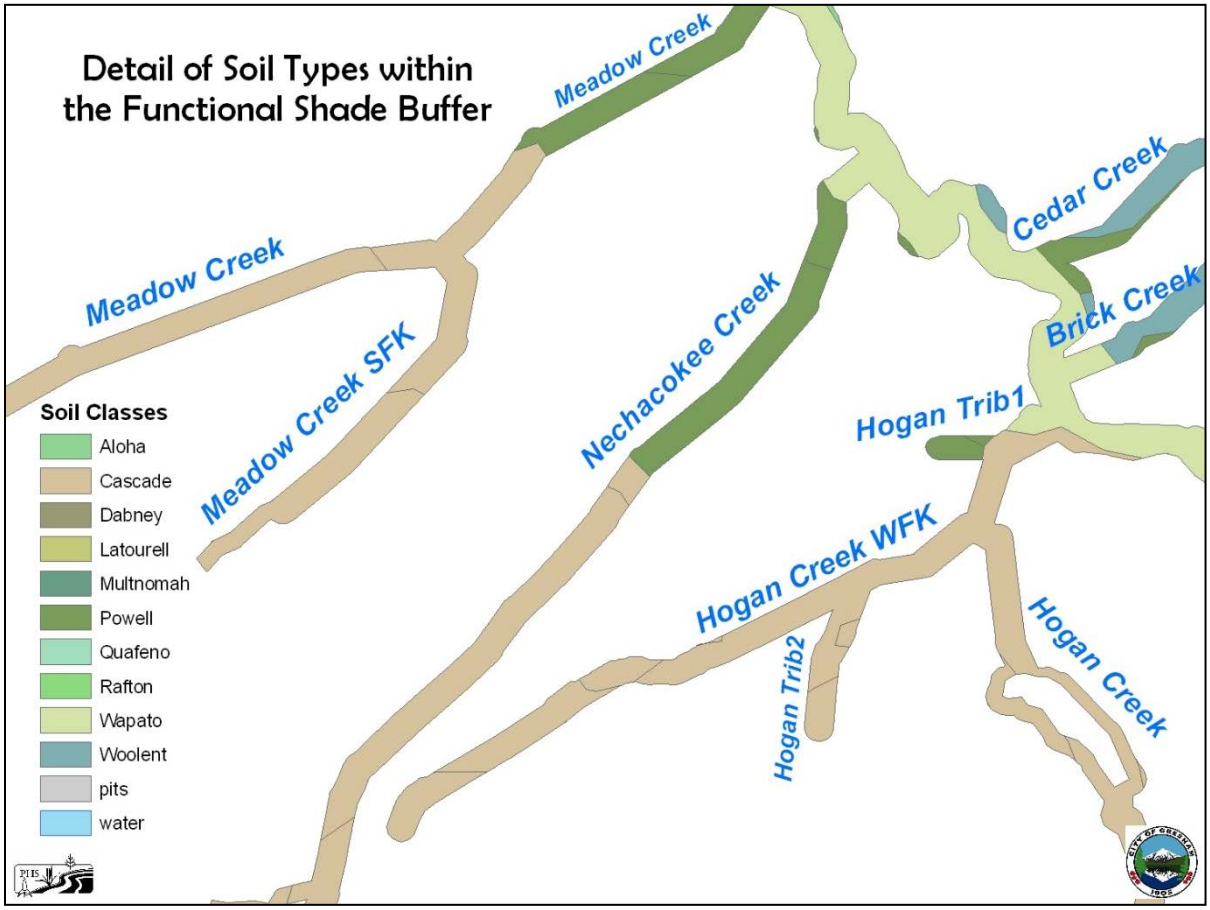
the initial 461 acres in the Functional Shade Buffer, a total of 211 acres of constraints were identified, leaving 250 acres of plantable Riparian Shade Zone.



Defining Gresham's System Potential Vegetation

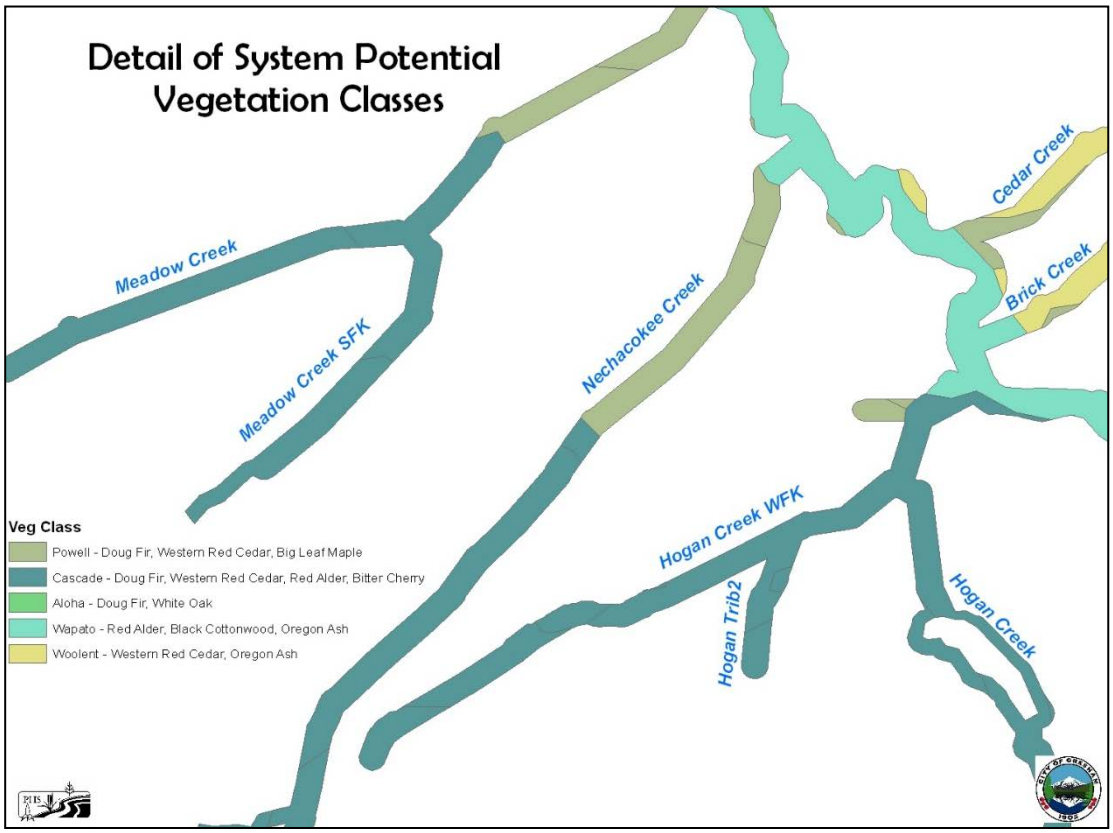
Gresham is located within the Portland Basin eco-region as specified by the Willamette TMDL. Plant communities that comprise Portland Basin System Potential Vegetation are not provided in the TMDL, but this information is needed as guiding criteria to develop projects that will effectively address the City's stream temperature obligations. The Gresham TMDL team also felt that developing general planting plans with specified plant communities would help ensure System Potential Vegetation is the target community installed when riparian planting is conducted by private homeowners, developers mitigating riparian impacts, utility maintenance staff, community volunteer groups, etc.

A list of recommended trees and shrub species for planting within the riparian shade zone is included in the addendum at the end of this volume. As a starting point, the soils within the Riparian Shade Zone were mapped by clipping the Multnomah County Soil Survey to the Functional Shade Buffer layer. Subclasses of soils were aggregated into major soil types, as shown in the example below.



Identification of plant communities both appropriate to the soil type and in keeping with the guidelines regarding system potential vegetation were then applied, resulting in a planned plant communities map that has the same classification boundaries as the soil map. A full multi-story

planting plan for each classification was developed. The map below represents the class planting plans according to the dominant shade-producing tree species.



Planting plans for system potential vegetation classes will be used to develop guiding criteria for projects the city will implement as part of its temperature TMDL management strategy, and to develop cost estimates for project implementation and maintenance.

Analysis Needed for the Final Temperature TMDL Implementation Plan
Per the Gresham TMDL team's understanding of the Water Quality Management Plans contained in the Willamette and Sandy TMDLs, DMAs are to address the elements listed below in their TMDL Implementation Plans. The location of each of these elements within this document is noted along with the name of the element.

- Condition Assessment (optional) – Provided in the "Introduction"
- Management Strategies – 2008 Addendum, page 32
- Identification of Constraints – discussed on page 26
- Mitigating Opportunities (mitigation requirement specific to the Sandy TMDL only) – page 33 of the 2008 Addendum
- Timeline for Implementation and Schedule for Completing Measurable Milestones – page 22, and 2008 Addendum, page 34
- Maintaining Management Strategies over Time –2008 Addendum, page 39
- Implementation Monitoring and Effectiveness Evaluation – 2008 Addendum, page 40
- Reporting and Adaptive Management – 2008 Addendum, pages 40 & 41
- Fiscal Analysis – 2008 Addendum, page 41
- Consistency with Land Use Requirements – 2008 Addendum, page 42
- Citation of Legal Authority – 2008 Addendum, page 42
- Public Involvement – 2008 Addendum, page 42

MARCH 2008 ADDENDUM

Background

In April 2007, the City of Gresham submitted to Oregon DEQ a preliminary plan for responding to the Willamette and Sandy Basin Temperature TMDLs. In that initial implementation plan, the City committed to submitting to DEQ by March 2008 a list of management strategies that would be utilized throughout the City's jurisdiction in order to move riparian shade conditions toward DEQ-established targets. These management strategies include implementation of on-the-ground stream channel and riparian improvement projects; long-term maintenance of improvement projects; and periodic evaluation of project performance and adaptive management response to increase long-term project benefits.

Subsequent to the submission of Gresham's April 2007 Temperature TMDL Implementation Plan, Gresham staff worked with natural resource consultants from Pacific Habitat Services, Inc. to:

- Conduct an analysis of existing shade conditions along Gresham's surface waters to determine priority shade needs;
- Develop planting protocols for areas within the City's designated Riparian Shade Zone;
- Evaluate natural resource projects proposed previously as part of basin master planning efforts;
- Identify additional project sites through field visits and site evaluations;
- Develop prioritization criteria for ranking projects;
- Incorporate the highest priority projects into the Watershed Management Division's 5-year CIP and receive City Planning Commission approval of the proposed projects;
- Establish maintenance and monitoring protocols that would improve survival rates and long-term project performance; and
- Analyze the probable rate of project implementation given the fiscal and community resources likely available.

Results of these efforts are reflected in the management strategies outlined below, and these management strategies comprise the City's initial efforts to progress toward improved riparian shade conditions throughout our portions of the Willamette and Sandy Basins.

Management Strategies

DMAs are to identify those projects and initiatives they will undertake to address the sources of anthropogenic warming listed in the TMDL. The specific sources of anthropogenic warming identified (in both the Sandy and Willamette TMDLs) for Gresham's streams are:

1. *Removal of riparian vegetation.* Implementation and maintenance of system potential vegetation within the Riparian Shade Zone will be the focus of Gresham's management strategies for this anthropogenic source of warming. Table A1.1 lists the highest priority projects in the Watershed Management Division's 5-year CIP, beginning in 2008-09In addition to these projects, the City will also support volunteer-based projects as time and resources allow.
   Obligatory measures:

The city will complete stream/riparian improvement projects as identified in watershed-specific stormwater master plans and included in the Watershed Management CIP. These projects include substantial riparian planting and maintenance and will vary from 1 to 50 acres in size. The City is obligated to implement the projects included in Table A1.1 by 2013.

a.

Voluntary measures (to be conducted as time and resources allow):

a. The city will seek to involve private landowners through existing state and regional incentive programs and will develop additional riparian enhancement incentive programs to encourage development of a 35- to 70-foot system potential vegetation-planted buffer wherever possible.
b. The Watershed Management Division will continue working with community volunteers to implement riparian planting projects. Whenever possible, volunteer efforts will be directed to areas shown to have the greatest benefit on stream temperatures, according to the modeling work completed by the Gresham TMDL team, as described above.

2. *Channel modifications and widening*. Channel degradation has been assessed through the City's watershed-specific stormwater master plans. Opportunities for stream channel restoration have been identified and included in the Watershed Management Division's CIP and are included in Table A1.1.
3. *Macrophyte growth (Columbia Slough/Fairview Creek only)*. Macrophytes (aquatic plants) typically found in Gresham thrive in areas with little shade. As such, implementation of system potential vegetation projects should reasonably also address macrophyte problems.

Public and private land activities will be scoped and prioritized based not only to reflect potential benefits to stream temperatures, but also in consideration of complementary needs for improvements in stream bank stability, meeting other water quality standards, and restoring habitat for state and federally listed species present in our watersheds.

Mitigation Opportunities

Mitigation (as required by the Sandy TMDL only) will be completed by:

- Planting system potential vegetation buffers where there is little direct shade benefit, but where there is substantial microclimate benefit (i.e. a 35-foot buffer on the north bank of an east-west oriented stream).
- Developing incentive and technical assistance for private landowners to install system potential vegetation for direct shade or microclimate benefits.
- The City will continue to work with state and regional partners to acquire riparian properties, both within the current city limits and in upstream areas where intact riparian vegetation can be preserved.

Implementation of Proposed Management Strategies

Gresham's temperature TMDL projects and initiatives will address the sources of anthropogenic warming as identified in the Willamette and Sandy TMDLs, specifically: removal of riparian vegetation, channel degradation, and aquatic macrophyte growth. While some projects such as macrophyte control or channel improvements may provide an immediate benefit in flow and temperature conditions, it is anticipated that it will take several decades after project implementation for effective shade benefits to be realized due to the realities of native tree growth rates.

Timeline for Project Implementation

A short-term planning horizon of 5 years is used for the City's funded Capital Improvement Plan (CIP), and was therefore chosen as the timeline for implementing the highest priority shade projects. The City's standard long-term community planning horizon of 20 years was chosen for overall Temperature TMDL project implementation planning. This is consistent with traditional infrastructure master planning, and staff also found the 20-year timeframe to be consistent with temperature management programs presented by Washington County and Clean Water Services.

These timeframes were used to establish implementation goals for prioritized temperature TMDL projects. Those projects ranking as the highest priority will be addressed within the first 5 years (starting 2008-09), medium-priority projects within 10 years, and lower-priority projects within 20 years. Large-scale, high-priority projects on public land have been included in the Watershed Management Division's CIP; high priority projects of a smaller scale or involving private lands will be placed on the priority list for riparian project sites targeted through the City's private landowner technical assistance programs and community-based volunteer restoration efforts.

The 5-year and 20-year planning schedules are reflected in the City's long-term effectiveness evaluation process; the impacts of these planting projects may take decades before significant increases in shade are realized. It is expected that in 20 years' time, staff will start to see measurable shade changes resulting from the implementation of our first high high-priority projects. A shade analysis periodicity of 10 years is a component of the City's long-term monitoring plan.

Prioritizing Volunteer and Landowner Involvement Efforts

Results of the existing shade analysis are now being used to help prioritize locations where landowner technical assistance strategies will be targeted. These results will also be used to select sites for community-based volunteer involvement.

Overview of the Existing Shade Analysis Process

The purpose of this baseline study was to provide an assessment of the extent and quality of existing shade; form a basis that could be used to help prioritize future restoration projects; and serve as a tool for monitoring shade conditions in future years. Prior to performing the existing shade analysis, three shade categories were established to characterize the existing shade along

the streams: 1) <25% of the stream shaded; 2) 25-75% of the stream shaded; and 3) >75% of the stream shaded. Current (2006) aerial photographs and the City's GIS shapefiles for their streams were reviewed to evaluate stream shade and identify contiguous segments of each shade category along each stream. Additional online aerial photo resources (e.g., http\\: www.live.com) were also reviewed to provide additional perspectives of the streams, where necessary.

Contiguous segments of each shade category were mapped along all the streams at a scale of approximately 1 inch = 650 feet. For larger streams such as Johnson Creek, separate shade categories were mapped on either side of the stream; for smaller streams (generally six feet wide or smaller), a single shade category was mapped for both stream banks. While mapping shade categories from the aerial photographs, areas needing field verification were identified. These sites and other random stream reaches were visited to verify the accuracy of the shade mapping. The mapping was adjusted as necessary. Once the mapping was complete, City GIS staff digitized the hand-drawn shade categories to create GIS shape files for incorporation into the City's GIS information.

Existing Shade Condition Findings

Of the City's three main watersheds (Johnson Creek, Kelly/Burlingame Creeks, and Fairview Creek/Columbia Slough), Johnson Creek has the highest proportion of existing shade, though levels of shade still fall significantly short of DEQ shade targets established for Johnson Creek. Much of Johnson Creek's riparian shade zone is included within publicly owned parcels, and large portions of many of those parcels are currently forested. Because much of the land is in public ownership, riparian shade zones that are inadequately shaded under existing conditions could be enhanced to provide system potential vegetation relatively easily.

In contrast, much of the riparian shade zones within the Kelly Creek/Burlingame Creek and the Fairview Creek/Columbia Slough watersheds are in private ownership. Publicly owned parcels along the streams in these watersheds are generally less contiguous and smaller than the ones within the Johnson Creek watershed. In these watersheds (and in some of the smaller tributaries of Johnson Creek), existing development generally occurs close to the streams and existing forested cover within the riparian shade zones is generally narrower and less extensive. Due to the large proportion of the riparian shade zones in private ownership, the relatively low proportion of existing forest cover within the riparian shade zone, and the proximity of existing development to the streams in these watersheds, the enhancement of inadequately shaded riparian shade zones to restore system potential vegetation will require greater coordination and cooperation with private landowners.

As it is difficult to predict the level of volunteer and landowner involvement in any given year, the City is not committing to any restoration targets involving volunteers or private landowners. City staff intends to pursue these initiatives at our current levels, using our shade model results and existing shade analysis as guidance in where to prioritize the resources we direct toward these efforts. The Watershed Management Division has embarked on two new initiatives involving private streamside landowners and Northwest Service Academy AmeriCorps volunteers to increase our progress on riparian improvements. Staff currently projects a goal of 12 acres of riparian planting per year between private landowners and volunteers, though actual riparian improvement progress may be significantly higher or lower. City staff will analyze

results of these initiatives each planting season to determine whether more effective strategies can be employed to accelerate riparian revegetation efforts within our existing resource levels. Progress on these initiatives will be reported annually in terms of acres treated, number of native plants installed, community members/landowners engaged in the process, and survival rates of plant communities at a subset of previously established sites.

Capital Improvement Projects (CIPs)

Projects listed in Table A1.1 were identified as our highest highest-priority project sites and, therefore, were recommended for inclusion in the Watershed Management Division's 5-year CIP, beginning in 2008-09. The projects were ranked as high priority based on their size and relative influence on the subbasin, potential for substantial increase in functional riparian shading, presence of listed salmonids, and ability to address multiple watershed priorities.

Table A1.1:
Temperature TMDL-Related Projects in the
Watershed Management Division's 2008-2009 5-Year CIP

Project Name	Project Start Year	Description
Johnson Creek Riparian Corridor Improvements: SE Regner to Hogan	2008-2009	Stabilize main stem and tributary confluence area banks, improve floodplain function, control invasives, and plant native trees and shrubs within a 42.61-acre area.
Johnson Creek Riparian Corridor Improvements: SW 7th Street Bridge area	2008-2009	Stabilize stream banks, improve bed conditions, reconnect floodplain, and replace aggressive invasive plant community with native trees within 16.8-acre area.
Johnson Creek Riparian Corridor Improvements: SW 14th Stabilization	2008-2009	Address massive slumping along 1.55 acres of private property by working with landowner, agencies, geotech, and stream restoration specialists; control invasive plant species and replant with native trees and shrubs.
Johnson Creek Riparian Coordinator Improvements: Walters Rd. Area	2009-2010	Improve side channel conditions, address bank erosion, stabilize slopes, control invasives, and plant natives. 2.5-acre area.
Kelly Creek Riparian Corridor Improvements: Bell Acres Trail Park	2012-2013	Re-establish channel morphology and structurally diverse riparian corridor by channel regarding, invasive control, and native plantings.

The five-year CIP will be updated annually to include projects that reflect the highest priority needs of the watersheds, based on current site conditions, changes in City jurisdiction (i.e., new high priority parcels acquired), or changes in regulatory expectations. As such, in future years

the actual projects implemented may vary from Table A1.1, but overall progress toward riparian improvement will continue according to the City's prioritization methodology.

Riparian Planting Strategy

The Gresham TMDL team has developed general planting plans with specified plant communities to ensure system potential vegetation is the target community installed when riparian planting is conducted by private homeowners, developers mitigating riparian impacts, utility maintenance staff, community volunteer groups, and others. As a starting point, the soils within the riparian shade zone were mapped by clipping the Multnomah County Soil Survey to the functional shade buffer layer. Subclasses of soils were combined into the following major soil types: Aloha; Cascade; Cornelius; Dabney; Delena; Moag; Haploxerolls, steep; Haplumbrepts, steep; Latourell; Multnomah; Powell; Quafeno; Rafton; Wapato; and Wollent.

Once the soil classifications within the riparian shade zones were identified, plant species appropriate for planting within each soil classification were identified, and recommended plant communities appropriate to the soil type and consistent with the guidelines for system potential vegetation were developed. This resulted in planned plant communities that correspond to the soil classification boundaries depicted on the Multnomah County Soil Survey, and that meet the need to achieve ecosystem-appropriate system potential vegetation. Each planned plant community contains trees and shrubs that, when established, will provide a full multi-story community. Table A1.2 lists the tree and shrub species recommended for planting within each soil type.

Local conditions related to slope, topography and soil texture within any mapped soils unit may result in moisture conditions that impact survival of various tree and shrub species, and therefore the plant communities recommended for a mapped soil classification may not be appropriate on a particular site (or a portion of the site) due to the local site conditions. Therefore, the recommended plant communities (Table A1.2) were also related to soil moisture and landscape position so that those installing riparian plantings can select plant communities appropriate for their local site conditions. For example, if a particular site has mapped Multnomah soils, but portions of the site have low areas with soils that are moist or saturated year-round, it may be appropriate to select plants from the moist riparian or wetland lists for planting in those wet areas, rather the plants typical for dry riparian conditions typically associated with Multnomah soils.

Table A1.2: Recommended Tree and Shrub Species for Planting within Riparian Shade Zone			
Site Conditions	**Typical Soil Series**	**Recommended Plant Community**	
Floodplain and wetlands adjacent to the Columbia Slough	Moag Rafton	Trees	Black cottonwood Pacific willow
		Shrubs	Red-osier dogwood Snowberry Willow Wild rose
Floodplain and wetlands adjacent to Johnson Creek, Fairview Creek, and Kelly Creek	Delena Wapato Wollent	Trees	Black cottonwood Pacific willow Red alder Oregon white ash Western red cedar
		Shrubs	Douglas spiraea Pacific ninebark Red-osier dogwood Snowberry Twinberry Wild rose Willow
Moist Riparian	Aloha Cascade Powell	Trees	Bigleaf maple Black cottonwood Grand fir Red alder Western red cedar
		Shrubs	Bitter cherry Black hawthorn Hazelnut Indian plum Oregon grape Red elderberry Salal Salmonberry Snowberry Thimbleberry Vine maple

Table A1.2: Recommended Tree and Shrub Species for Planting within Riparian Shade Zone			
Site Conditions	**Typical Soil Series**	**Recommended Plant Community**	
Dry Riparian	Cornelius Dabney Haploxerolls, steep Haplumbrepts, steep Latourell Multnomah Quafeno	Trees	Bigleaf maple Douglas fir Oregon white oak Western hemlock
		Shrubs	Hazelnut Indian plum Oceanspray Oregon grape Salal Snowberry Vine maple

Maintaining Management Strategies over Time

To ensure the successful establishment of system potential vegetation and maximize possible shade along the City's streams, the City recommends planting densities and spacing of trees and shrubs established by the City of Portland's Watershed Revegetation Program planting protocols. Based on these protocols, the City recommends planting 820 trees and 820 shrubs from the above list per acre. This high planting density assumes that the plantings will not be irrigated and that there will be a relatively low rate of survival. If the area to be planted will be irrigated, plants may be installed at lower densities; however, the final number of native trees and shrubs in the project area should be no lower than the target density of 500 trees and 650 shrubs per acre.

Following planting, regular maintenance will be performed to maximize the rate of plant survival. All sites will be regularly inspected for the presence of invasive, non-native species, such as English ivy and Himalayan blackberry, which can out-compete desirable native trees and shrubs. Appropriate control measures will be undertaken, as necessary, to control the spread of the invasive species. It is anticipated that over time, as the native trees and shrubs become established, the frequency of such maintenance activities will decrease.

Macrophyte Control Projects

Macrophyte (rooted aquatic plant) growth can significantly affect water temperatures because the greater channel friction raises water levels and decreases flow rates. Within the City of Gresham, the Columbia Slough is the only stream where aquatic macrophytes are prevalent. Therefore, the control of macrophytes may be an important tool for improving temperature conditions in the Slough. Aquatic macrophytes typically thrive in areas with little shade, and the increased shade that will result from the implementation of system potential vegetation projects would be reasonably expected to also address macrophyte problems. If necessary, the City may

partner with private landowners or the Multnomah County Drainage District to explore physical removal of macrophytes to improve flow and consequently reduce water temperatures.

Monitoring, Evaluation, and Reporting

The City of Gresham will monitor its TMDL implementation projects to document the success of the proposed management strategies. The monitoring program will be designed to respond to the Willamette and Sandy TMDL requirements by demonstrating successful implementation of proposed management strategies; demonstrating continuing benefit of implemented strategies; and evaluating management strategy effectiveness. Generally, the City intends to monitor and evaluate projects annually, every five years, and every ten years, as described below.

Annually, the City will report to DEQ on the implementation and performance of the program. These annual reports to DEQ will include details on the projects installed during the previous year. Such details will include (but may not be limited to) the number and size of the sites planted, the numbers and densities of plants installed, and the number of private property owners participating in the program. The annual implementation and performance monitoring will also provide an evaluation of the City's success in adhering to the implementation schedule and the success in reaching established goals and milestones.

Every five years, vegetation will be monitored at a subset of active restoration sites in order to assess plant survival statistics, vegetation height, canopy densities and growth rates attributable to the planting plans and maintenance strategies *being employed by the City. The data collection may include densitometer readings to estimate canopy cover and shade. At all active project sites, photo documentation points will be established at selected locations to record the growth of vegetation within the riparian corridors. These photo documentation points will be revisited at 5-year intervals. To* assess and document *the efficacy of riparian ordinances in allowing "passive restoration" to recover a system potential vegetation riparian canopy, representative lands where no active restoration efforts have been employed will also be selected for photo-point analysis at 5-year intervals. Within these select passive restoration sites, species type, height, and density will also be assessed.*

At ten-year intervals, the City will collect field data (likely via solar pathfinder or hemispherical photography) to ground-truth shade estimates derived through aerial image analysis. It is possible that the City will use Light Detection and Ranging (LiDAR) survey data for this purpose. LiDAR data were collected in 2007. LiDAR data can also be used to calculate the baseline riparian area canopy cover (area and height) and to estimate canopy density. LiDAR has been firmly established as an effective tool for monitoring forest development and health, and it has been shown to yield results comparable to field-based stand inventory methods. Gresham expects to acquire new LiDAR data at roughly ten-year intervals, though collection of this data is dependent on region-wide cooperation. As LiDAR data is made available, Gresham will perform a change detection to monitor and quantify canopy development and progress toward system potential vegetation in its riparian areas. In the absence of new LiDAR data, other current aerial imagery will be used, according to appropriate protocols.

Adaptive Management Strategy

Gresham will track its temperature TMDL implementation activities and report to DEQ annually on progress and accomplishments. Results of implementation will be gauged against the goals of the plan to assess whether satisfactory progress is being made. The City's annual report to DEQ will describe what information was used in the evaluation, the findings of the evaluation, and the basis for this reasoning. If the evaluation indicates that the current implementation approach is not likely to be adequate to realize the system potential vegetation goals set for public lands, the City will describe how it will modify this plan or undertake other efforts to achieve these goals, and the timeline for accomplishing this. Each year City staff will need to update our TMDL plan to reflect changes in the City's urban growth patterns, including in associated changes in prioritization, planning, planting, maintenance, monitoring, and reporting efforts for all surface waters in newly annexed areas. It is anticipated that the majority of land within the Springwater and Pleasant Valley planning areas will be annexed into the City within the next 20 years, increasing the City's size by 3000 acres and adding nearly 25 miles of streams to the City's surface water infrastructure.

The results of the City's vegetation monitoring will be evaluated to determine if adaptive management measures are needed to ensure success of the planting projects. If the monitoring indicates that the desired survival rates and densities are not being achieved, the City will attempt to determine the reason for the plant mortality and take corrective actions to achieve higher survival rates. Examples of corrective actions that may be taken may include the following:

- Control of invasive, non-native species;
- Pest management to reduce predation and herbivory;
- Species selection changes if planted species appear to be poorly suited to local site conditions;
- Irrigation where soil moisture is inadequate to allow for successful plant establishment;
- Organic amendments to provide suitable soil conditions;
- Public education; and
- Fencing to prevent trampling of planted vegetation in high-use areas.

Projects will include both measures that the City will obligate itself to implementing (represented by inclusion in the Watershed Management CIP) and volunteer-based projects the City will support as time and resources allow.

Fiscal Analysis

Gresham will submit for City Council approval a financing plan or funding strategy for their temperature TMDL plan that is publicly acceptable and moves toward system recovery in a timely manner. The financing plan will consider what resources are needed to develop, execute, and maintain the Implementation Plan's management strategies. It will include elements for completing land acquisition and capital improvement projects, maintaining the benefit of completed projects, supporting improvements on public lands, and supporting volunteer efforts.

Consistency with Land Use Requirements

Provided in Volume 1 of the Gresham TMDL Implementation Plan.

Citation of Legal Authority

The proposed plan is consistent with City code, and state and federal law.

Public Involvement Process

The approach outlined in this document was explained to the City's Environmental Services Citizen Advisory Committee on February 20, 2008. The Committee expressed appreciation for the logic of the plan and recommended no changes. In the future, City staff and consultants will review the protocols described in this Implementation Plan with local watershed councils, Metro Regional Government, the City's Citizen Advisory Committee, and other concerned stakeholders as appropriate to obtain input regarding resource commitments prior to presentation to City Council.

Conclusion

It is the City's intention to make defensible and reasonable progress towards compliance with in-stream temperature standards as they pertain to: Johnson Creek, Fairview Creek, and the Columbia Slough (through the Willamette River TMDL); and Kelly/Burlingame Creek (through the Sandy River TMDL)