Appendix R

Whipple Creek Watershed-Scale Stormwater Plan Report

Whipple Creek Watershed-Scale Stormwater Planning Scope of Work and Schedule

Prepared by

Clark County Department of Public Works

Clean Water Division

June 2014

Clark County

Whipple Creek Watershed-Scale Stormwater Planning

Scope of Work and Schedule

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Contents

INTRODUCTION

The Washington State Department of Ecology issued a 2013-2018 Phase I Municipal Stormwater Permit (Permit) on August 1, 2012 that requires Clark County (County) to select a watershed and perform watershed-scale stormwater planning as outlined in section S5.C.5.c. This section states that "the objective of watershed-scale stormwater planning is to identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support 'existing uses' and 'designated uses', as those terms are defined in WAC 173-201A-020, throughout the stream system." The submittal of this scope of work and schedule addresses the permit requirement that "No later than April 1, 2014, the Permittee shall submit a scope of work and schedule to Ecology for the complete watershed planning process." Of the two watersheds listed in the permit as options for watershed-scale stormwater planning, Clark County has selected Whipple Creek.

WHIPPLE CREEK WATERSHED

Whipple Creek watershed is located in southwest Clark County, draining west from low hills to the Columbia River flood plain (Figure 1). Whipple Creek watershed was once dominated by rural and agricultural land uses. It is currently moderately developed with a mix of rural, urban and urbanizing areas at the northern edge of the Vancouver Urban Growth Area (Figure 1). The 8.8 square mile upper sub-watershed (including Packard Creek) includes approximately 4.4 square miles inside the Vancouver urban growth area, while the 3.3 square-mile lower watershed is entirely outside the urban growth area. Historic clearing and development impacts have degraded stream habitat and caused areas of severe channel instability and erosion. Impacts from these land use changes are consistent with those documented elsewhere around Washington State and the country for channel stability, water quality, and overall ecological function.

Whipple Creek is not specifically listed in WAC 173-201A-602. The designated uses for streams not specifically listed are: salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; shellfish harvesting; commerce and navigation; boating; and aesthetic values. Among these, the salmonid uses are the most challenging to maintain and restore, typically requiring habitat conditions equivalent to those found in a predominantly forested watershed.

The 2010 Clark County Stream Health Report rated Whipple Creek as poor for flow, water quality, and biological health. Ecology includes Whipple Creek in its 303(d) Category 5 list (polluted waters requiring a TMDL) for fecal coliform bacteria and Category 2 list (waters of concern) for temperature. In addition to the 303(d) listings, high nutrient concentrations, low Benthic Macroinvertebrate Index of Biological Integrity (BIBI) and Oregon Water Quality Index (OWQI) scores, and elevated turbidity levels are commonly observed (Clark County, 2006). There is currently only limited fish distribution data, but anecdotal information indicates that Whipple Creek may be used by anadromous fish including cutthroat trout, steelhead, and Coho salmon. The most suitable habitat has been identified in the lower Whipple Creek Basin (Clark County, 2006).

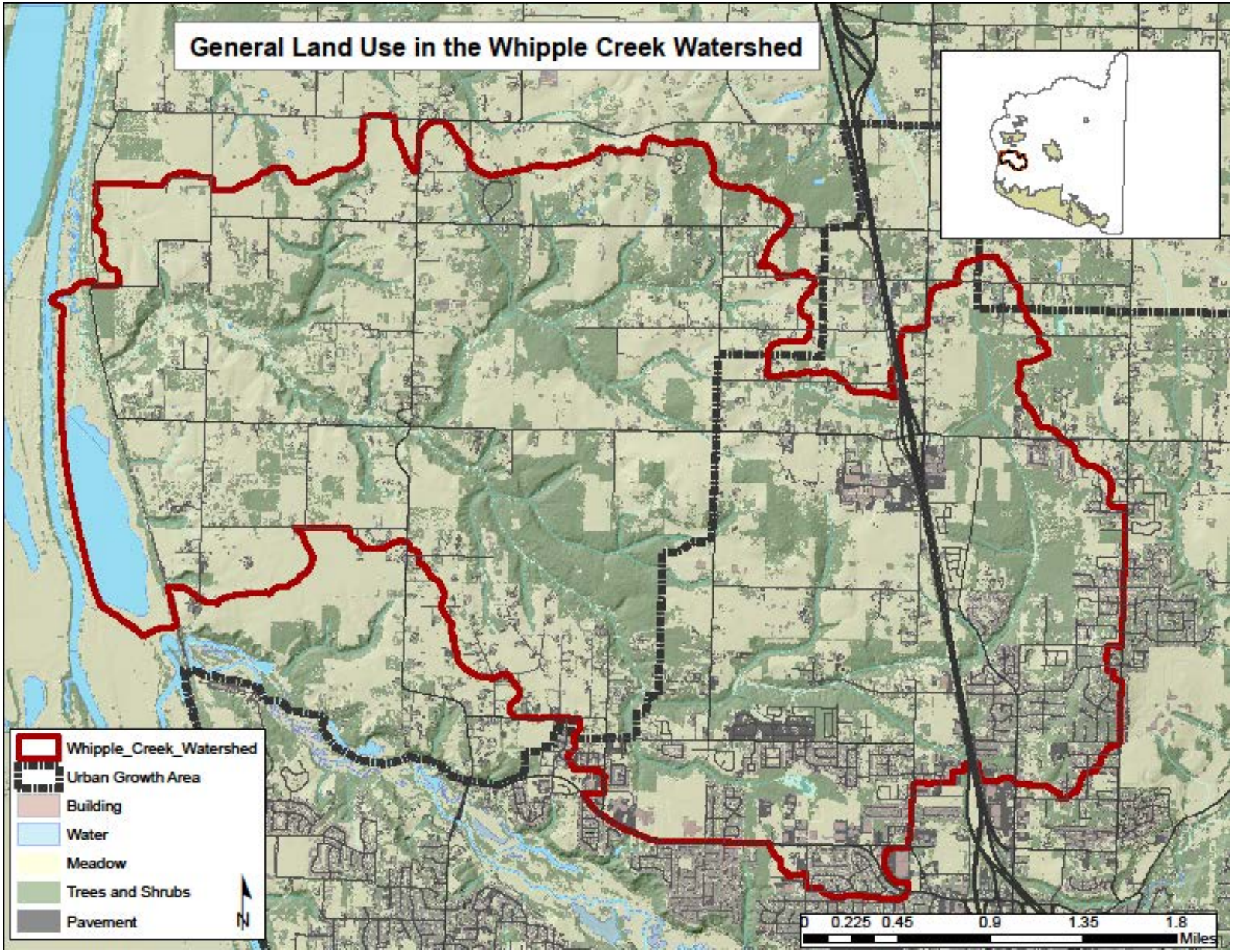

Figure 1 Whipple Creek watershed, general land use

SCOPE OF WORK

Section S5.C.5.c. of the Phase I permit describes required work products and the types of stormwater planning activities required for each. This scope of work describes the proposed watershed-scale stormwater planning for Whipple Creek to be accomplished through the following tasks:

- Task 1. Data Collection and Assessment of Existing Conditions
- Task 2. Environmental Mapping Dataset Development and Assessment
- Task 3. Develop and Calibrate Existing Conditions Runoff and Water Quality Models
- Task 4. Model Baseline Scenarios
- Task 5. Evaluate Watershed-Scale Stormwater Planning Scenarios
- Task 6. Develop Draft and Final Implementation Plan
- Task 7. Public Review and Comment Process
- Task 8. Project Management

TASK 1. Data Collection and Assessment of Existing Conditions

An assessment of existing hydrologic, biological, and water quality conditions will be performed using existing and newly collected environmental monitoring data. Water quality data will be compared, as applicable, to state water quality standards and accepted metrics. The data will also serve as input datasets for hydrologic model and water quality model development and calibration described in Task 3.

The assessment will include a variety of data including water chemistry, continuous temperature, macroinvertebrates base flow and storm event samples, continuous stream flow, and precipitation. Project sampling sites are described in the following sections and shown in Figures 2-4 and Tables 1-3.

The existing data review will include a description of data suitability for use in this project. Clark County will develop a QAPP to guide each data gathering task.

Due to the important role sediment has in the ecological health of Whipple Creek, the County has added total suspended solids (TSS) to the list of parameters to be evaluated as part of this project. Suspended sediment (as TSS) is also the constituent simulated by most common continuous runoff models. Strategies identified to address suspended sediment may also have secondary benefits on nutrient concentrations in Whipple Creek, although nutrients will not be directly investigated as part of this project.

The monitoring and mapping data reviewed and collected in Tasks 1 and 2 will be used to calculate and compile metrics characterizing hydrology and water quality in up to 10 subareas based on land use and hydrologic setting. A narrative description of each subarea will include analysis of map information compiled for Task 2.

Task Outcomes/Deliverables:

- **A report characterizing existing conditions in Whipple Creek**
- **Datasets for calibration of continuous hydrologic and water quality models**

TASK 1.a.i. Water Quality Assessment – Existing Site Data

Long-term Index Site Project (LISP) Site – The only existing long-term monitoring site in the Whipple Creek basin is WPL050, located just downstream of the confluence with Packard Creek at 179th Street, which has been operated since water year 2002. Water quality monitoring at this site allows calculation of the regionally-appropriate Oregon Water Quality Index and comparisons with state water quality standards. Monitoring at WPL050 also includes annual macroinvertebrate sampling, year-round continuous stream flow measurements, and summer continuous temperature measurements. Starting in WY2013, monitoring of dissolved copper and dissolved zinc was added. In addition to the existing parameters being collected at WPL050, continuous recording of water temperature will be performed year-round, and the collection of air temperature data may also be added.

Stormwater Needs Assessment Program Sites (3 total) – During WY 2012, the County performed monitoring to calculate the OWQI and BIBI at WPL010, WPL080, and PCK010 (See Table 1 and Figure 2). These sites will be included in proposed base flow, storm flow and continuous temperature monitoring.

Stormwater Outfall Characterization at LDR010 – From 2010 to 2013, approximately 33 composite stormwater samples, continuous stream flow and continuous precipitation data were collected at this site. These data provide detailed information about stormwater runoff from a small rural headwater basin.

Table 1. Existing Data

Station	Station Location Description	Water Quality	Stormwater Discharge	Macroinvertebrate	Temperature
WPL010	Whipple Cr upstream of Kreiger Rd	WY2012	----	WY2012	----
WPL050	Whipple Cr upstream of NW 179th St	WY2002 - Current	----	WY 2001 Current	WY2002 - Current
WPL080	Whipple Cr Downstream of Union Rd	WY2012	----	WY2012	----
PCK010	Packard Cr downstream of NW 179th St	WY2012	----	WY2012	----
LDR010	Packard Cr west of NW 184th St	----	WY2010 - WY2013	----	----

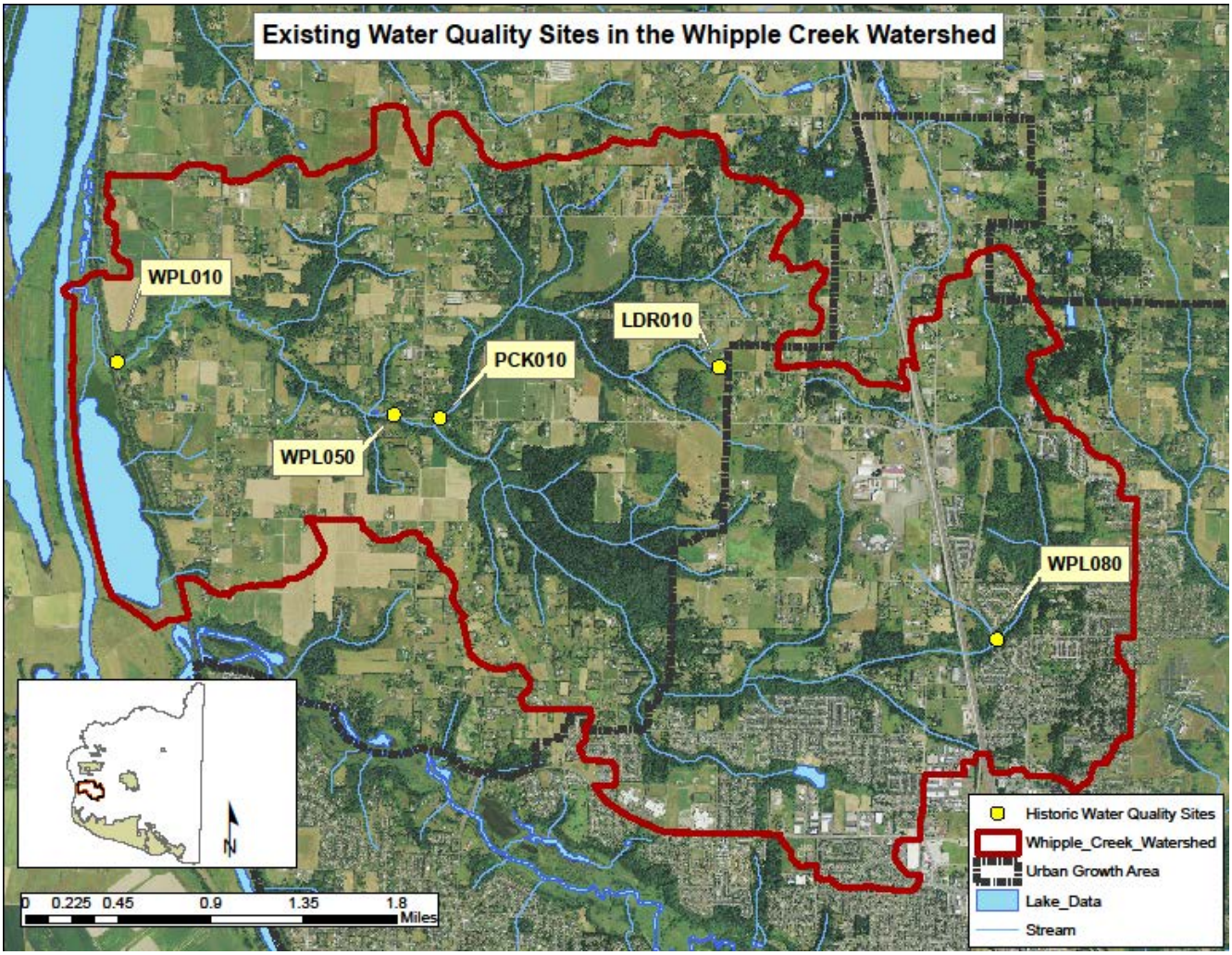

Figure 2. Sites with existing data

TASK 1.a.ii. Water Quality Assessment – Base Flow and Storm Grab Samples

Along with data collected by the County since 2002, additional water quality samples are needed to characterize existing conditions and calibrate water quality models. The Permit requires that sampling be performed "*at locations up-gradient and down-gradient of stream sections influenced by MS4 discharges*". In Whipple Creek watershed, the headwaters of both Packard Creek and Whipple Creek already receive water from the County's MS4, making it impossible to locate monitoring sites upstream of MS4 discharges. Instead, the intent of this permit requirement was interpreted to require a characterization of the gradient of water quality and stream flow within the system. Parameters will include, at a minimum:

- Dissolved copper (Cu)
- Dissolved zinc (Zn)
- Temperature
- Turbidity
- pH
- Fecal coliform
- Total Suspended Solids
- Hardness

Monitoring for base flow and storm events is planned to occur at nine sites (Figure 3). Base flow water quality will be assessed by collecting samples twice a day (morning and afternoon) at each site during

each event. A total of six base flow sampling events will be performed; three in the wet season (October – April) and three in the dry season (May – September).

To the extent allowed by hydrologic conditions and logistical constraints, storm sampling will collect three samples per event, distributed to capture a range of conditions during the storm (one sample each on the rising, peak, and falling limb of the hydrograph). The project goal is six storm-flow sampling events with four wet season and two dry season events.

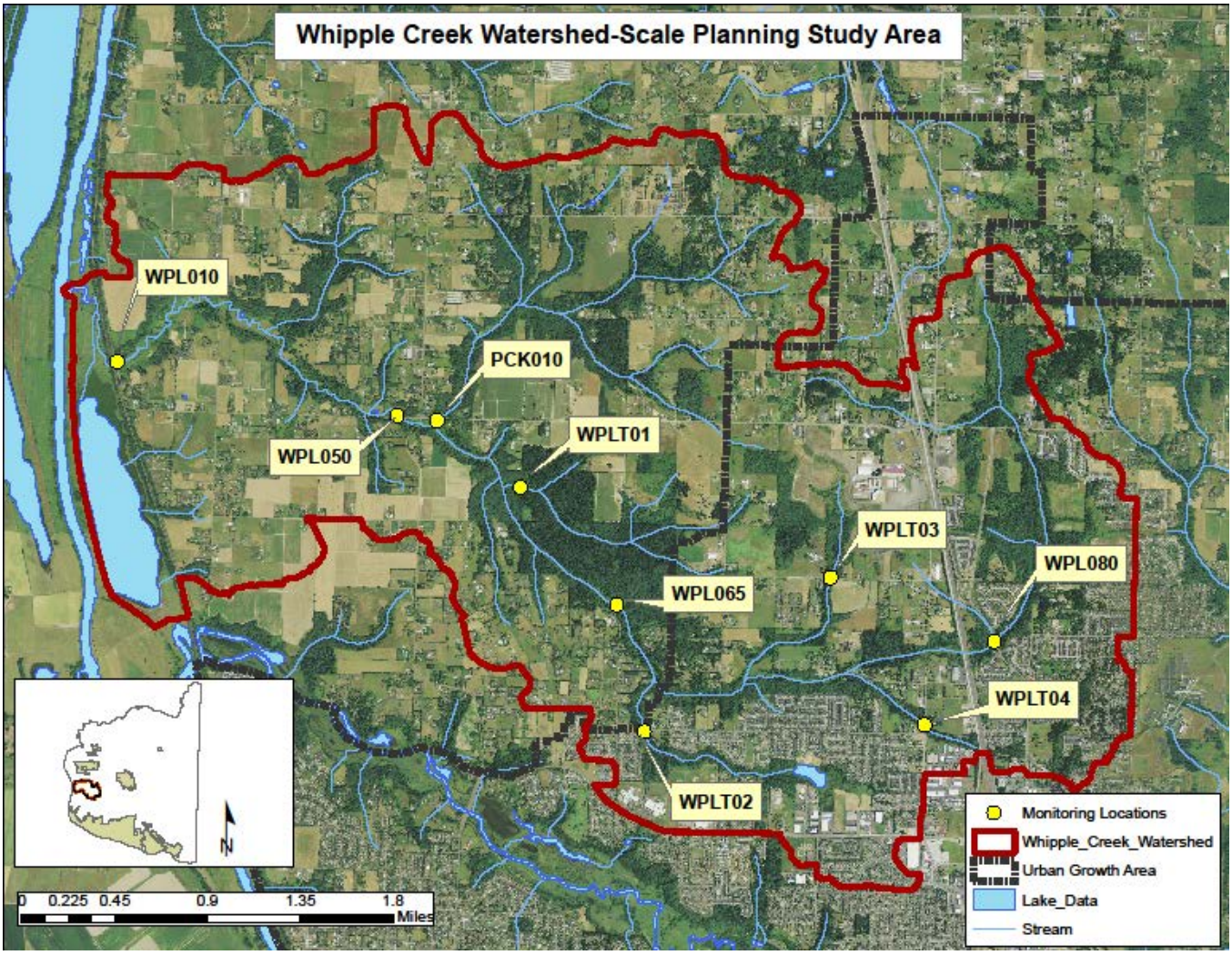

Figure 3. Water quality monitoring locations

Table 2. Project Water Quality and BIBI Monitoring Sites

Station	Description	Water Quality	BIBI	Temperature Gauge
WPL010	Whipple Creek mouth	Yes	No	Yes
WPL050	Whipple Creek at NW 179th St	Yes	Yes	Yes
WPL080	Whipple Creek at Union Rd	Yes	Yes	Yes
PCK010	Packard Creek at mouth	Yes	Yes	yes
WPL065	Whipple Creek at NW 21st Ave.	Yes	No	Yes
WPLT01	Tributary at NW 31st Ave.	Yes	No	Yes
WPLT02	Tributary at NW 149th St.	Yes	No	Yes
WPLT03	Tributary at NW 164th St.	Yes	No	Yes
WPLT04	Tributary at NE 10th Ave.	Yes	No	Yes

TASK 1.b. Hydrologic Conditions Assessment

The County will collect additional stream flow and precipitation data at multiple sites (Table 3, Figure 4). Flow monitoring will continue at WPL050 and two gauges will be added at PCK010 and WPL080. In 2012, Clark County contracted with Northwest Hydraulic Consultants to prepare a preliminary scope of work, which stated flow data is needed at PCK010 for calibration of the continuous runoff model and may be helpful at WPL080. Where the record is sufficient, flow data will also be used to calculate priority hydrologic metrics to compare to BIBI scores using DeGasperi and others (2009). Ongoing continuous rainfall monitoring includes three gauges in use since 2002 and newer gauges since 2010 as shown in Figure 4.

Table 3. Hydrologic sites

Station	Station Location Description	Stream Flow	Precipitation	Data Record
WPL050	Whipple Creek upstream of NW 179th St	Yes	No	5/15/2003 - Current
WPL080	Whipple Creek downstream of Union Rd	Yes	No	New
PCK010	Packard Cr downstream of NW 179th St	Yes	No	New
LDR010	Packard Cr west of NW 184th St	Yes	Yes	12/16/2009 - Current
RDGFLD	Ridgefield Treatment Plant	No	Yes	10/01/2003 - Current
SMCRTP	Salmon Creek Treatment Plant	No	Yes	4/05/2003 - Current
SMN045	Salmon Creek at NE 156th St	No	Yes	10/01/2003 - Current

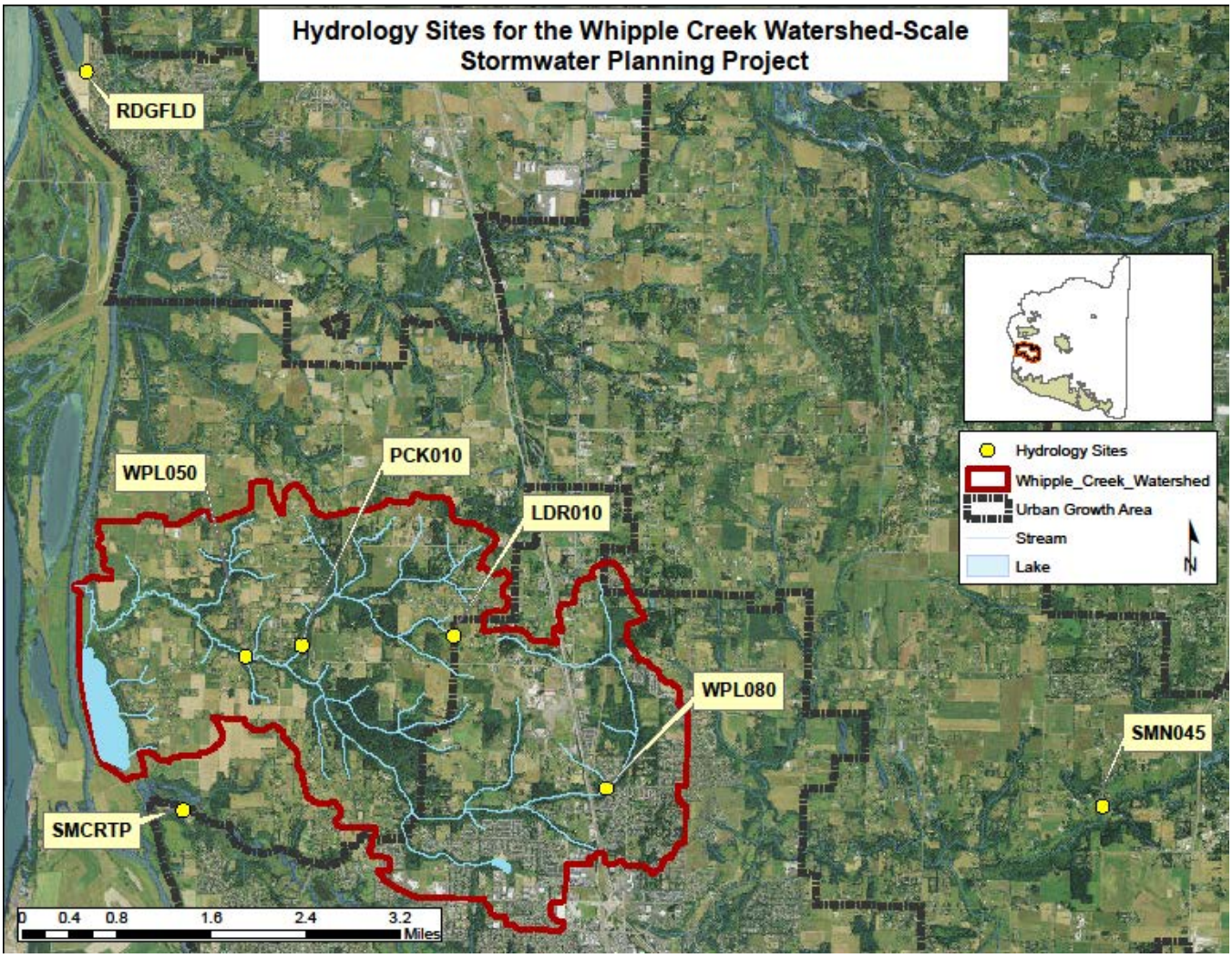

Figure 4. Hydrologic Sites

TASK 1.c. Macroinvertebrate Data

Macroinvertebrate data will be used to characterize current watershed conditions and compare to modeled flow metrics as described in the Permit. Sites are limited to stream reaches where the key assumptions of the BIBI metric are met: sample reaches consist of riffle-habitat with gravel substrate. Whipple Creek geology is predominantly fine-grained Ice Age Cataclysmic Flood deposits with limited amounts of Pliocene Troutdale Formation sand and gravel deposits. There are over 10 years of macroinvertebrate data at WPL050 and one year at WPL010, PCK010 and WPL080. Data will be collected at WPL050, WPL080, and PCK010. Additional sites where stream channel geomorphology and hydrology are appropriate for the BIBI may be sampled to increase the number of data points for comparison to hydrologic metrics.

TASK 1.d. Fish Distribution

Salmon and trout distribution will be described using available data from the Washington Department of Fish and Wildlife.

TASK 2. Environmental Mapping Dataset Development and Assessment

Environmental mapping datasets will be used to characterize the current hydrologic condition of the Whipple Creek basin and also to serve as primary data sources for hydrologic model and water quality model development. The data will also be used to identify areas where special attention should be paid for hydrologic and water quality impacts. The mapping datasets used for runoff modeling and planning may include the following:

- **Existing datasets in the Clark County GIS system (principal ones)**
  - Stream channels using standard Washington DNR data
  - Storm sewer system and treatment/flow control facilities mapped by Clark County
  - Facility and Outfall catchments mapped by Clark County
  - Drainage Catchments at the 50 to 100 acre level mapped by Clark County
  - Surficial geology mapped by the USGS and Clark County
  - Soil units mapped by the USDA NRCS
  - Detailed 2002 land cover mapped by Clark County
  - Orthophotography for various years from 1955 to 2012 owned by Clark County
  - Existing 20-year comprehensive land use plan approved by Clark County
  - Permit-regulated and non-permit regulated storm sewer system mapped by Clark County
  - LiDAR ground elevation and canopy owned by Clark County
  - Field assessment data, HPSF model output, and HEC-RAS model data from mid-2000's studies completed by Clark County
  - Critical Areas mapped by Clark County pursuant to the state Growth Management Act, such as wetlands, geologic hazard areas, and riparian habitat zones using various data sources
  - Buildable and under-utilized lands inventory maintained by Clark County for comprehensive plan development

- **Datasets to be developed under this task**
  - Land cover for model calibration (if needed)
  - Areas within the watershed appropriate for special attention in regard to hydrologic and water quality impacts, as required under S5.C.5.c.ii.(2) (e.g. headwater wetlands and critical aquifer recharge areas)

Task Outcomes/Deliverables:

- **A GIS workspace including existing and developed environmental mapping datasets**
- **Data in suitable format for use in hydrologic and water quality models**

TASK 3. Develop and Calibrate Existing Conditions Runoff and Water Quality Models

Clark County intends to use an HSPF continuous runoff model for this project. Clark County will also review proposed strategies for analysis to select an optimization model (if needed) that best accommodates the key strategies. Clark County possesses an uncalibrated HSPF model for Whipple Creek (Otak, 2007) that has sufficient detail to simulate scenarios required by the permit. The hydrologic model will be calibrated primarily using ten years of flow data collected at WPL050 and county rain gauges. Flow data from the two project sites at PCK010 and WPL080 will be used to further refine

model calibration. The existing HSPF model will also be used to model water quality using data described in Task 1.

Existing flow control and treatment BMPs are not represented in the 2007 Whipple Creek hydrologic model. Approximate drainage catchments are defined for most of the facilities. The effective flow control and/or water-quality treatment capacity of these BMPs will be added to the model using available engineering plans. This may include lumping multiple smaller facilities together when modeled hydrologic response is representative of the facilities.

The model will be used to simulate stream flow and water quality for the time when data are available, referred to as the calibration period. The model parameters will be adjusted to calibrate the model to match the observed streamflow and water quality values for the calibration period.

Model performance and calibration accuracy will be described by presenting qualitative and quantitative measures, involving both graphical comparisons and statistical analysis. Calibration accuracy metrics will focus on observed flow at WPL050. Statistics characterizing model accuracy may include root-mean-square error, Pearson correlations, coefficient of determination, relative percent difference, mean errors, and absolute errors. Metrics may include mean daily stream flow volumes, mean annual flow volumes, daily mean discharge rates, and storm peak discharge rates. Calibration will also include graphical comparisons of hydrographs for simulated flows to observed flows, which will be a principal tool at the two project gauges where less than two years of data will be available. Since the frequency of channel modifying flow events is a key issue for stormwater planning, flows in those ranges should be a focus of calibration. While the objective is for the model to be as accurate as possible, there will be variability in model accuracy depending on flow rates and location. Quantification of calibration accuracy allows the user of model results to describe the degree of certainty or limitations of planning and analysis.

Model output will be used to generate hydrology metrics that will be compared to published stream flow metrics and corresponding BIBI scores in DeGasperi and others (2009) and any updates from more recent work in the Puget Sound Basin. While it is not possible to calibrate the model to BIBI scores, comparison of model flow metrics to observed BIBI scores will provide some degree of understanding of the ability of the model to correlate flow metrics with the published relationships.

Task Outcomes/Deliverables:

- **Calibrated HSPF hydrology and water quality models**
- **Memorandum documenting model calibration**
- **Memorandum comparing modeled flow metrics to observed BIBI scores**

TASK 4. Model Baseline Scenarios

The Permit requires modeling to estimate the hydrologic changes from historic conditions to the existing (calibrated) condition. It also requires the use of the model to predict future hydrologic, biological and water quality conditions based on full build-out of the current or proposed comprehensive plan.

Three mandatory scenarios prescribed under Section S5.C.5.c.ii(5) of the Phase I permit will be simulated to evaluate how Whipple Creek measures up to Washington State water-quality criteria, under current and full-buildout conditions. These include:

- Historic landcover (simulate hydrologic condition with current stream structure)
- Existing landcover/land use (simulate hydrologic condition using the calibration model) and calculate change relative to historic landcover condition
- Full-buildout land use under existing comprehensive land use plan and stormwater standards of the 2013 permit (simulate hydrologic, water-quality, and stream flow metrics to estimate BIBI scores)

If model results show Whipple Creek fails water-quality criteria under the full-buildout land use scenario, runoff model-based stormwater management strategies will be evaluated as part of Task 5.

Runoff flow rates for future development will be based on implementation of the 2012 Stormwater Management Manual for Western Washington (SWMMWW) including mandatory LID lists and the flow duration standard to predeveloped forested land cover. Infiltration feasibility based on soil and geologic factors will determine where infiltration BMPs are modeled.

Existing stormwater monitoring data collected by Clark County in rural, urban-residential and urban-commercial land uses will be used to estimate pollutant concentration in future runoff before treatment. Clark County will utilize the methodology described by the water quality model to estimate runoff temperature by land use type. The removal efficiency targets currently established by Ecology for basic and enhanced treatment in the 2012 SWMMWW will be applied to future development.

Future land use will be determined by the Comprehensive Plan for the period of the plan. For future scenarios beyond the 20-year comprehensive plan window, the county will develop a process to estimate longer-term land use changes, perhaps in collaboration with the other phase I counties. Other information such as GMA critical areas and the Clark County vacant or underutilized buildable lands model will help identify areas that develop or remain undeveloped. The amount of effective impervious area depends on several factors and will be estimated as future land development and its likely permit-required stormwater infrastructure are defined for each modeled sub-basin.

The full-buildout scenario will use existing stormwater data and standard treatment BMP effectiveness values to estimate pollutant concentrations for existing development. The full-buildout scenario will only include treatment BMPs simulated in the calibration model for existing development.

The method described in DeGasperi and others (2009) will be used to associate BIBI scores with modeled hydrologic metrics.

Task Outcomes/Deliverables:

- **Model results for the three mandatory scenarios**
- **Memorandum describing modeled hydrology changes from historical conditions to existing conditions, and estimated water quality standard attainment under full buildout scenario**

TASK 5. Evaluate Watershed Scale Stormwater Planning Scenarios

The purpose of the watershed-scale stormwater planning process is the evaluation of stormwater management strategies and other watershed-scale activities. The list of scenarios to be evaluated will be finalized in Task 5.1. Selected scenarios meeting the permit objective will be evaluated in Task 5.2 and Task 5.3. The scenario results will be compared to one another and the preferred strategies will be selected in Task 5.4.

TASK 5.1. Develop Strategy Scenarios

Runoff-model based strategies are required to come from the following list of potential stormwater strategies:

- Changes to development-related codes, rules, standards, and plans
- Potential future stormwater control projects consistent with S5.C.6.a.

The Permit does not specify which development-related codes, rules, standards and plans should be evaluated as stormwater strategies.

Task 5 may also evaluate additional stormwater strategies that include alternative stormwater standards as allowed by Appendix 1 of the Permit and regulations or programs encouraging infill and redevelopment. Evaluations of other watershed-scale strategies such as channel restoration, culvert removal and woody debris placement are considered optional under section S5.C.5.c.iii of the Permit but may be evaluated as effective measures to restore salmon habitat.

Assumptions for BMP pollutant removal will be based on the standards of the 2012 SWMMWW and influent concentrations based on past Clark County stormwater monitoring, the SWMMWW, and/or data from Puget Sound permittees.

Flow control regulation for future development will apply the current standard of Permit Appendix 1, considering the influence of soil and geologic conditions on infiltration practices. Infiltration rates will be based on soil types in published NRCS maps. Geologic mapping by Washington DNR and the USGS will augment the published soil information for description of earth materials underlying mapped topsoil.

Task 5.1 Outcomes/Deliverables:

- **List of stormwater strategies to be evaluated (will be incorporated into a later report developed under Task 5.2)**

TASK 5.2. Apply Runoff Model to Simulate Required Planning Scenarios

The hydrologic, water-quality, and biological conditions in Whipple Creek will be simulated for the Task 5.1 scenarios to define several combinations of stormwater strategies that meet the overall goal of the planning effort to restore and protect designated uses. Along with the hydrology and water quality model, an optimization model such as SUSTAIN may be used to evaluate scenarios to find the most cost-effective mix of strategies to meet the watershed scale stormwater planning objective under S5.C.5.c.

Task 5.2 Outcomes/Deliverables:

- **Memorandum documenting the analytical assumptions, methods and results for incorporation into the report produced in Task 6.**

TASK 5.3. (OPTIONAL) Apply Runoff Model to Simulate In-Channel Treatments or other Watershed-Scale Strategies

In-channel restoration projects may be the most effective tools to restore hydrology through direct intervention with the stream channel and flood plain. These strategies go beyond the structural controls required to meet Special Condition S5.C.6. Scenarios evaluated in Task 5.2 may be revised to include optional channel and flood plain restoration projects.

Task 5.3. Outcomes/Deliverables:

- **Memorandum describing optional strategy scenarios and results**
- **Model results**

TASK 6. Develop Draft and Final Implementation Plan

Task 6 will develop the implementation plan using information produced in Tasks 1 through 5. A set of preferred strategies should be selected for the implementation plan. The plan and schedule will include:

- potential future actions
- responsible parties
- estimated costs
- potential funding mechanisms

Task Outcomes/Deliverables:

- **Draft and final reports meeting the permit requirements for an implementation plan, including appendices describing the methods and results from Tasks 1-5.**

TASK 7. Public Review and Comment Process

The public involvement process will be focused on addressing key milestones. Public review and comment will target citizen education and public review of the primary documents. Clark County will establish a Whipple Creek Watershed-Scale Stormwater Planning web page with a project description and timeline. Project documents will be posted as they are completed. Internal stakeholders will be identified early in the project. These will include staff whose input is needed to complete the plan, coordinate with plan development or implement strategies of the plan. External stakeholders will be identified for targeted outreach as plan documents are completed. Other department programs that focus on outreach and education may be utilized, as appropriate, to identify stakeholders and interested citizens and direct them to available materials.

The project will have a 60-day public review and comment period for the draft implementation plan. Public input will inform the final report created under Task 6. Clark County will distribute the implementation plan review notice to stakeholders and interested parties in Whipple Creek watershed and within the region, such as the Lower Columbia Fish Recovery Board, state agencies, neighborhood associations and tribes.

Task Outcomes/Deliverables:

- **Project web page**
- **Public comment records**
- **Memorandum documenting county response to comments**

TASK 8. Project Management

The Clark County project team will meet on a routine basis to ensure efficient project communication. The project manager will track project scope, schedule, budget and quality to ensure that all permit obligations are met.

The project will involve county departments such as Public Works, Community Development and Community Planning who have a stake in the planning and implementing stormwater strategies. The Washington State Department of Transportation will also be engaged and invited to participate.

Task Outcomes/Deliverables:

- **Meeting notes, project schedule, project review notes, financial records**

SCHEDULE

Task	2014		2015				2016		
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
1. Data Collection and Analysis for Existing Conditions	X	X	X	X	X	X			
2. Mapping Dataset Development and Assessment	X	X	X	X					
3. Calibrate Existing Conditions Runoff and Water Quality Models		X	X						
4. Complete Model Baseline Scenarios				X					
5. Evaluate Watershed-Scale Stormwater Planning Scenarios		X	X	X	X	X	X	X	
6. Develop Draft and Final Implementation Plan					X	X	X	X	X
7. Public Process	X	X	X	X	X	X	X	X	X
8. Project Management	X	X	X	X	X	X	X	X	X

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