City of Eugene
Hydromodification Assessment Report

November 17, 2014

Submitted in accordance with the requirements of:

National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Discharge Permit Number 101244 (File Number 107989)

City of Eugene
Hydromodification Assessment Report

Submitted by:
City of Eugene

Submitted to:
Oregon Department of Environmental Quality

Report prepared by:
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in conjunction with the City of Eugene

Submitted in accordance with the requirements of:
National Pollution Discharge Elimination System (NPDES) Permit Number 101244
(File Number 107989)

Cover Photo: Amazon Creek in west Eugene (RaptorViews)

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Executive Summary

This report represents a *Hydromodification Assessment* for the land and waterways contained within the City's stormwater planning area. The Assessment examines the potential causes of hydromodification and related impacts to the open waterways within the City's stormwater planning area. It summarizes the City's strategies and actions over the past two decades to address hydromodification and will be used to guide future stormwater management decisions. The Assessment meets the requirements of the City's Nation Pollutant Discharge Elimination System (NPDES) permit (#101244), Schedule A.5.

Hydromodification is a term used to describe how alterations in land uses impact the hydrologic and physical characteristics of a watershed and associated waterways. Land use alterations in an urban setting such as Eugene often result in increases in impervious surfaces, changes in vegetative cover, conversion of open waterways to an underground piped system, channelization of natural waterways, and general increases in peak flow and velocities in waterways. Physical impacts to waterways resulting from hydromodification can include erosion, channel incision, bank failure, and sedimentation.

For over two decades, the City of Eugene (City) has been committed to the continued implementation of the *Comprehensive Stormwater Management Plan* (CSWMP), which was adopted by the Eugene City Council in 1993 and provides the overarching policy framework for the City's Stormwater program. Under CSWMP policy guidance, the City has utilized an integrated approach to managing and improving its Municipal Separate Storm Sewer System (MS4) that has combined robust system-wide and site-specific planning, regulatory measures, revised maintenance practices, stream acquisition and restoration, stormwater related capital improvement projects, public education, and monitoring.

This assessment report includes an extensive review and evaluation of stormwater policies, plans, studies, initiatives, and monitoring efforts and documents local variables that are relevant to hydromodification including the regional drainage context, climate, topography, geology, soils, existing and projected land uses, surface cover, and impervious surface. The City of Eugene's stormwater planning area includes about 34,500 acres of land within Eugene's city limits and urban growth boundary (UGB), plus an additional 14,500 acres of land outside of the UGB that feeds into the City's stormwater drainage area. This 49,000-acre stormwater planning area is broken into a total of seven smaller basins and much of the data presented in this report is also split out by basin.

The report provides an overview of the extent and condition of the open waterways within the City's stormwater planning area along with associated information about the piped stormwater system and floodplain. A key component of the assessment process was an evaluation of the physical condition of the open waterway system and identification of specific reaches currently suffering negative impacts associated with hydromodification including bank/bed stability issues, incision, and sedimentation.

Key findings of the evaluation include a determination of the general nature and geographic extent of waterway issues and an assessment of existing strategies for addressing hydromodification. Potential new strategies are identified that the City will consider implementing to further minimize and address the impacts of hydromodification. A summary of key findings and potential strategies related to addressing the impacts of hydromodification is included in Section 5 of this report in the categories *of Planning and Policy*; *Regulation*; *Restoration and Enhancement*; *Maintenance and Management*; and *Monitoring, Evaluation, and Assessment*. The proposed strategies from this section are listed below:

- Continue to implement CSWMP goals and policies related to limiting impacts of new land uses, protection of headwater streams, multi-objective management of waterways, and waterway enhancement and restoration.
- Update the *Stormwater Basin Master Plan* to reflect up-to-date land use, impervious surface, and hydrology data and updated future capital projects lists.
- Incorporate in the *Basin Plan* update the long-range planning decisions represented by *Envision Eugene* (adoption anticipated in 2015) including proposed UGB expansion areas and policies related to infill and redevelopment which may impact projected impervious surface calculations and runoff potential. Include additional public projects as appropriate.
- When updating the *Basin Plan*, utilize the same format and methodologies for calculating data (e.g. impervious surface area) so that changes over time can be tracked.
- As part of the Amazon Basin update, evaluate what has been done and what is planned to address bank stability issues on the main stem of Amazon Creek, and identify any potential additional strategies necessary to address the root cause.
- Review the relatively generic setback protection provided by /WR and /WQ overlay zones against more site-specific target acquisition areas identified in the earlier *Stream Corridor Acquisition Study* (2001) and *Stormwater Corridor Management Plans* (2002); identify potential gaps in protections important to addressing hydromodification.
- Reevaluate the need for stream acquisition funds and consider possible reallocation of those funds to restoration and enhancement capital improvement projects to address hydromodification.
- Coordinate with the upcoming *Eugene Park and Recreation Master Plan* update process (scheduled to begin in 2015) on future land acquisitions related to waterway and headwater protection.

Potential Strategies Related to Regulation

- Continue to implement and monitor the waterway protection overlay zones by tracking land use and adjustment applications. Document annually in TMDL Implementation Report.
- Consider potential non-regulatory strategies for addressing short-term regulatory gap for certain waterway segments not subject to /WQ Overlay Zone until and unless properties annex to the City. See Waterway Maintenance and Management, Assistance to Private Landowners, below.
- Track implementation of stormwater development standards including the geographic location, BMP type, and delineated treatment catchment area for all public and private stormwater facilities constructed.
- Review data and assess results (e.g. number of on-site LID facilities, on-site mechanical facilities, and off-site LID mitigation) as part of the regular adaptive management process.
- Track implementation of headwater flow controls including the geographic location, BMP type, and delineated flow control catchment area for all public and private facilities constructed to meet headwater flow control requirements. Document in annual stormwater MS4 report.
- Review data and assess results (e.g. number of flow control facilities or alternative measures via adjustment review) as part of the regular annual adaptive management process.

Potential Strategies Related to Waterway Restoration and Enhancement

- Document the City's significant waterway restoration efforts completed to-date and currently under construction.
- Integrate the proposed (future) Amazon Creek restoration projects that had been developed by the Corps and its Metro Waterways Study partners into the City CIP and seek additional funding sources where appropriate.
- Continue to provide funding for streambank stabilization projects and monitor their effectiveness. Ensure as much as possible that funding for streambank stabilization is adequate for taking a proactive, rather than reactive approach to managing these issues.
- Continue to support the Parks and Open Space Division's *Streamside Shading Program* and fill-in shading gaps identified in the 2014 *Amazon Creek Streamside Shading Assessment*.
- Continue to document tree planting in annual TMDL Implementation Report.
- Consider expanding the tree planting effort to additional waterways.

Potential Strategies Related to Waterway Maintenance and Management

- Update and streamline the *Open Waterway Maintenance Plan* to improve its usability and to incorporate recently acquired waterways. This work is currently underway, with an expected completion of 2015.
- Consider producing outreach and educational materials for private land owners describing best management practices for maintaining and enhancing waterways that pass through their properties. Materials that have already been produced by other entities may be utilized for this purpose if they exist.
- Consider developing a program for providing technical assistance to property owners to help them maintain waterways that pass through their properties and identify funding sources to help support restoration, enhancement, and maintenance projects on private lands.
- Coordinate with local watershed councils including the Long Tom Watershed Council on the implementation of their *Urban Waters and Wildlife* initiative. Watershed Councils are uniquely positioned to assist businesses, commercial property owners, farmers, and others in taking voluntary actions to make our local waterways more visible, accessible, and functional.
- Identify waterways where maintenance access by City staff would be beneficial and develop a process for establishing formal drainage and conveyance easements along those waterway reaches so that City crews are able to better access for evaluation and maintenance.
- Continue the current City practice of evaluating, on a case-by-case basis, the transfer of existing maintenance easements held by other agencies (e.g. Junction City Water Control District) for properties containing waterways that are annexed to the City.

Potential Strategies Related to Monitoring, Evaluation, and Assessment

- Continue regular physical conditions monitoring using the current methodology and consider expanding monitoring sites to include additional City owned/managed waterway reaches (in addition to what is currently required in the *MS4 Permit Stormwater Monitoring Plan*).
- Consider adding a more detailed rapid assessment element (to supplement the existing physical monitoring program), which will allow staff to evaluate and record more detailed information on sedimentation and bank and bed stability issues.
- Consider conducting detailed monitoring of representative headwater streams, using a methodology that identifies and tracks physical condition and related issues such as sedimentation, bank erosion, bed erosion, erosion at culvert outfalls, high flow events, and capacity issues.
- Evaluate the need for, and potential uses of, flow monitoring data at key points in the stormwater system. Evaluate the feasibility and cost of installing automated flow monitoring equipment at strategic locations. Potential uses of the data include tracking changes in runoff rates in developing areas and calibrating hydraulic models associating with updates to the *Basin Plan*.

Section 1: Introduction and Background

1.1 Purpose and Organization

This report presents a Hydromodification Assessment for the City of Eugene (City), which will be used to guide future stormwater management decisions and to meet requirements of the City's Nation Pollutant Discharge Elimination System (NPDES) permit. Hydromodification is a blanket term used to describe how alterations in land uses impact the hydrologic and physical characteristics of a watershed and associated waterways. Land use alterations in an urban setting such as Eugene often result in increases in impervious surfaces, changes in vegetative cover, conversion of open waterways to an underground piped system, channelization of natural waterways, and general increases in peak flow and velocities in waterways. Physical impacts to waterways resulting from hydromodification can include erosion, channel incision, bank failure, and sedimentation.

The report provides a high level overview of the local variables and impacts of hydromodification within the City's 49,000-acre stormwater planning area, an assessment of the City's current strategies and tools for addressing hydromodification and associated waterway impacts, and identification of information gaps and potential strategies and tools that would further address impacts of hydromodification. The City's *Waterways Team*, which includes multiple staff responsible for monitoring and maintaining area waterways, has been utilized to help identify waterway specific hydromodification issues and to provide input on potential strategies and tools to address these issues. The analysis and recommendations included in this report have been reviewed by the City's *Stormwater Management Team* and will be considered by the City's *Stormwater Policy Team*, as appropriate.

The report has been organized into the following sections:

- Section 1: Introduction and Background
- Section 2: City and Regional Efforts Related to Hydromodification
- Section 3: Local Variables Contributing or Relevant to Hydromodification
- Section 4: Waterway Characteristics and Impacts Related to Hydromodification
- Section 5: Key Findings and Potential Strategies

1.2 City of Eugene NPDES Permit History

The City of Eugene holds a permit (Number: 101244), under the federal Clean Water Act for the municipal stormwater it discharges directly into the Willamette River and indirectly into the Willamette River through other local waterways, including Amazon Creek, McKenzie River, Amazon Diversion Channel, A-3 Channel, and Fern Ridge Reservoir (via the Long Tom River). The permit, formally called the *Phase I National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System (MS4) permit* requires that the City reduce the discharge of pollutants from the municipal system to the maximum extent practicable, and includes monitoring and reporting requirements, as well as a set of best management practices that define the City's Stormwater Management Plan (SWMP). First issued in 1994, the permit was renewed twice - once in 2004 and again in 2010. The Oregon Department of Environmental Quality (DEQ) administers federal NPDES permits for municipalities and other local agencies in Oregon. The hydromodification assessment presented in this report is being conducted to document existing tools and strategies to address hydromodification, inform the City's future stormwater management related decisions, and to fulfill the City's responsibilities under the NPDES permit.

Since the adoption of the Comprehensive Stormwater Management Plan (CSWMP) in 1993, the City has made significant progress toward implementing the Plan's multi-objective stormwater policies. During the development of this policy document, the City Council and community recognized at the outset that an opportunity existed to more effectively manage the system if a broader range of stormwater issues was addressed than just the mandates. Implementation of CSWMP has included a multi-faceted approach which included implementation of on-the-ground capital projects, acquisition of waterway corridors and headwater streams, stormwater education, ongoing waterway maintenance, a robust water quality monitoring program, and regulatory approaches such as stormwater development standards and waterway overlay zones. These stormwater related programs and associated studies and reports, are outlined later in this report, specifically as they relate to hydromodification.

1.3 NPDES Permit Requirements for Hydromodification Report

As specified under Schedule A.5 of the City's NPDES permit, the permittee (City of Eugene) must conduct an initial hydromodification assessment and submit a report by December 1, 2014 that examines hydromodification impacts related to the permittee's MS4 discharge, including erosion, sedimentation, and/or alteration to stormwater flow, volume, and duration that may cause or contribute to water quality degradation. The report shall describe existing efforts and proposed actions the permittee has identified to address the following objectives:

a. *Collect and maintain information that will inform future stormwater management decisions related to hydromodification based on local conditions and needs;*
b. *Identify or develop strategies to address hydromodification information or data gaps related to waterbodies within the permittee's jurisdiction;*
c. *Identify strategies and priorities for preventing or reducing hydromodification impacts related to the permittee's MS4 discharges; and,*
d. *Identify or develop effective tools to reduce hydromodification.*

This report directly addresses these objectives.

1.4 Definitions and Assumptions

1.4.1 Definitions

- Basin: A specific area that contributes stormwater runoff to a particular point of interest, such as a stormwater management facility, stream, wetland, or pipe. For the purposes of the City's stormwater planning efforts and this report, the term basin is used to refer to a specific planning or study area. While the planning or study areas were developed primarily based on topography and drainage patterns, they may include several discharge points, or they may exclude specific tributary areas based on convenience for planning purposes. In some cases, portions of the basin were not included in the planning area as they are managed by other jurisdictions. The City of Eugene stormwater planning area contains a total of seven major basins covering approximately 49,000 acres.
- Conveyance: The transport of stormwater from one point to another.
- Headwater Areas: The area within Eugene city limits that is above 500 feet in elevation.
- Headwater Streams: Streams that have all or a portion of their length located in a headwaters area and are on slopes greater than 10%, are at least 500 feet or longer, and drain at least 10 acres.
- Hydromodification: Hydromodification is a term used to describe how alterations in land uses impact the hydrologic and physical characteristics of a watershed and associated waterways.

- Hydromodification Impacts: Impacts to the physical condition of a waterway that are caused specifically by hydromodification. This could include streambed incision, bank failure, erosion, and active sedimentation.
- Impervious Surface/Area: Any surface area that causes water to run off the surface in greater quantities or at an increased rate of flow from conditions pre-existing to development. Types of impervious surface include, but are not limited to, rooftops, asphalt and concrete parking lots, driveways, roads, sidewalks, and pedestrian plazas.
- Low Impact Development (LID): A stormwater management approach that seeks to mitigate the impacts of increased runoff and stormwater pollution using a set of planning, design, and construction approaches and stormwater management practices that promote the use of natural systems for infiltration, evapotranspiration, and reuse of rainwater, and can occur at a wide range of landscape scales.
- Sedimentation: The buildup of silt and soil within the bottom of a waterway. Sedimentation is considered to be active if vegetation is covered, absent, or sparse. Sedimentation often results from erosion within an upstream segment of a waterway, change in upstream vegetative cover, or due to construction site erosion.
- Erosion: Removal of bank or bed material due to elevated volume or velocity of flows within a waterway or due to loss of stabilizing vegetation. Erosion is evidenced by exposed soils or bedrock, collapsed banks, undercut banks, cracks in banks adjacent to the stream channel, slumping of blocks of bank material at the toe of the bank, and scoured channels at stormwater outfalls.
- Channel Incision: The down-cutting of a channel bottom, usually due to increased volumes and velocity of flows or disruption of natural movement of sediment.
- Outfall: A location where collected and concentrated water is discharged. Outfalls include discharge from stormwater management facilities, drainage pipe systems, and constructed open channels.
- Pervious Surfaces: Pervious surfaces are undeveloped lands that are typically covered with lawn, forest, prairie, agricultural fields, or pasture where water is free to naturally infiltrate into the ground. Undisturbed pervious surfaces provide certain stormwater functions. They help reduce the amount and velocity of runoff by facilitating absorption of precipitation into the groundwater, which results in less runoff and a lower but longer duration of peak flows. The level of permeability in an area is often dictated by the soil type and underlying geology.
- Stormwater: Water runoff that originates as precipitation on a particular site, basin, or watershed.

1.4.2 Planning Assumptions

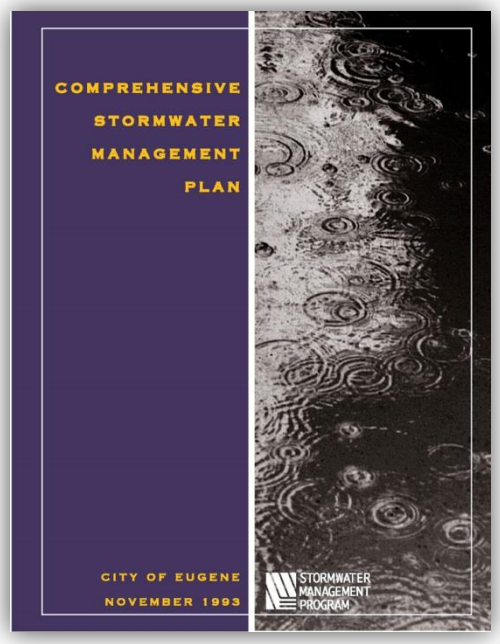
The following planning assumptions were used during the development of this assessment report:

1. This initial assessment is intended to characterize the sources and impacts of hydromodification at a high level, document existing tools and strategies, identify gaps in information, and to suggest possible additional approaches for addressing and monitoring the impacts of hydromodification. More detailed analysis and planning may be conducted based on the recommendations listed in this initial assessment.
2. The assessment will not include the Willamette River mainstem or the McKenzie River. These rivers are excluded because MS4 stormwater discharges account for a very small fraction of a percent of the total flow in these rivers. However, it should be noted that even though the City has limited influence on the river flows, significant bank stabilization and riparian restoration efforts have been implemented along the Willamette River over the past decade as a component of the City's waterway maintenance program related to infrastructure protection, water quality, and habitat enhancement.
3. Habitat (aquatic and riparian), fish passage, education, and flood control are all important CSMP objectives, but are not addressed specifically in this assessment. The focus of this report is hydromodification and associated waterway impacts.

Section 2: City and Regional Efforts Related to Hydromodification

2.1 Overview of the City of Eugene's Integrated Approach

The *Comprehensive Stormwater Management Plan* (CSWMP) was adopted by the Eugene City Council in 1993 as a refinement to the Metro Plan and provides the overarching policy framework for the City's Stormwater program. The impetus for preparing CSWMP grew out of the need to meet federal water quality mandates, but the plan includes a much broader range of stormwater objectives than just the mandates.



CSWMP establishes the City's comprehensive public policy for addressing stormwater conveyance and urban stormwater quality issues. The overarching goals listed in CSWMP include the following:

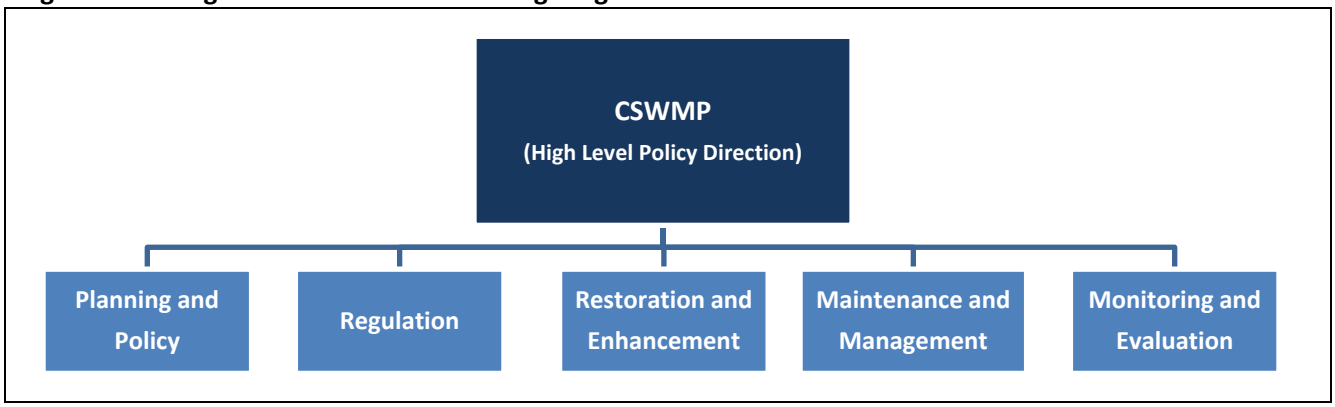
- **Goal 1:** Through an interconnected system of constructed and natural facilities, provide multiple stormwater benefits to the community including: flood control and drainage services, protection and enhancement of water quality and natural resources that perform stormwater functions, recreational facilities, and educational opportunities.
- **Goal 2:** Protect life and property from flood and drainage hazards through a combination of constructed flood control and drainage facilities and natural resource systems.
- **Goal 3**: Provide a safe and healthy environment for humans, plants, aquatic, and other wildlife by maintaining and improving water quality in the city's rivers, creeks, channels, ponds, and wetlands.
- **Goal 4**: Manage the ongoing maintenance of the public waterway system so that long-term, multiple benefits are achieved.
- **Goal 5:** Educate, inform, and organize the citizens of Eugene about stormwater issues so they can become active participants in improving stormwater quality, protecting natural resources, and minimizing drainage and flood related hazards.
- **Goal 6**: Maximize communication, coordination, and cooperation both within the city and among other agencies and jurisdictions.
- **Goal 7:** Establish a comprehensive, fair, and stable funding program that provides the resources necessary to meet the goals and policies of the comprehensive stormwater management plan.

Under this policy guidance provided in CSWMP, the City has utilized an integrated approach of managing and improving its Municipal Separate Storm Sewer System (MS4) over the past two decades since the plan's adoption. This has combined robust system-wide and site-specific planning, regulatory measures, revised maintenance practices, stream corridor acquisition, construction of stormwater related capital improvement projects, and monitoring. Additionally, the City has participated in numerous regional planning efforts that

have helped achieve stormwater management related goals outlined in CSWMP. Under the combined influence of these initiatives, significant on-the-ground progress has been made over the past two decades, much of which has directly or indirectly addressed hydromodification and its associated waterway impacts.

The City's integrated approach to managing stormwater, as it relates to hydromodification considerations, is illustrated in Figure 2-1. Related plans, studies, initiatives, regulations, and monitoring are described below in Section 2.2. Hydromodification-related restoration and enhancement projects and stream corridor acquisition are described in Section 2.3 and itemized in detail in Appendix A. Waterway maintenance and management practices are summarized in Section 4.1.5.

Figure 2-1: Integrated Stormwater Planning Diagram



2.2 Related Plans, Studies, Initiatives, Regulations, and Monitoring

City and regional efforts related to addressing hydromodification and related impacts are summarized below in chronological order by date and described in detail in Appendix A.

2.2.1 Stormwater Planning and Policy

The City's stormwater planning efforts have produced a number of planning and policy documents that support and implement the policies outlined in CSWMP.

Figure 2-2: Planning and Policy Documents

Plan Name and Date	Relationship to Hydromodification
Upper Amazon Flood and Water Quality Analysis (Woodward-Clyde Consultants and Jeff Krueger, September 1992)	The report contained an analysis of potential benefits of a multi-objective proposal to restore the southern segment of Amazon Creek and included assessment of channel stability, capacity, and water quality.
Comprehensive Stormwater Management Plan (City of Eugene, 1993)	Sets overarching stormwater policy and integrated approach (see Section 2.1 and diagram above).
West Eugene Wetlands Plan (1994)	The WEW Plan was developed in response to the discovery of a significant amounts of jurisdictional wetland located throughout the lower Amazon Creek basin. Much of this area had been designated for urban land uses including significant quantities of industrial zoned land. The Plan designates high quality areas for protection and restoration as well as development of lower quality areas and led to waterway overlays described below.
Assessment of Headwater Streams Eugene/Springfield Natural Resources Study, Eugene (LCOG, Esther Lev, June 2000)	This assessment conducted by biologist Esther Lev focused on evaluation of 32 headwater streams located in the South Hills and made management/protection recommendations.
City of Eugene Stream Corridor Acquisition	This study to develop a short-term, responsive acquisition approach

Plan Name and Date	Relationship to Hydromodification
Study (City of Eugene, 2001)	for protecting five to ten high priority waterways until the Metropolitan *Natural Resources Study* was completed and regulatory protections implemented.
Headwaters Area Study: Evaluation of Additional Stormwater Management Issues and Options (URS, 2001)	This study was initiated in anticipation of adopting new post-construction stormwater management requirements for on-site water quality treatment, with an emphasis on assessment of low impact development techniques for headwater streams.
Stormwater Corridor Management Plans **(**City of Eugene, October 2002)	Includes recommendations for management of streams identified in the 2001 Stream Corridor Acquisition Study (see above) and more detailed delineation of targeted acquisition areas and potential sites for flow control facilities to protect sensitive headwater streams.
Stormwater Basin Master Plan – Volume I: Study Methodology and Summary (City of Eugene, 2002)	This document represents the introductory volume of an eight-volume report that describes the process and results of the City of Eugene's development of Stormwater Basin Master Plans. Much of the information presented in Section 3 of this Hydromodification Assessment Report is drawn from this and accompanying Stormwater Basin Master Plans.
Stormwater Corridor Management Plans **(**City of Eugene, October 2002)	This document contains management plans for a total of ten Stormwater Corridors including: Upper Braeburn Creek, East Santa Clara Waterway, Gilham Creek, Amazon Creek Headwaters (east fork), Amazon Creek Headwaters (west fork), Videra Creek, West Laurel Hill Creek, Timberline Creek, and Bailey Hill Oak Woodlands
Stormwater Basin Master Plan – Volumes II-VIII (City of Eugene, 2002 with River Road/Santa Clara added in 2012)	Volumes II through VII provide more detailed information regarding development of the stormwater management strategies for each of the basins as follows: Volume II: Amazon Creek; Volume III: Bethel-Danebo; Volume IV: Laurel Hill; Volume V: Willakenzie; Volume VI: Willamette River; Volume VII - Willow Creek; and Volume VIII: River Road/Santa Clara completed in 2012.
Open Waterway Maintenance Plan (City of Eugene, developed in 2003 and updated in 2008)	The OWMP was developed to provide City maintenance field staff with comprehensive direction on how to maintain open waterways that have a history of at least some level of City maintenance or that will require maintenance in the future. The City is currently in the process of updating this plan
Eugene-Springfield Metro Waterways Study Feasibility Report with Integrated Programmatic Environmental **Assessment** (U.S. Army Corps of Engineers, Internal Review Draft, May 2012) Note: The Metro Waterways Study was not completed and this is the last iteration of the plan carried forward with the City of Eugene as a project partner.	The Metro Waterways Study (MWS) was a comprehensive approach for identifying and addressing degraded aquatic habitat conditions within the broader, metropolitan area of the Upper Willamette River watershed, and for formulating and implementing measures for restoring these conditions. This Feasibility Report represents the MWS process for formulating, reviewing, and approving restoration plans for implementation in the Amazon Creek and Cedar Creek Planning Areas. The plan recommended restoration projects on a total of 14 waterway reaches within the Amazon Creek watershed.
City of Eugene, Oregon MS4 Permit 101244 *(2010)*	Permit issued by Oregon DEQ to City of Eugene in accordance with requirements of the federal Clean Water Act. Requires City to reduce pollutants discharges from its municipal stormwater systems to the maximum extent practicable. First issued in 1994, the MS4 permit was re-issued in 2004 and, most recently, in 2010.
City of Eugene, Oregon MS4 Permit Stormwater Management Plan (Eugene, December 2012)	The *Stormwater Management Plan* (SWMP) describes the set of best management practices (BMPs) that the City of Eugene has committed to conducting to reduce pollutant discharges from the municipal stormwater system to the maximum extent practicable. Incorporated into the City's MS4 permit by reference. See Appendix A for categories of BMPs.

Plan Name and Date	Relationship to Hydromodification
Envision Eugene (City of Eugene long-range planning process, in progress)	Under this process, the City will be determining the best way to accommodate up to 34,000 more people by 2032, including where densification will occur and where the Urban Growth Boundary (UGB) will be expanded. May set new policy for the affected areas related to stormwater, waterways, and wetlands.

2.2.2 Stormwater Related Regulation

Adopted as an amendment to the City's Comprehensive Plan, the West Eugene Wetlands (WEW) Plan set regulatory policy for preserving wetlands and later requiring waterway setbacks. Waterway setbacks were initially established within the WEW planning area and later expanded to include most other waterways within the city and have been integrated into the City's Land Use Code. In 2014, the City updated its Stormwater Development Standards to emphasize low-impact development practices, source control measures, and revise O&M practices. Combined, these regulatory approaches serve to both limit the impacts of hydromodification associated with new urban development and restrict development immediately adjacent to area waterways.

The ongoing *Envision Eugene* planning process, which will eventually lead to an updated Comprehensive Plan, will help guide where future urban development will occur and will likely set new policy related to stormwater, waterways, and wetlands. The Envision Eugene planning process is expected to be complete in early 2015.

Figure 2-3: Stormwater Related Regulation

Plan Name	Relationship to Hydromodification
Waterways Protections – Overlay Zones (Eugene Code, Adopted, variously from 2005 - 2010)	Establishes setbacks on area waterways for permitted/prohibited uses, siting requirements, and standards. The existing Waterway Protection Overlay Zones include: • /WP Waterside Protection Zone - Applies to certain waterways within the West Eugene Wetlands (WEW) Plan boundary. • /WB Wetland Buffer - Applies to certain wetlands within the WEW Plan boundary. Setbacks are between 0 and 50 feet based on the designation shown on the City's adopted Goal 5 map. • /WR Water Resource Conservation Overlay Zone - Applies to certain waterways outside of the WEW Plan boundary. Setbacks range from 0 feet to 100 feet. • /WQ Water Quality Overlay Zone – Protections added under the 2009 ordinance and applies to the certain waterways outside of the WEW Plan boundary, directly influential to waterways that do not meet state of Oregon water quality standards, have a water quality function, and not otherwise protected. Setbacks extend 25-feet from top of high bank for non-headwater streams and 40-feet from the centerline of headwater streams.
Stormwater Management Manual (City of Eugene, March 2014)	The Stormwater Management Manual provides developers and design professionals with facility design guidelines for reducing the impacts of stormwater runoff quantity and pollution resulting from new development - Is applicable to development that is subject to the adopted stormwater development standards (described in Section 2.2.2 below).
Stormwater Development Standards (Eugene Code, first adopted 2006, last updated March 2014)	These standards apply to new development and significant re-development and include water quality treatment requirements for stormwater runoff, flow control requirements for developing sites

	draining to sensitive headwater streams, source control measures for certain high pollutant land uses and activities, and operations and maintenance expectations for stormwater management facilities. Standards updated in 2014 to emphasize low-impact development (LID) practices (infiltration and filtration) over off-site LID mitigation or mechanical treatment.

2.2.3 Monitoring

Since receiving its first stormwater NPDES permit in 1994, the City has been systematically collecting water quality data from multiple locations on rivers and streams within the City's jurisdictional boundaries. These monitoring efforts have been expanded over time to include a high level assessment of the physical condition of some selected waterway reaches and macroinvertebrate monitoring, primarily along Amazon Creek.

Figure 2-4: Monitoring and Program Assessment

Plan Name	Relationship to Hydromodification
City of Eugene Stormwater Monitoring Plan for NPDES MS4 Discharge Permit 101244 (Eugene, November 2011)	Monitoring elements currently in place include the following: • Instream Monitoring: Streams that receive MS4 runoff generated by the permittee sampled and analyzed for water quality. • Storm-Event Monitoring using Focused Basin Approach: Stormwater runoff at selected sites sampled and analyzed during select storm events for water quality. • Stormwater Monitoring for Bacteria: Stormwater samples collected during storm events and analyzed as part of the City's bacteria pilot study. • Macroinvertebrate Monitoring: Monitoring done in Amazon Creek and Willamette River basins to characterize current macroinvertebrate community conditions compared to reference sites to assess the effects of stormwater runoff on receiving waters. • Physical Monitoring: Monitoring conducted at select locations to characterize the current physical condition of receiving waterbodies, assess the effects of stormwater runoff on receiving waters, and effects of future restoration efforts. • Structural BMP Monitoring: Select structural monitored to assess their effectiveness in mitigating identified stormwater quality issues.
2012 Stormwater Annual Report – Appendix C: Amazon Basin and Willamette River Macroinvertebrate Study *(City of Eugene, December2012)*	As a component of the City's 2012 Stormwater annual report, the results of macroinvertebrate monitoring on selected waterway reaches was included as Appendix D. The monitoring was conducted by ABR Consultants in Fall 2011 at twelve reaches of Amazon Creek and one reach of Spring Creek.
2012 Stormwater Annual Report – Appendix D: Physical Assessment *(City of Eugene, December2012)*	As a component of the City's 2012 Stormwater annual report, the results of physical monitoring on selected waterway reaches was included as Appendix D. The monitoring was conducted by Parks and Open Space staff and occurred in 2005, 2011, and 2014. Physical monitoring is currently limited to twelve reaches of Amazon Creek and one reach of Spring Creek (monitored in 2011 only), coincident with macroinvertebrate monitoring sites.
Amazon Basin Streamside Shading Assessment (City of Eugene, March 2014)	From 2002 through 2014, the City of Eugene planted over 2,500 trees and plugged willows along 46,000 linear feet of Amazon

Plan Name	Relationship to Hydromodification
	Creek. The purpose of this document is to summarize the riparian plantings that have taken place along the Amazon Creek since 2002, to present data collected during a 2013 riparian planting assessment, and to identify future opportunities for willow and tree planting in the Amazon Basin.
Total Maximum Daily Load (TMDL) Fifth Annual Report and Review (City of Eugene, March 23, 2014)	Part I of this document, the TMDL Fifth Annual Report, summarizes the progress of TMDL implementation activities conducted by the City of Eugene from July 1, 2012 through June 30, 2013. Part II of this document, the TMDL Fifth Year Review, is an assessment of the progress made in implementing the City's TMDL Plan during the first five years.

2.2.4 Other Related Studies, Plans, Reports, and Initiatives

A significant number of related local or regional studies, plans, and reports have been developed that address hydromodification and related waterway impact in some way. Each of these studies, plans, and reports listed below are described in detail in Appendix A.

- *Lane County Fairgrounds Amazon Creek Enhancement Study* (LCOG, June 1998)
- *Bank Failure Investigation Amazon Canal Near Garfield Street* (GeoScience, Inc. for City of Eugene, March, 2000)
- *Upper Amazon Creek Enhancement Study* (LCOG, October 2000)
- *Assessment for the Eugene-Springfield Area* (MECT, September, 2002)
- *Rivers to Ridges: Eugene-Springfield Regional Parks and Open Space Vision* (LCOG and Regional Partners, 2003)
- *Amazon Creek – Plant Community Restoration Plan* (University of Oregon and City of Eugene, 2004)
- *Guidelines for Tree and Shrub Planting Along Amazon Creek Eugene Oregon* (City of Eugene, October 2008)
- *Guidelines for Tree and Shrub Planting Along Amazon Creek Eugene Oregon* (City of Eugene, October 2008)
- *Willamette River Open Space Vision and Action Plan* (LCOG and regional partners, 2010)
- *Amazon Creek Flood Damage Reduction Project – Periodic Inspection No. 1* (U.S. Army Corps of Engineers, March 2011)
- *Eugene-Springfield Metro Waterways Study Feasibility Report with Integrated Programmatic Environmental Assessment* (U.S. Army Corps of Engineers, Internal Review Draft, May 2012)
    - *Metro Waterways Study Technical Appendix B: Waterway Assessments – Amazon Creek Priority Planning Area* (City of Eugene, 2006)
    - *Metro Waterways Study Technical Appendix C: Without-Project Conditions Report – Cedar Creek and Amazon Creek Planning Areas* (U.S. Army Corps of Engineers, 2010)
    - *Metro Waterways Study Technical Appendix H: Amazon Creek Planning Area Reach Restoration Options* (U.S. Army Corps of Engineers, 2011)
- *Willamette River Bank Stability Study – Phases I and II* (Vigil Agrimis for City of Eugene, June 2012)
- *Fish Passage and Recreational Boating Feasibility Study – Alton Baker Park Canoe* Canal (City of Eugene, February 2013)
- *Sustainable Rivers Project* (The Nature Conservancy and U.S. Army Corps of Engineers, Ongoing)
- *Amazon Creek Initiative – Private Retrofit Projects* (Agreement with Long Tom Watershed Council to partner on a pilot project to implement stormwater retrofits on privately owned, developed properties, November 2012)

2.3 Implementation of Major Waterway Enhancement and Restoration Projects

The City of Eugene along with various local, state and federal partners has implemented a significant number waterway enhancement and restoration projects since adoption of the Comprehensive Stormwater Management Plan in 1993. These projects have directly or indirectly addressed the impacts of hydromodification through bank stabilization, channel widening, floodplain restoration, and vegetative enhancement. Beyond improving the physical conditions of the waterways, these projects often provide significant habitat, water quality (erosion control, sediment reduction, filtration and detention), and recreational benefits. The geographic location and extent of these projects is shown on the *Waterways Conditions Map* (Map 12) in Section 4.2.

Figure 2-5: Major Waterway Enhancement and Restoration Projects

Project Name	Date	Description
Amazon Creek Enhancement Project (2.5 miles from Bailey Hill Road to railroad)	1996	Channel widening, side channel creation, bank stabilization, creation of wetland bench, riparian planting, and hard surfaced path along length of project
Lower Amazon Creek Restoration Project - Meadowlark Prairie (380 acres and 2.5 miles of waterway)	1999	Major floodplain restoration, relocation of flood control levees, prairie and riparian planting along Amazon Creek, Amazon Diversion Channel, Dead Cow Creek, and A-3 Channel, hard surfaced paths, and interpretive features
Amazon Creek at Oak Patch Road (900 lf)	2002	Channel widening, creation of side channels, bank stabilization, and riparian planting
Dragonfly Bend Channel Restoration Project	2004	Channel widening, creation of side channels, riparian and prairie planting, and habitat features
Tugman Park Creek Restoration Project (500 lf)	2005	Wetland and floodplain restoration and converting channelized drainage into a meandering waterway
East Branch of Amazon Creek Daylighting Project (650 lf)	2006	Diverted flow from piped system back into historic channel alignment in Frank Kinney Park, grade control, riparian planting, and soft-surfaced recreational trail and two pedestrian bridges
Golden Gardens Ponds Restoration Project (60 acres)	2008	Re-contouring of steep banks of ponds to create wetland bench, riparian plantings, re-contouring a portion of the A-2 Channel to create side-channel habitat, and soft-surfaced recreational trails
Amazon Creek Restoration Project at Fox Hollow Road (400 lf)	2009	Channel widening, creation of side channels, bank stabilization, riparian planting, and reconstruction of stormwater outfall
Delta Ponds Restoration Project (100 acres)	2006-2013	Reconnection of former aggregate mining ponds to the Willamette River to create 2.2 miles of side-channel habitat, construction of wetland benches, invasive species control, riparian plantings, habitat features, hard- and soft-surfaced paths and trails, and interpretive signage
Heron Slough Restoration Project (2,200 lf)	2011	Reconnection of isolated side channel with Willamette River with significant riparian planting
Amazon Creek Stabilization and Enhancement Project – Chambers to Garfield (1,400 lf)	2014	Creek realignment, creation of floodplain bench for added capacity, bank stabilization, and riparian planting
Multiple smaller bank and bed stabilization projects (see map)	-	Repair of failed banks, toe stabilization, bioengineering, grade control, and aggregate placement

Major Waterway Enhancement Project Examples (see Figure 2-5 for detail)

East Branch of Amazon Creek Daylighting Project (2006)

Golden Garden Ponds and A-2 Channel Restoration Project (2008)

Amazon Creek Restoration Project at Dragonfly Bend (2004)

Amazon Creek Stabilization and Enhancement Project – Chambers to Garfield (2014)

Lower Amazon Creek Restoration Project – Meadowlark Prairie (1999)

Heron Slough Side Channel Restoration Project (2011)

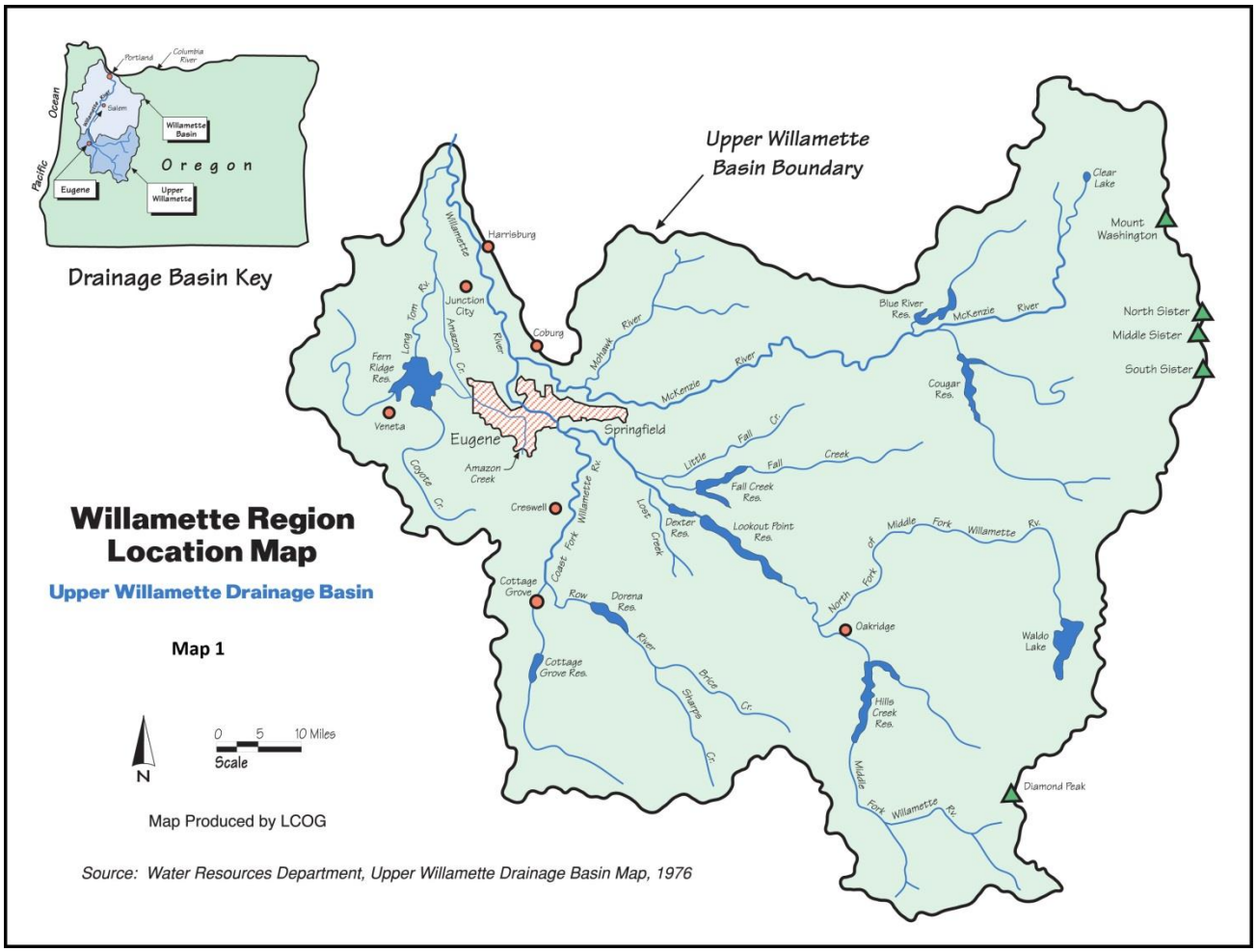
Section 3: Local Variables Contributing or Relevant to Hydromodification

3.1 Regional Drainage Context and Planning Area

This section is intended to provide a high level characterization of the City's stormwater planning area as it relates to hydromodification. The information below is drawn from a variety of sources including the Stormwater Basin Master Plan – Volume I (City, 2002), Stormwater Basin Master Plan – Volumes II-VII (City, 2002 and 2012), and the *Metro Waterways Study Technical Appendix C: Without-Project Conditions Report – Cedar Creek and Amazon Creek Planning Areas* (U.S. Army Corps of Engineers, 2010).

3.1.1 Regional Drainage Context

Eugene is located in the western third of the Upper Willamette Drainage Basin as shown on Map 1 below. Drainage in the southern Willamette Valley is a combination of natural and built systems that have evolved over time. The natural system is composed of rivers, creeks, and a series of interconnected and isolated ponds and wetlands. Historically, the natural system had an extensive floodplain that frequently experienced over-bank flooding. The built drainage system includes a series of dams, pipes, and waterways that were constructed to contain over-bank flooding, and to retain water for recreational purposes. The primary drainage features of the Upper Willamette Drainage Basin are: Main Stem of the Willamette River, Middle Fork of the Willamette River, Coast Fork of the Willamette River, McKenzie River, Amazon Creek, Amazon Diversion Channel, Coyote Creek, and the Long Tom River. From 1940 to 1960, the U.S. Army Corps of Engineers built nine flood control dams on this system.

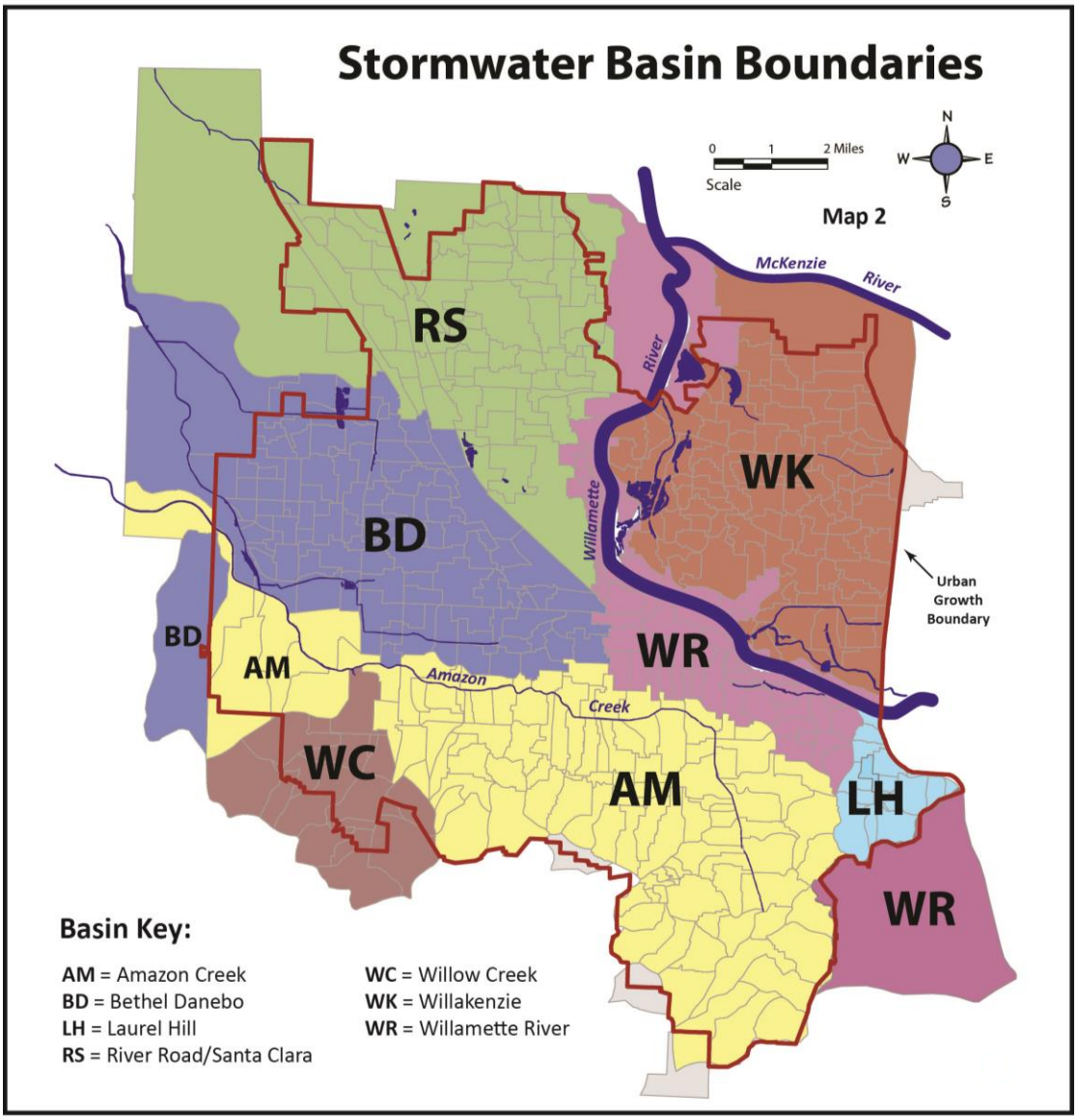


The cities of Cottage Grove, Creswell, and Springfield are all upstream from the City of Eugene and contribute urban runoff to the regional drainage system via the Willamette River. A significant portion of west Springfield's drainage area, approximately 4,800 acres, discharges urban runoff into the Q Street Floodway which is within Eugene's public drainage system.

3.1.2 Planning Area

The City of Eugene's stormwater planning area includes all land within Eugene's city limits and urban growth boundary (UGB), plus some additional unincorporated lands within the associated stormwater basins. The planning area is approximately 49,000 acres in size, with about 34,500 acres located within the city limits and UGB, and about 14,500 acres outside the UGB. The planning area was delineated into seven major drainage basins:

- Amazon (11,442 acres)
- Bethel-Danebo (9,318 acres)
- Laurel Hill (829 acres)
- River Road Santa Clara (10,432 acres)
- Willakenzie (7,314acres)
- Willamette River (7,023 acres)
- Willow Creek (2,567 acres)



Much of the information presented in this section and later in the assessment is sorted by the sub-basins. It should be noted that the term basin is typically used to refer to a defined surface area that drains to a common discharge point. However, for the purposes of this study, the term basin is used to refer to a specific planning or study area. While the planning or study areas were developed based on topography and drainage patterns, they may include several discharge points, or they may exclude specific tributary areas based on convenience for planning purposes. In some cases, portions of the basin were not included in the planning area as they are managed by other jurisdictions.

3.2 Climate and Precipitation

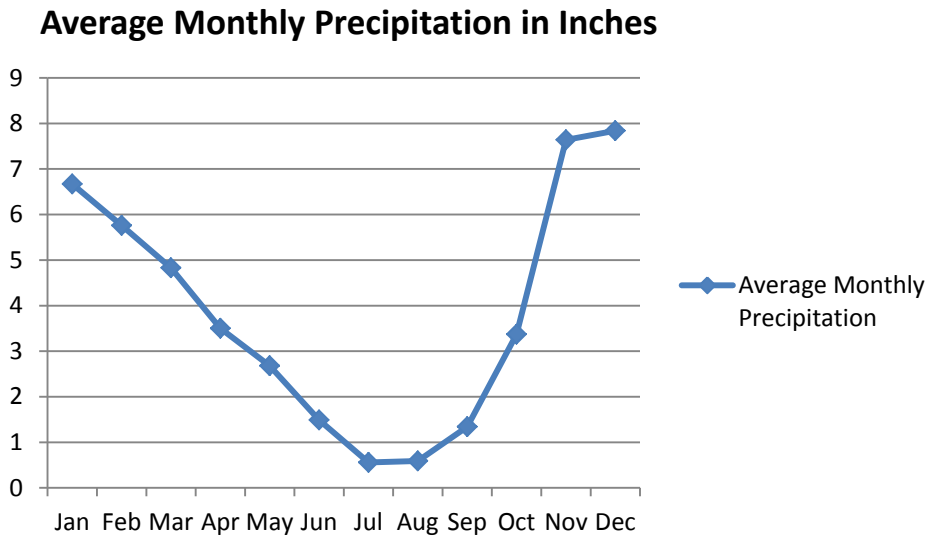
The climate in the Eugene area are typically consistent with the broader patterns found throughout the Willamette Valley, where the climate is relatively mild throughout the year, characterized by cool, wet winters and warm, dry summers.

As is the case of all of western Oregon, the Willamette Valley has a predominant winter rainfall climate. The source of the following information is the National Weather Service, as described by Oregon State Climatologist George Taylor and data collected from the weather station at the Mahlon Sweet Airport in Eugene and has been in operation since 1948.

The typical yearly distribution of precipitation includes about 50 percent of the annual total falling from December through February, with lesser amounts in the spring and fall months, and very little precipitation falling during summer. Precipitation tends to vary inversely with temperatures, with the cooler months being the wettest and the warm summer months the driest. There is considerable variation in precipitation within the Willamette Valley, ranging from annual totals below 40 inches in the Portland area to upwards of 80 inches in the Cascade and Coast Range foothills. Based on National Weather Service evaluation, elevation is the single most important determinant of precipitation totals in the Willamette Valley. Portland, for example, at 21 feet above sea level, receives an average of 37.4 inches, while Salem at 196 feet above sea level receives 40.4 inches and Eugene at 359 feet above sea level receives 46.3 inches. Extreme temperatures in the Willamette Valley are rare. Days with maximum temperature above 90 degrees F occur only 5-15 times per year on average, and below zero temperatures occur only about once every 25 years. Mean high temperatures range from the low 80's in the summer to about 40 degrees F in the coldest months, while average lows are generally in the low 50's in summer and low 30's in winter. Although snow falls nearly every year, amounts are generally low. Valley floor locations average 5-10 inches per year, mostly during December through February, although higher totals are observed at greater elevations.

Average annual precipitation as recorded at the Mahlon Sweet Airport (1971-2000), which is located on the north western edge of Eugene is 46.3 inches. Of this rainfall, an average of 32.7 inches, or 71 percent of the yearly total yearly amount, fell within the five month period between November and March (see Figure 3-1), with heavier rainfall events also occurring during this period (see Figure 3-2).

Figure 3-1: Average Annual Precipitation by Month at Mahlon Sweet Airport (1981-2010)



Source: Oregon Climate Services, Oregon State University

Although rainfall occurs in the Eugene area relatively frequently in the winter months, rainfall accumulation is typically small, with events of over 1.0-inch of recorded precipitation per day being relatively rare. On average, rainfall of 1.0-inches or more within a day occur occurs fewer than 12 times per year (see Figure 3-2 for detail).

Figure 3-2: Average Number of Days with Selected Precipitation at Mahlon Sweet Airport (1971-2000)

Precipitation Threshold (in inches)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
.01"or more	17.1	15.9	17.3	14.2	10.8	7.4	3.2	4.1	5.9	10.9	17.7	17.3	141.8
.10"or more	11.9	11.3	12	8.9	7.1	4.1	1.5	2.1	3.7	7	13.2	12.6	95.3
.50"or more	5.3	4.3	4.1	2.1	1.4	0.8	0.3	0.6	1	2	6.2	5.7	33.8
1.00"or more	2.1	1.4	1.2	0.6	0.3	0.2	0	0.2	0.2	0.6	2.5	2.3	11.5

Source: National Weather Service

3.3 Topography, Geology, Soils

3.3.1 Geology

The landforms within the stormwater planning area were formed over millions to thousands of years by a combination of influences including ice ages, volcanism, and cataclysmic hydrologic events. The area is comprised of three major geologic formations. One, the *basalt geology*, is found below the steeper slopes and their rock outcroppings to the north and south of Springfield and along the south hills of Eugene. This is

believed to be from andesitic basaltic or pyroclastic bedrock formed some 10 to 25 million years ago. The second geologic formation is the *Missoula flood deposits* which consists of that part of the main valley floor buried with silts believed to have been deposited as a results of a series of epoch floods between 12,000 to 600,000 years ago. The third geologic formation is the *river alluvium*. This is the area within and near the rivers that has been scoured of silts left over from these epoch floods and is characterized by coarse sediments and gravel deposited by rivers originating in the Cascade Mountains.

The most recent significant events that have influenced the geology within the planning area are thought to be the Lake Missoula Floods, which occurred approximately 12,000 to 15,000 years ago. Prior to these floods, the valley floors were shaped much as they are now, although the Willamette Valley was likely deeper and both the Willamette and McKenzie Rivers were thought to be significantly larger, being fed by retreating glacial melt from the ice capped Cascades. Evidence suggests that a series of epic floods along the Columbia River temporarily inundated the Willamette Valley under as much as 400 feet of water in the northern valley and extending as far up the valley as Eugene. As water flowed up the valley, it slowed, leaving depositing silts and the smaller materials in the southern valley (around present day Eugene), with larger bed-load materials deposited in the northern valley. The flat valley floor portion of our study area experienced the finest deposition of silts and clays with the majority of these depositions reaching to the west Eugene area. There is also research showing that ash deposits from the Mount Mazama (now Crater Lake) eruption that occurred approximately 5,700 years ago may have also contributed to the formation of fine valley floor sediments.

3.3.2 Topography and Slopes

The landform of the stormwater planning area is diverse yet well-defined. In general, the southerly portion is characterized by the steep slopes of the *South Hills Ridgeline Area*, which extends east and west from Spencer Butte. The northerly portion generally made up of the flat valley bottoms of the Willamette River, McKenzie River, and Amazon Creek floodplains or historic floodplains. Nearly three quarters of the land within the stormwater planning area has slopes of five percent or less. Slopes in excess of 25 percent make up approximately 5 percent of the planning area.

Figure 3-3: Slope Distribution within the Stormwater Planning Areas

	Slope Distribution by Acres and Percent of Area					
	Slopes 0-5%	**Slopes 6-10%**	**Slopes 11-15%**	**Slopes 16-25%**	**Slopes >25%**	**Total**
Acres % of Total Planning Area	36,109 (74%)	3,362 (7%)	2,947 (6%)	4,212 (8%)	2,297 (5%)	48,927 (100%)

Source: City of Eugene Stormwater Basin Master Plan – Volume I (2002)

Slope gradient and length are important factors from a hydromodification standpoint. Steeper and longer slopes generally result in greater runoff volumes and velocities, which can be amplified with urban development. These conditions require special engineering designs to accommodate the hydraulic conditions that occur at the interface of waterways with the piped system. Depending on soil and surface cover type, slope gradient can also increase risks to water quality impacts—due to erosion and sedimentation—and to public safety due to earth slides and slumping.

3.3.3 Soils

Soil characteristics are important factors in predicting the amount, rate, and quality of stormwater runoff and for selecting management measures for addressing the effects of runoff. Key soil parameters relative to hydromodification include permeability, runoff potential, erodible soils, unstable slopes, and hydric soils. All soils data presented below were obtained from the Soil Survey of Lane County, Oregon (1987) and compiled in the 2002 Stormwater Basin Master Plan.

Permeability: Soil permeability measures the rate of water movement through the soil horizon. This factor is important in managing stormwater quantity and quality. Permeability rates are assigned based on the dominant soil horizon (15-40 inches). Nearly 80 percent of the stormwater planning area contains soils in the very slow to moderately slow categories, and most of these soils are located in the Amazon Creek, Laurel Hill, Willow Creek, and Bethel-Danebo basins. Due to the prevalence of soils with slow to moderate permeability, infiltration as a BMP for reducing stormwater runoff is limited in the planning area. The following figure displays the distribution of soil permeability rates for the study area:

Figure 3-4: Permeability (Aggregate for Entire Stormwater Planning Area)

Permeability (percent of overall planning area)							
Very Rapid	Moderately Rapid	Moderate	Moderately Slow	Slow	Very Slow	No Data*	Total
6%	6%	4%	41%	19%	20%	4%	100%

Source: USDA Soil Survey of Lane County Area, Oregon (1987) and the City of Eugene Stormwater Basin Master Plan – Volume I (2002)

Runoff Potential: Soil groups have been rated according to their runoff potential under non-vegetated and saturated conditions without consideration to topographic conditions. Hydrologic stormwater models often use this parameter in conjunction with slope and surface cover factors for estimating surface flows under undeveloped conditions. Runoff potential measures a soil's capacity to permit infiltration and can be used to describe the degree of runoff expected during storm events. For example, soils rated with "low runoff potential" are more likely to have high infiltration rates and, conversely, soils rated "high runoff potential" are more likely to have slow infiltration rate. Over 80 percent of the study area contains soils that are in the moderately high to high categories, which are primarily located in the Amazon Creek, Laurel Hill, Willow Creek, and Bethel-Danebo basins.

Figure 3-5: Runoff Potential (Aggregate for Entire Stormwater Planning Area)

Location	Runoff Potential (percent of overall planning area)					
	High	Moderately High	Moderately Low	Low	No Data*	Total
All Basins % of all basins)	41%	40%	15%	3%	1%	100%

Source: USDA Soil Survey of Lane County Area, Oregon (1987) and the City of Eugene Stormwater Basin Master Plan – Volume I (2002)

Erodible Soils: For erodibility purposes, the U.S. Department of Agriculture classifies soils as high, moderate, or other. The other category indicates soils that do not meet the criteria for high and moderate and, therefore, are either less erodible or require more research. Highly erodible soils have significant stormwater management implications. If not properly protected during construction and logging activities, erosion and sedimentation from these soils can have the following negative effects:

- Reduction in the conveyance capacity of downstream stormwater facilities due to sedimentation resulting in potential drainage and flooding problems.
- Reduction or elimination of aquatic habitat by covering or destroying spawning beds.
- Water quality impacts due to pollutants that are attached to sediments.

25% of the study area is affected by highly erodible soils; most are located in the South Hills and adjacent, low-lying areas within of Amazon Creek basin.

Figure 3-6: Erodible Soils (Aggregate for Entire Stormwater Planning Area)

Location	Erodible Soils		
	High	Moderate	Low
All Basins (%of all basins)	25%	4%	71%

Source: USDA Soil Survey of Lane County Area, Oregon (1987) and the City of Eugene Stormwater Basin Master Plan – Volume I (2002)

Unstable Slopes: Unstable slopes can present structural problems especially where extensive grading is needed for siting roads and building foundations. Roads requiring significant cuts should not be located on these soils. Unstable slopes combined with saturated soil conditions create high potential for mass movement. Properly designed drainage systems can help mitigate slump potential.

Figure 3-7: Unstable Slopes (Aggregate for Entire Stormwater Planning Area)

Location	Percent of Area Subject to Slumping
All Basins (of all basins)	17%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987 and the City of Eugene Stormwater Basin Master Plan – Volume I

Hydric Soils: Hydric soils are one of three criteria for determining the presence of wetlands; the other two being inundated or saturated soil conditions and the presence of hydrophytic vegetation. Federal and state regulations limit activities that can occur in wetlands, including the direct discharge of untreated stormwater runoff. 26% of the study area is affected by hydric soils, with most located in the low-lying, historic drainageways of the Amazon Creek, Laurel Hill, Willow Creek, and Bethel-Danebo basins.

Figure 3-8: Hydric Soils (Aggregate for Entire Stormwater Planning Area)

Location	Percent in Area
All Basins %of all basins)	26%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987 and the City of Eugene Stormwater Basin Master Plan – Volume I

3.4 Land Use and Surface Cover (Existing and Projected)

A major element of hydromodification is the conversion of land from undisturbed to developed land uses. These changes of land use and related surface cover can significantly affect the quantity and quality of stormwater runoff and have direct impact on the physical condition of receiving waterways. Stormwater runoff volumes and velocities typically increase as impervious surface areas increase unless significant BMPs such as detention and infiltration are employed. This section describes existing and projected land use and surface cover and utilizes data compiled during the development of the 2002 Basin Master Plans. Land uses described as "existing" are based on data current to November 1998. Projected land uses area calculated based on the assumption that undeveloped lands will develop at their *Metro Plan* designations. In the coming years, the Stormwater Master Plans will be updated, and more recent land use data utilized.

3.4.1 Existing Land Uses

The Stormwater Planning Area contains a total of 48,927 acres, of which approximately 34,445 acres are within the Urban Growth Boundary (UGB). Based on data from the 2002 Stormwater Master Plan, 76% of the UGB area was considered developed to urban uses with low density residential (31% of UGB) and street rights-of-way (17% of UGB) being the predominant land uses. Approximately 24% of the land within the UGB is in agricultural, timber, or undeveloped conditions which are considered vacant and potentially available for urban development. Predominant land uses outside the UGB include agriculture (42%) and undeveloped (23%). For a complete listing of all land use categories, see Figure 3-9. See Appendix B for Existing Land Use Maps of each basin.

Figure 3-9: Existing Land Use

Land Use Categories	Acres	% of Area
Inside UGB		
Agriculture*	2,285	7.0%
Commercial	1,819	5.0%
Communication and Utilities	286	1.0%
Industrial	1,195	3.0%
Low- to Medium-Density Residential	10,605	31.0%
Medium- to High-Density Residential	978	3.0%
Other Government	293	1.0%
Parks and Recreation	2,790	8.0%
Railroads	276	1.0%
Streets (ROW)	5,945	17.0%
Willamette River and Ponds	320	1.0%
Schools-Churches-Cemetery	1,365	4.0%
Golf Course	402	1.0%
Timber*	90	0.0%
Undeveloped*	5,807	17.0%
Subtotal	**34,456**	**100.0%**

Land Use Categories	Acres	% of Area
Outside UGB		
Agriculture	6,103	42.2%
Commercial	66	0.5%
Communication and Utilities	13	0.0%
Industrial	1,052	7.3%
Low- to Medium-Density Residential	17	0.0%
Medium-to High-Density Residential	797	5.4%
Other Government	305	2.5%
Parks and Recreation	577	4.0%
Railroads	16	0.0%
Streets (ROW)	964	6.7%
Willamette River and Ponds	107	0.7%
Schools-Churches-Cemetery	167	1.2%
Golf Course	47	0.3%
Timber	581	4.0%
Undeveloped	3,418	23.5%
Sand and Gravel	241	1.7%
Subtotal	**14,471**	**100.0%**
Grand Total	**48,927**	

Source: Data from City of Eugene Stormwater Master Plan – Volume I (2002)

**Potentially available for urban development.*

3.4.2 Buildout Land Use

The *Eugene-Springfield Metro Plan* (1987) is the primary land use policy document governing the study area. Other policy documents related to land uses include the *Bethel-Danebo Refinement Plan* (1982), the *Laurel Hill Neighborhood Plan* (1974), the *Laurel Hill Plan* (1982), the West Eugene Wetlands Plan (November 2004, amended), the *Willakenzie Area Plan* (1992), the *Willow Creek Special Area Study* (1982), the *River Road-Santa Clara Public Facilities Plan (1987), and the South Hills Study (1974)*. The City is now engaged in the process of updating the *Metro Plan* through the *Envision Eugene* process, which will be identifying UGB expansion areas and designating future urban uses (see Section 3.4.3). However, the projections below are based on current UGB extent and the adopted *Metro Plan* designations.

For each build-out land use category, Figure 3-10 indicates the total amount of acres allocated and the amount vacant for development. Vacant acres are used to estimate future impervious surface area, stormwater runoff volumes and pollutant loads. Because urban levels of land use are restricted to urban growth boundaries by state law, vacant acres apply only to areas within UGBs. In some cases, the acres listed under *Currently Developed* do not necessarily reflect actual land use. For example, the low-density residential category indicates 11,758 acres are currently developed within the UGB. Not all of those acres may, in fact, be in a residential use as there may have been pre-existing, non-conforming uses that existed prior to the *Metro Plan* designation. For a more accurate description of existing land uses, refer to Figure 3-9 above.

Buildout Land Use within the UGB: This area includes both the current city limits and the unincorporated UGB. Approximately 70 percent of the study area is currently within the UGB. Of this, 8,182 acres are considered vacant and expected to develop to urban land uses and intensities. As shown in Figure 3-10, the land use categories with the most remaining vacant acres are: low-density residential (3,749 acres), industrial (1,630 acres), and medium-density residential (643 acres).

Since adoption of the *Metro Plan* in 1982 and the update in 1987, significant concentrations of wetland resources have been identified on land in the western portion of the Amazon basin and in Willow Creek and Bethel-Danebo basins. This area is accounted for in either the natural resources, parks, and opens space category or under Wetlands Protection column of the Buildout Land Use table (Figure 3-10).

Buildout Land Use Outside the UGB: Approximately 30 percent of the stormwater planning area lies outside the UGB. The majority of this land will remain in agriculture and forest use based on current *Metro Plan* designation until which time UGB expansion is approved for those areas. See Appendix B for Projected Land Use Maps of each basin.

Figure 3-10: Buildout Land Use

Generalized Plan Designation	Designated Acres	
	Total	Vacant for Future Urban Development
Inside UGB		
Agriculture	9	6
Forest	0	0
Sand and Gravel	5	1
Commercial/Residential Commercial	1,458	189
High-Density Residential	596	186
Industrial and Com/Industrial	4,191	1,630
Low- Density Residential	15,538	3,749
Parks and Recreation	3,315	217
Roads/Walkways/Water	6,599	1,524
Gov, Ed	711	37
Medium-Density	1,713	643
Willamette River and Ponds	320	0
Subtotal	**34,455**	**8,182**
Outside UGB/UR		
Agriculture	5,702	0
Forest	2,667	0
Sand and Gravel	1,072	0
Commercial/Residential Commercial	31	0
High- Density Residential	0	0
Industrial and Com/Industrial	31	0
Low- Density Residential	11	0
Parks and Recreation	926	0
Roads/Walkways/Water	1,914	0
Gov, Ed	1,417	0
Med. Density	0	0
Rural Residential	594	0
Willamette River and Ponds	107	0
Subtotal	**14,472**	**0**
Grand Total	**48,927**	**8,182**

Source: Data from City of Eugene Stormwater Master Plan – Volume I (2002) as derived From LCOG and City of Eugene Geographic Information System data (1998)

Note: Streets (Right-of-Way). The Metro Plan does not have a "Streets" Plan designation. This amount was estimated based on the difference between total designated area and total basin size. In undeveloped areas, 15% of the land area was put into the Streets (Right-of-Way) category to account for streets that will serve future designated development.

3.4.3 Surface Cover

Other than precipitation, surface cover is perhaps the single most influential factor relating to hydromodification in that it affects the volume and velocity of stormwater runoff and the ability to treat runoff through filtration and other natural processes. The purpose of this section is to describe surface cover conditions as they currently exist and as they are projected to exist at buildout of the entire stormwater planning area.

Impervious surfaces pictured along Amazon Creek include rooftops, roads, and parking lots (photo: RaptorViews).

Impervious Surfaces

Impervious surfaces are lands covered by hard surfaces such as rooftops, roads, and parking lots that allow little or no infiltration of water to occur. Impervious surfaces are unable to absorb and infiltrate precipitation, which results in greater runoff volumes, higher but shorter duration peak flows, and higher concentrations of pollutants. Total impervious surface area for the stormwater planning area was calculated using a set of impervious surface area factors (ISAF) that were applied to the existing and projected land use data. To calculate total impervious surface area, the ISAF percentages were multiplied by the total land area in each of the land use categories. The ISAF factors were derived during the development of the Stormwater Master Plan (2002) through a process that used existing developed properties in Eugene to generate typical impervious percentages. Impervious surface area for residential, commercial, and industrial land uses had previously been developed and digitized as the basis for calculating stormwater user fees. By using this data source, the resulting ISAFs have been calibrated specific to the City of Eugene and in some cases specific to the basin. The ISAF percentages for land use categories that were not previously digitized were derived through review of national standards and by calculating impervious surface area on sample sites.

The amount of existing impervious surface area in 1998 is estimated to be 11,800 acres in UGBs (34% of total area inside the UGB) and 1,830 acres outside UGB (12.6% of all areas outside the UGB). That equates to

a grand total of 13,639 acres of impervious surface within the stormwater planning area (27.8% of total area)

Pervious Surfaces

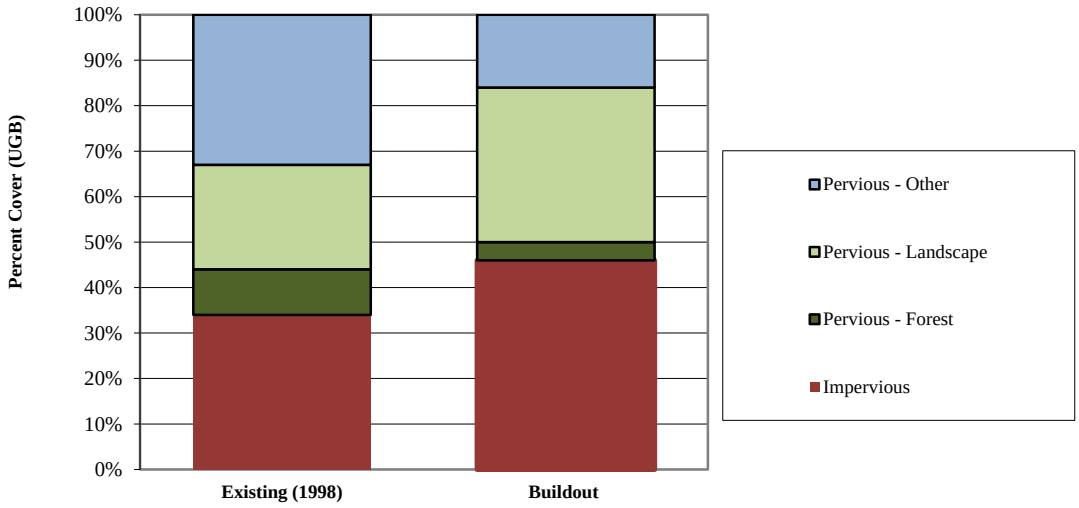
Pervious surfaces are undeveloped lands that are typically covered with lawn, forest, prairie, agricultural fields, or pasture where water is free to infiltrate into the ground. Pervious surfaces have been organized into *Forest Cover*, *Landscaping*, and *Other Vegetated Areas* as described below:

Pervious surfaces include forest cover, landscaping, and other vegetated areas (photo: RaptorViews).

- Forest Cover is highly effective in preventing erosion (e.g., reduces soil impact by slowing down the velocity of precipitation and by intercepting up to 35 percent of it before hitting the ground) and stabilizing steep slopes (established root zones). Areas were included in this category if the forested area exceeded one acre in size. Existing *Forest Cover* within the UGB is estimated at 3,310 acres (10%) and is projected to decrease to 1,062 acres (4%) at UGB buildout.
- Landscaping areas, including lawns, streetscape and parking lot landscaping are associated with site improvements due to urban development. This category was distinguished to highlight both its positive and potential negative impacts on stormwater resources. Positive impacts include protection of surface soils, filtration of sediments, and infiltration. The use of chemical fertilizers, pesticides, and herbicides can cause negative impacts to water quality. Existing *Landscaping* area within the UGB is estimated at 8,086 acres (23%) and is projected to increase to 11,668 acres (34%) at UGB buildout.
- Other Vegetated Areas are those not in *forest cover* or *landscaping* use, such as agriculture fields, pasture, vacant lots, prairie, and small clusters of trees (less than one acre). Similar to the landscaping category, these areas have both positive and negative impacts on stormwater resources. Agriculture and pasture uses are perhaps the largest contributors of pollutants in this category due to the use of chemical fertilizers, pesticides, herbicides, and fecal coliform due to grazing. Existing *Other Vegetated*

Areas within the UGB is estimated at 11,523 acres (33%) and is projected to decrease to 5,496 acres (16%) at UGB buildout.

Figure 3-11: Existing and Projected Pervious and Impervious Cover within UGB



Source: Data from City of Eugene Stormwater Master Plan – Volume I (2002

Figure 3-12: Basin Size, Vacant Land, and Impervious Surface Area

Basin	Basin Size *(acres)*	Remaining Vacant Acres *(1998)*	Existing Impervious Surface Acres *(1998)*	Buildout Impervious Surface Acres
Amazon Creek				
Inside UGB	10,656 (93% of basin)	2,415 (23% of UGB)	3,566 (33% of UGB)	4,655 (44% of UGB)
Outside UGB	786 (7% of basin)	0	79 (10% of non-UGB)	79 (10% of non-UGB)
Total Basin	**11,442 (100% of basin)**	**2,415 (21% of basin)**	**3,645 (32% of basin)**	**4,734 (41% of basin)**
Bethel-Danebo				
Inside UGB	6,175 (66% of basin)	1,593 (26% of UGB)	2,186 (35% of UGB)	3,060 (50% of UGB)
Outside UGB	3,143 (34% of basin)	0	334 (11% of non-UGB)	334 (11% of non-UGB)
Total Basin	**9,318 (100% of basin)**	**1,593 (17%)**	**2,520 (27%)**	**3,394 (36%)**
Laurel Hill				
Inside UGB	804 (97% of basin)	458 (57% of UGB)	163 (20% of UGB)	348 (43% of UGB)
Outside UGB	25 (3% of basin)	0	0	0
Total Basin	**829 (100% of basin)**	**458 (55% of basin)**	**163 (20% of basin)**	**348 (42% of basin)**

Basin	Basin Size *(acres)*	Remaining Vacant Acres *(1998)*	Existing Impervious Surface Acres *(1998)*	Buildout Impervious Surface Acres
River Road-Santa Clara				
Inside UGB	6,063 (58% of basin)	1,744 (29% of UGB)	2,056 (34% of UGB)	3,063 (51% of UGB)
Outside UGB	4,370 (42% of basin)	0	748 (17% of non-UGB)	748 (17% of non-UGB)
Total Basin	**10,432 (100% of basin)**	**1,744 (17% of basin)**	**2,804 (27% of basin)**	**3,811 (37% of basin)**
Willakenzie				
Inside UGB	6,096 (83% of basin)	1,124 (18% of UGB)	2,258 (37% of UGB)	2,842 (47% of UGB)
Outside UGB	1,218 (17% of basin)	0	125 (10% of non-UGB)	125 (10% of non-UGB)
Total Basin	**7,314 (100% of basin)**	**1,124 (15% of basin)**	**2,383 (33% of basin)**	**2,967 (41% of basin)**
Willamette River				
Inside UGB	3,492 (50% of basin)	295 (8% of UGB)	1,412 (40% of UGB)	1,552 (44% of UGB)
Outside UGB	3,531 (50% of basin)	0	445 (13% of non-UGB)	445 (13% of non-UGB)
Total Basin	**7,023 (100% of basin)**	**295 (4% of basin)**	**1,857 (26% of basin)**	**1,997 (28% of basin)**
Willow Creek				
Inside UGB	1,169 (46% of basin)	553 (47% of UGB)	159 (14% of UGB)	486 (42% of UGB)
Outside UGB	1,398 (54% of basin)	0	110 (8% of non-UGB)	110 (8% of non-UGB)
Total Basin	**2,567 (100% of basin)**	**553 (22% of basin)**	**269 (10% of basin)**	**596 (23% of basin)**
All Basins				
Inside UGB	34,455 (70% of basin)	8,182 (24% of UGB)	11,799 (34% of UGB)	16,010 (46% of UGB)
Outside UGB	14,472 (30% of basin)	0	1,840 (13% of non-UGB)	1,840 (13% of non-UGB)
Total Study Area	**48,927 (100% of basin)**	**8,182 (17% of basin)**	**13,639 (28% of basin)**	**17,850 (36% of basin)**

Source: Data from City of Eugene Stormwater Master Plan – Volume I (2002)

3.4.4 Projecting Future UGB Expansion

The *Envision Eugene* planning process, currently underway, will eventually lead to an updated Comprehensive Plan and will indicate where future urban development will occur through urban growth boundary (UGB). Eugene is expected to grow by an additional 34,000 people over the next 20 years and has not had to expand its boundary by any significant extent since the boundary was established in 1982. Although the population is expected to increase by approximately 20 percent over the next 20 years, the City is focusing on infill and redevelopment to accommodate much of this anticipated growth. The current Envision Eugene recommendation is to increase our UGB by only 3 percent, with expansion areas being considered in the Willow Creek, lower Amazon, River Road-Santa Clara, Russel Creek, and Bethel-Danebo basins. For *Envision Eugene* updates, go to: http://www.eugene-or.gov/envisioneugene. The Envision Eugene process is not likely to be completed until 2015, at which time, the exact locations of the UGB expansion will be defined.

Section 4: Waterway Characteristics and Impacts Related to Hydromodification

4.1 Open Waterways, Piped System, Floodplain, and Waterway Maintenance

4.1.1 Open Waterways within Stormwater Planning Area

The major rivers and streams in the stormwater planning area include the Willamette River, McKenzie River, Amazon Creek, Canoe Canal-Patterson Slough, Dedrick Slough, North Beltline Floodway, Willow Creek, East Santa Clara Waterway, Flat Creek, Spring Creek, Laurel Hill Creek, Mill Race, Roosevelt Channel, Bertelsen Slough, the Amazon Diversion Channel, and the so-called "A" Channels, which are constructed tributaries of lower Amazon Creek. In addition, an extensive network of headwater streams exist in the South Hills area, all of which flow into Amazon Creek or Willow Creek.

Pre-settlement (ca. 1850) morphological conditions in the Willamette Valley reflected a network of shallow, broad swales that would often experience over-bank flooding during storm events creating ponded conditions. Today, most of these waterways have been altered into narrow, deep, and well-defined channels where the management objective of preventing over-bank flooding conditions has been accomplished for most storm events. Comparing historic drainage patterns in the South Hills area to current conditions, it is clear that pipes and other built drainage facilities have replaced many of the historic annual and perennial streams where urban development has occurred. See Figure 4-1 below for remaining waterway miles per basin.

For purposes of this planning process, the term "open waterways" refers to creeks, streams, and channels that, along with the City's stormwater pipe system, constitute the local drainage network. In this context, the Willamette and McKenzie rivers are outside the local drainage system and, therefore, are not reflected in the data below or included in the hydromodification assessment.

Figure 4-1: Miles of Open Waterway by Basin

Basin	Open Waterways (miles)		Total
	Inside UGB	Outside UGB	
Amazon	36	2	38
Bethel-Danebo	31	17	48
Laurel Hill	3	0	3
River Road/Santa Clara	29	19	48
Willakenzie*	22	3	25
Willamette River*	3	8	11
Willow Creek	9	8	17
Total	**133**	**41**	**190**

Source: Data from City of Eugene Stormwater Master Plan – Volume I (2002)

**Does not include the main channels of the Willamette River or McKenzie River.*

4.1.2 Public Piped MS4 System

There are currently an estimated 324 miles of stormwater pipes located within the stormwater planning area (mostly within City limits). The public piped system includes the stormwater facilities that the City of Eugene owns and maintains. The public system does not include private drainage facilities. The extent of privately owned and maintained storm pipe systems within the city limits is unknown. The piped system primarily serves the function of carrying stormwater away from development and conveying it to receiving

waters such as Amazon Creek and the Willamette River. Figure 4-2 below shows the extent of the piped system by basin.

Figure 4-2: Public Piped Stormwater System

Basin	Miles of Public Piped System
Amazon	123
Bethel-Danebo	54
Laurel Hill	3
River Road/Santa Clara	30
Willakenzie	59
Willamette River	54
Willow Creek	1
Total	**324**

Source: Data from City of Eugene Stormwater Master Plan – Volume I (2002)

4.1.3 Floodplain

While most streams and open waterways in Eugene have natural, hydrologic floodplains, the only waterways that have mapped floodplains are those where the Federal Emergency Management Agency (FEMA) has performed specific flood studies. FEMA designates 100-year and 500-year floodplain areas and offers flood insurance at reduced rates for cities and property owners that participate in the federal insurance rate program. The overall floodplain consists of two areas: 1) the *floodway*, which is the area needed to pass the 100-year peak flow condition, is the most restrictive where development activities are prohibited; 2) the *floodway fringe* area extends landward from the floodway and is often inundated during 100-year overbanking conditions. Development activities are allowed in the floodway fringe provided flood standards are met, such as building above the 100-year flood elevation.

FEMA designated floodplains in the stormwater planning area are associated with the Willamette River; Amazon Creek; Q Street-Patterson Slough-Canoe Canal system; Debrick Slough; Ayers Pond-Dodson Slough system; McKenzie River, East Santa Clara Waterway; Spring Creek; Flat Creek; A1, A2, A3, A Channel system; and Amazon Creek-Diversion Channel system. The stormwater planning area includes approximately 8,104 acres of 100-year floodplain.

Figure 4-3: Floodplain Area by Basin

Basin	Mapped Floodplain Area (acres)								
	Floodway			Floodway Fringe			Total Floodplain		
	UGB	Outside UGB	Total	UGB	Outside UGB	Total	UGB	Outside UGB	Total
Amazon	128	0	128	503	222	725	631	222	853
Bethel-Danebo	4	0	4	705	1,306	2,011	709	1,306	2,015
Laurel Hill	1	0	1	3	0	3	4	0	4
RR-SC	0	0	0	635	636	1,271	635	636	1,271
Willakenzie	77	12	89	947	896	1,843	1,024	908	1,932
Willamette River	462	575	1,037	310	660	970	772	1,235	2,007
Willow Creek	1	0	1	21	0	21	22	0	22
Total	**673**	**587**	**1,260**	**3,124**	**3,720**	**6,844**	**3,797**	**4,307**	**8,104**

Source: City of Eugene Stormwater Master Plan – Volume I (2002)

Insert 11x17 Map Set (8 maps total covering 16 pages)

Single sided – engineer folded

4.1.4 Waterway Related Best Management Practices

The 2012 City of Eugene Stormwater Management Plan (SWMP) describes the set of best management practices (BMPs) that the City of Eugene has committed to conducting to reduce pollutant discharges from the municipal stormwater system to the maximum extent practicable. This plan is incorporated by reference into the City's NPDES permit. Waterway related BMPs include the following:

- ***P1 - Educational Volunteer Program***: Manage and support the City's Eugene Park Stewards volunteer program that promotes stormwater education. Provide opportunities to involve citizens of all ages and socio-economic backgrounds in meaningful, hands-on and educationally oriented stormwater related projects. Such projects are aimed at providing both physical benefits and participant awareness related to protecting stormwater quality, fostering citizen stewardship of the City's water resources, promoting the use of native-vegetation, and enhancing fish and wildlife habitat within the local urban watershed.
- ***P3 - Tree Planting Information Program***: Manage and support both governmental and community tree planting programs. Provide information to the public about the multiple benefits that trees provide for protecting and enhancing stormwater quality.
- ***P5 - Public Stormwater System Maintenance***: Open Waterways: Maintain and manage open waterways consistent with adopted Open Waterway Maintenance Plans. These plans are intended to protect and enhance stormwater quality and natural resources values while continuing to maintain sufficient conveyance capacity in the waterways.
- ***E1 - Stormwater Capital Improvement Projects***: Implement the Stormwater capital improvement program (CIP), including projects identified in the City's Stormwater Basin Master Plans (Basin Plans) for Amazon, Willow Creek, Bethel-Danebo, Willakenzie, Laurel Hill, and Willamette River and the River Road – Santa Clara basins.

4.1.5 Existing Waterway Maintenance Practices

The City of Eugene is responsible for maintaining all drainage facilities within the City that carry storm runoff originating on public right-of-ways or other publicly owned land. Most of the piped system lies within street rights-of-way or within easements on private property. Nearly 30 miles of open drainage channels are maintained by the City as either public right-of-way or through easements.

Prior to the adoption of CSWMP in 1993, the primary objective of the City's maintenance program was to ensure adequate conveyance and to prevent localized flooding that may result from obstructions or restrictions in the flood channels. Under CSWMP, Eugene has moved toward a multiple objective approach to managing its waterways and flood channels. Water quality, natural resource values, and recreation opportunities are now also considered when assessing what type and what frequency of maintenance should be performed on these flood conveyance structures. For this reason, the City's maintenance practices are constantly being evaluated and revised as the City addresses the following issues:

- Cleaning and Debris Removal: The pre-CSWMP practice was to routinely remove sediment deposits and associated in-stream vegetation on a rotating schedule of approximately every seven to ten years. However, large items of junk, woody debris, beaver dams and/or other potential restrictions to conveyance were always removed shortly after being identified. In light of the City's shift to a multiple management objective approach, this practice has evolved over the past decade so that such obstructions are no longer automatically removed. They are now evaluated on their potential benefits and liabilities such that each case is handled individually, with varying prescriptions performed based on the risk posed to the conveyance capacity. Junk, trash, and other human discarded materials are still removed on a frequent routine basis and illegal camping is discouraged in order to meet the management objectives.

- Vegetation Management: As with channel cleaning and debris removal, the City's channel vegetation management strategies and practices have evolved significantly over the past decade. Where access allows, the City still mows the top of bank and upper slopes of both major and minor flood control channels several times each season. This is both for bank stability inspection purposes and to keep grass and weeds in compliance with the City's own nuisance vegetation codes. Where other mowing constraints provide an opportunity, trees and large shrubs are encouraged along the upper slopes and top of bank within the mow zone.

The City's waterway management approach promotes tree and shrub growth along most channel banks for shading, habitat, and bank stabilization benefits while keeping the central flow channel clear for adequate stormwater conveyance.

The biggest management evolution has been in the approach taken toward vegetation in the bottom and along the slopes of the channels. Based solely on maximizing flood conveyance, the City's previous practice was to remove all vegetation between the tops of the respective channel banks. The City has moved to more selective vegetation removal techniques, which emphasizes leaving significant vegetation along the channel banks, especially near the toe, yet at the same time keeping a central flow channel free from any woody vegetation that could snag other waterborne debris and create impediments to flow. This technique is informally called *green piping* as it allows bank stabilizing vegetation to grow vertically up out of the flow channel and then form a canopy over the channel to provide shade, wildlife habitat, and natural resource aesthetics. The amount, type, and frequency of vegetation that is removed on each channel are evaluated annually in order to ensure that the system continues to meet its flood conveyance objectives.

- Bank Repair: Bank erosion, scour, toe-cutting and sloughing are prevalent on almost all headwater tributaries as well as many flood control channels. In addition, rotational slumping of excavated banks and wide spread nutria burrows are serious bank stability issues on Amazon Creek, the Diversion Channel and several other major excavated drainage channels. Where access is allowed, the City's previous practice was to excavate the unstable or damaged slope to below the waterline and replace all the material with stone rip-rap to the top of the bank. While this created an extremely durable armored slope, it also eliminated the possibility of improving water quality or natural resource values. It also tended to deflect the problem to an adjacent section of channel bank. As more naturalized stream bank repair techniques have evolved, the City has begun to utilize more bio-engineered bank repair. While it is often still necessary to excavate out slumped materials, the City now attempts to minimize the amount of rip-rap placed into the channel, confining it primarily to repair areas at the toe of the channel. After one or more of these *green* bank reconstruction techniques have been employed, the area is replanted with native species that help bind the repair and provide the opportunity for increasing water quality and natural resource benefits. In addition, the City has begun a policy of partnering with

private property owners in order to help them solve erosion and banks stability problems on creeks and stream that are not covered under the City's maintenance jurisdiction.

Outside the City limits, Lane County maintains roadside ditches but does not actively maintain runoff from adjacent private lands. As land is annexed to the City, Eugene will assume maintenance responsibilities provided that they meet City standards.

In areas where slumping or toe-cutting is problematic, such as the Amazon Creek Diversion Channel shown above, the City places rip-rap along the toe of the bank to limit further erosion. Bioengineering techniques, such as willow staking, are utilized where feasible to further stabilize the banks.

4.2 Waterway Impacts Associated with Hydromodification

4.2.1 Physical Assessment Methodology (Amazon and Spring Creek only)

City of Eugene Parks and Open Space staff have conducted physical monitoring for selected waterways in 2005, 2011, and 2014. Physical monitoring is currently limited to twelve reaches of Amazon Creek and one reach of Spring Creek. These reaches were selected, in part, because they are known to have experienced issues with physical stability, incision, or sedimentation in the past. Four categories associated with the physical condition of the channel are evaluated and given a score ranging from 1-10, with a total of 40 points possible. The scoring criteria are listed below:

Physical Characteristics: (Shape / Size)

Measure: Physical Characteristics will be measured against a natural healthy stream with balanced deposition and transport throughout a year. Channel type is a function of the Grade (steep grade straighter stream, flat grade, more sinuosity). Structural modifications should be an enhancement to the stream. While a channel may be an effective means to transport flows, it may be unable to accommodate other goals such as water quality, or habitat resource. Rate the reach for the ability to achieve multiple goals.

Natural Form Channel Type fits Grade, Minor or no modifications, capacity contained	Channel has some Natural form returning.	Closed or Lined channel No Natural features Creates ecological problems. Modifications are failing, needs attention. Flooding occurs.
10	5	1

Channel Stability (Banks)

Measure: Channel Stability - BANKS will be measured against a natural healthy stream with functional, stable banks. Vegetated with grasses, native shrubs and trees rate higher than invasive types due to their ability to root deeper and provide more strength. Natural stabilization will weigh higher than artificial methods such as concrete or rip rap lining. *Note bank profile from above.

Channel banks are in stable, well protected and vegetated condition.	Channel banks show sign of erosion, sloughing, cracking…	Channel banks seriously eroded; stream function impaired, needs immediate attention.
10	5	1

Channel Stability (Bed)

Measure: Channel Stability -BEDS will be measured against a natural healthy stream with functional, stable beds. Higher ratings will be given for natural formed beds with balanced deposition and transport. Lower ratings are given for incision, head cutting, or other eroding or flow preventive factors. *Note channel gradient from above.

Channel beds are stable provide deposition and transport	Channel bed shows signs of minor failures or erosion. Stream function is not altered	Channel bed seriously eroded and incised; stream function impaired, needs immediate attention.
10	5	1

Sediment

Measure: Sediment can be an indicator of stability within the channel. Sediment source can be from outside the channel and potentially create stability problems. Rate known sediment values high when there is no indication of damming or starvation within the channel. Rate low when sediment deposition influences flows in a negative manner such as minimal sediment or over deposition creating damming.

Sediment quantities are stable. Provide balanced deposition and transport, creates good environmental conditions	Sediment values seem unbalanced. Stream function seems stable. Sediment problems during specific events.	Sediment volume is either heavy or non-existent. Bed and bank are altered because of extreme sediment conditions. Toxicity is present
10	5	1

4.2.2 Physical Assessment Scoring and Change over Time

The 2014 scoring for the thirteen waterway reaches is listed below in Figure 4-4 and the change of condition over time between 2005 and 2014 is shown in Figure 4-5.

Figure 4-4: Physical Assessment Scores

Reach #	Waterway	Reach Extent	Physical Assessment					
			Physical Char.	Channel Stability BANKS	Channel Stability BEDS	Sed.	*TOTAL SCORE*	% Total of 40 Possible)
1	Amazon Creek	Martin Street - Snell Street (2005)	7	8	4	8	*27*	68%
1	Amazon Creek	Martin Street - Snell Street (2011)	8	9	5	8	*30*	75%
1	Amazon Creek	Martin Street - Snell Street (2014)	8	9	5	8	*30*	75%
2	Amazon Creek	Snell - Fox Hollow (2005)	3	6	6	8	*23*	58%
2	Amazon Creek	Snell - Fox Hollow (2011)	3	6	6	8	*23*	58%
2	Amazon Creek	Snell - Fox Hollow (2014)	3	6	6	8	*23*	58%
3	Amazon Creek	Fox Hollow - 30th Ave (2005)	3	6	6	7	*22*	55%
3	Amazon Creek	Fox Hollow - 30th Ave (2011)	4	6	6	7	*23*	58%
3	Amazon Creek	Fox Hollow - 30th Ave (2014)	4	6	6	7	*23*	58%
4	Amazon Creek	30th Av. - 24th av. (2005)	4	8	9	8	*29*	73%
4	Amazon Creek	30th Av. - 24th av. (2011)	4	8	9	8	*29*	73%
4	Amazon Creek	30th Av. - 24th av. (2014)	4	8	9	8	*29*	73%
5	Amazon Creek	24th Ave. - Fairgrounds (2005)	1	1	1	5	*8*	20%
5	Amazon Creek	24th Ave. - Fairgrounds (2011)	1	1	1	5	*8*	20%
5	Amazon Creek	24th Ave. - Fairgrounds (2014)	1	1	1	5	*8*	20%
6	Amazon Creek	Fairgrounds - Chambers St. (2005)	3	6	5	6	*20*	50%
6	Amazon Creek	Fairgrounds - Chambers St. (2011)	3	6	5	6	*20*	50%
6	Amazon Creek	Fairgrounds - Chambers St. (2014)	3	7	5	6	*21*	53%
7	Amazon Creek	Chambers St. - Oak Patch (2005)	2	1	2	5	*10*	25%
7	Amazon Creek	Chambers St. - Oak Patch (2011)	2	1	2	5	*10*	25%
7	Amazon Creek	Chambers St. - Oak Patch (2014)	5	4	3	6	*18*	45%
8	Amazon Creek	Oak Patch - Bailey Hill (2005)	3	5	3	4	*15*	38%
8	Amazon Creek	Oak Patch - Bailey Hill (2011)	3	5	3	4	*15*	38%
8	Amazon Creek	Oak Patch - Bailey Hill (2014)	3	5	3	4	*15*	38%
9	Amazon Creek	Bailey Hill Rd. - Railroad Bridge (2005)	5	2	6	4	*17*	43%
9	Amazon Creek	Bailey Hill Rd. - Railroad Bridge (2011)	5	2	6	4	*17*	43%
9	Amazon Creek	Bailey Hill Rd. - Railroad Bridge (2014)	5	5	6	4	*20*	50%
10	Amazon Creek	Railroad Bridge - Royal Ave. (2005)	7	10	10	10	*37*	93%
10	Amazon Creek	Railroad Bridge - Royal Ave. (2011)	7	10	10	10	*37*	93%
10	Amazon Creek	Railroad Bridge - Royal Ave. (2014)	7	10	10	10	*37*	93%
11	Amazon Creek	Royal Ave. - Fern Ridge Reservoir (2005)	5	3	8	3	*19*	48%
11	Amazon Creek	Royal Ave. - Fern Ridge Reservoir (2011)	5	6	8	3	*22*	55%
11	Amazon Creek	Royal Ave. - Fern Ridge Reservoir (2014)	5	6	8	3	*22*	55%
12	Amazon Creek	Royal Ave. - Greenhill Rd. (2005)	8	7	9	9	*33*	83%
12	Amazon Creek	Royal Ave. – Greenhill Rd. (2011)	8	7	9	9	*33*	83%
12	Amazon Creek	Royal Ave. – Greenhill Rd. (2014)	8	7	9	9	*33*	83%
13	Spring Creek	Awbrey Park (2005)**not assessed	-	-	-	-	-	-
13	Spring Creek	Awbrey Park (2011)	6	6	8	9	*29*	73%
13	Spring Creek	Awbrey Park (2014)	6	6	8	9	*29*	73%

Figure 4-5: Change in Physical Condition between 2005 and 2014

Waterway Reach	Reasons for change in values between 2005 and 2011	Change*
Summary of Changes between 2005 and 2011		
Martin Street – Snell Street	CIP (new channel) in East Fork Amazon headwaters, maturing willows	Up 7 %
Snell – Fox Hollow	Change in shade value since 2005 due to maturing vegetation, increased shrub and tree cover	No change
Fox Hollow – 30th Ave	Capital improvement project (widening north of Fox Hollow), maturing shrub cover, plantings and weed control 30th to 33rd	No change
30th Av. – 24th av.	Increased shade and slope stability due to willow plantings and maturation	No change
24th Ave. -Fairgrounds	No significant change in this stretch	No change
Fairgrounds – Chambers St.	Shrub and tree plantings and maturation, and weed control by volunteer group	No change
Chambers St. – Oak Patch	Six major bank repair projects in this stretch, also willow planting and maturation, blackberry removal Garfield to City View	No change
Oak Patch – Bailey Hill	Tree and shrub plantings and maturation, rock placement at toe-of-slope Acorn Park to Richardson Bridge	No change
Bailey Hill Rd. - Railroad	Tree and shrub plantings and maturation	No change
Railroad - Royal Ave.	Maturation of streamside willows	No change
Royal Ave. – Fern Ridge Reservoir	Capital improvement project (rock placement) in majority of this stretch increased bank stability, integrity and protection	Up 7%
Royal - Greenhill Rd.	Maturation of streamside willows	No change
Spring Cr - Awbrey Park	This stretch not scored in 2005	n/a
Summary of Changes between 2011 and 2014		
Martin Street – Snell Street	Slight increase in shade due to maturing willow plantings in East Fork Amazon headwaters (T. Colvin's 2005 project)	No change
Snell – Fox Hollow	No significant changes in channel; Rexius Trail slowly declining in quality due to poor construction, lack of maintenance	No change
Fox Hollow – 30th Ave	One small bank repair (2013); maturing tree and shrub cover (especially 33rd to 30th)	No change
30th Av. – 24th Ave.	Increased shade and slope stability due to ash & willow maturation	No change
24th Ave. - Fairgrounds	No significant change in this stretch	No change
Fairgrounds – Chambers St.	Increased shade and slope stability due to willow maturation; many new trees planted; concrete pedestrian path reconstructed/improved	Up 3%
Chambers St. – Oak Patch	Capital improvement 2014 (Chambers - Arthur) increased slope stability, native plant cover; willow maturation & tree planting elsewhere	Up 20%
Oak Patch – Bailey Hill	Increased shade and slope stability due to willow plantings and maturation	No change
Bailey Hill Rd. – Railroad	Capital improvement project (rock placement); City acquisition of Rexius property; willow maturation	Up 7%
Railroad – Royal Ave.	No significant change in this stretch	No change
Royal Ave. – Fern Ridge Reservoir	No significant change in this stretch	No change
Royal - Greenhill Rd.	No significant change in this stretch	No change
Spring Cr. – Awbrey Park	Active volunteer group has removed blackberries, established native shrubs & forbs along most of this reach	No change

** Percent change shown is for the physical condition category only. Many of the reaches have seen an overall improvement, but may not have changed based on the physical condition assessment factors.*

4.2.3 Identification of Channel Reaches with Physical Problems and Past Enhancement Efforts

On June 26, 2014, a half-day work session was conducted by the City of Eugene's *Waterways Team* with a goal of using "institutional knowledge" to identify specific channel reaches where physical problems such as bank/bed stability, incision, and sedimentation were occurring and where past CIP or bank stabilization projects have been implemented. The *Waterways Team* is made up of approximately ten staff from the Parks and Open Space Division and Public Works Engineering who are responsible for maintaining and restoring waterways within the City's stormwater planning area. This group as a whole possesses an in-depth on-the-ground knowledge of area waterways.

The results of this work session are documented on the *Waterways Conditions Map* on the following page. This information will be used to help determine the general nature and geographic extent of waterway issues and to help inform the development of strategies and approaches that the City will consider for addressing the impacts of hydromodification in the future.

4.3 Summary of Channel Condition by Basin

The following sections qualitatively describe the current general condition of the waterways within each of the City's seven stormwater planning basins and notes the locations where major known physical issues are occurring. This qualitative information is in addition to what is already documented in the Stormwater Master Plan and Open Water Maintenance Plan.

4.3.1 Amazon Basin

All twelve waterway reaches of Amazon Creek that are being monitored for physical conditions have either improved slightly or stayed the same since monitoring began in 2005. None of the scores have declined. Improvements are due to a combination of tree and shrub planting efforts, bank repairs, or implementation of major capital improvement projects such as the daylighting project at Frank Kinney Park (Martin Street to Snell Street) and the channel widening projects at Oak Patch and Fox Hollow. Waterway reaches receiving the lowest scores for physical condition include the following:

- Amazon Creek from 24th Avenue - Fairgrounds (20% of total points)
- Amazon Creek from Oak Patch to Baily Hill (38% of total points)
- Amazon Creek from Chambers to Oak Patch (45% of total points)
- Amazon Creek from Fairgrounds to Chambers (53% of total points)

Additionally, in their work session, the *Waterways Team* identified a number of isolated locations along the main channel of Amazon Creek where physical problems such as slumping, incision, and sedimentation were occurring. In the headwater streams of Amazon Creek, physical issues were noted in a number of locations including Braeburn Creek (just above where it enters the piped system), Tiara Creek (incision), Timberline Creek (erosion and incision), Videra Creek (incision and sedimentation). Due to access limitations along some of these waterways, the *Waterways Team* was unsure of the physical conditions along some reaches.

4.3.2 Bethel-Danebo Basin

Few physical issues were identified by the *Waterways Team* in the Bethel-Danebo basin. Waterways such as the A2 Channel, A3 Channel, Amazon Creek (A Channel), Marshall Channel, and Roosevelt Channel were found to be generally stable, in part due to the excess capacity within these waterways. Tree planting projects along a number of these waterways have helped to further stabilize the physical conditions of the channel banks in addition to providing habitat and water quality benefits.

4.3.3 Laurel Hill Basin

There were no significant problem areas identified by the *Waterways Team* within the Laurel Hill Basin.

4.3.4 River Road-Santa Clara Basin

The most significant problem identified within this basin is associated with many of the land owners along Flat Creek and Spring Creek modifying or negatively impacting these waterways. Common infractions include channel filling, unpermitted piping, installation of undersized culverts, dumping of debris and lawn clippings, creation of impoundments, and channel relocation. Additionally, some sedimentation was noted along Spring Creek, resulting from dense concentrations of reed canarygrass growing in the channel. The waterway assessment conducted by the City (see Section 4.2.2) gave this reach 29 out of a possible 40 points for physical condition (73%). It was noted by the *Waterways Team* that many of the waterways in this basin are difficult to access due to limited public ownership and conditions along many of these reaches were unknown.

4.3.5 Willakenzie Basin

There were no significant problem areas identified by the *Waterways Team* within the Willakenzie basin. The recently completed Delta Ponds Restoration Project has resulted in significant improvement to Dedrick Slough and the ponds themselves. This included extensive re-contouring of the steep banks of the ponds to create more gradual slopes with wetland benches, extensive invasive species removal, and significant tree and shrub plantings.

4.3.6 Willamette River Basin

There were no significant problem areas identified by the *Waterways Team* within the Willamette River Basin, with the exception of the river banks themselves, which are being impacted more by upstream flows than local factors. These bank stabilization issues are being addressed through other efforts including implementation of riverbank bioengineering projects, tree planting projects, relocation of at-risk infrastructure such as shared use paths, and working directly with the US Army Corps of Engineers on modifications to dam releases under their Sustainable Rivers Project.

4.3.7 Willow Creek Basin

The primary reach of Willow Creek experiencing physical problems is a channelized portion located between 18th Avenue and 11th Avenue. This was identified by the *Waterways Team* as having significant physical issues including incision and bank failure. The Corps of Engineers' *Metro Waterways Study* conducted a waterway assessment in 2010 using the same methodology as the City is using for monitoring Amazon Creek (see Section 4.2.2). In that assessment, this reach of Willow Creek only received only 8 of the possible 40 points for physical condition. The Nature Conservancy owns much of the land along lower Willow Creek and is currently investigating restoration options including abandoning the constructed channel and restoring the two historic branches of Willow Creek which were bypassed when the drainage channel was constructed.

In addition to the reach described above, the *Waterways Team* identified isolated areas of significant areas of incision occurring along upper Willow Creek, just downstream of Gimpl Hill Road, and along Bailey Hill Creek. Should UGB expansion occur within the Willow Creek basin in the future, additional physical conditions are likely to emerge if runoff volumes and velocities increase due to urban development. Portions of the Willow Creek basin are currently being evaluated for UGB expansion in the *Envision Eugene* process.

Insert 11 x 17 Waterways Conditions Map (Map 11)

Examples of Physical Problems Occurring on Area Waterways

Bank failure along Amazon Creek (2010)

Wall failure along the concrete channel segment of Amazon Creek (2012)

Bank failure along Amazon Creek (2011)

Incision along a headwater stream

Incision along a headwater stream below an outfall

Unpermitted channel modifications made by private property owner along Spring Creek

Section 5: Key Findings and Potential Strategies

5.1 Planning and Policy

Key findings and potential strategies that are related to stormwater planning and policy are listed in Figure 5-1 below. These address the high level policy direction provided by the 1993 *Comprehensive Stormwater Management Plan*, the more detailed policy and strategy direction provided by the 2002 *Stormwater Basin Master Plan*, and corridor specific acquisition and management plans that were developed for headwater stream areas in 2001 and 2002. Each row is keyed to indicate the implementation status of the potential strategy using the following codes: **C** = Continue with Current Practices; **P** = Planned; **F** = Future Consideration.

Figure 5-1: Key Findings and Potential Strategies Related to Planning and Policy

Key Findings	Potential Strategies	Status
Regulation		
High Level Stormwater Policy Direction: The 1993 *Comprehensive Stormwater Management Plan* (CSWMP) still provides adequate policy direction to support efforts to address the impacts associated with hydromodification.	• Continue to implement CSWMP goals and policies related to limiting impacts of new land uses, protection of headwater streams, multi-objective management of waterways, and waterway enhancement and restoration.	**C**
Stormwater Basin Master Planning: The eight volume *Stormwater Basin Master Plan* was completed in 2002 (with the River Road/Santa Clara volume updated in 2012). The *Basin Plans* apply CSWMP policies at the individual basin level. They lay out the long-term stormwater management strategy for each basin including capital projects and context for stormwater-related regulations. Some basin characterization data and the list of capital projects in particular are in need of updating.	• Update the *Stormwater Basin Master Plan* to reflect up-to-date land use, impervious surface, and hydrology data and updated future capital projects lists. • Incorporate in the *Basin Plan* update the long-range planning decisions represented by *Envision Eugene* (adoption anticipated in 2015) including proposed UGB expansion areas and policies related to infill and redevelopment which may impact projected impervious surface calculations and runoff potential. Include additional public projects as appropriate. • When updating the *Basin Plan*, utilize the same format and methodologies for calculating data (e.g. impervious surface area) so that changes over time can be tracked. • As part of the Amazon Basin update, evaluate what has been done and what is planned to address bank stability issues on the main stem of Amazon Creek, and identify any potential additional strategies necessary to address the root cause.	**P**
Protection of Waterway Corridors: The City's adoption of /WR and /WQ overlay zones in 2005 and 2010 respectively, provides Waterway protection in alignment with Oregon Statewide planning Goals 5 & 6. This regulatory approach reduced the need for the City to use acquisition funds for stream corridors as a protection measure, which had been a priority prior to implementation of the overlay zones.	• Review the relatively generic setback protection provided by /WR and /WQ overlay zones against more site-specific target acquisition areas identified in the earlier *Stream Corridor Acquisition Study* (2001) and *Stormwater Corridor Management Plans* (2002); identify potential gaps in protections important to addressing hydromodification. • Reevaluate the need for stream acquisition funds and consider possible reallocation of those funds to restoration and enhancement capital improvement projects to address hydromodification. • Coordinate with the upcoming *Eugene Park and Recreation Master Plan* update process (scheduled to begin in 2015) on future land acquisitions related to waterway and headwater protection.	**F**

5.2 Regulation

Key findings and potential strategies that are related to stormwater regulations are listed in Figure 5-2 below and address waterway protection overlay zones, stormwater development standards/low impact development, and development standards/flow controls. Each row is keyed to indicate the implementation status of the potential strategy using the following codes: **C** = Continue with Current Practices; **P** = Planned; **F** = Future Consideration.

Figure 5-2: Key Finding and Potential Strategies Related to Regulation

Key Findings	Potential Strategies	Status
Regulation		
Waterway Protection Overlay Zones: The existing combined overlay zones including Waterside Protection (/WP), Wetland Buffer (/WB), Water Resource (/WR), and Water Quality (/WQ) overlay zones provide effective protection for a connected system of waterways within the Stormwater Planning Area, with the exception of the /WQ overlay zone which does not apply to waterways outside of the city limits.	• Continue to implement and monitor the waterway protection overlay zones by tracking land use and adjustment applications. Document annually in TMDL Implementation Report. • Consider potential non-regulatory strategies for addressing short-term regulatory gap for certain waterway segments not subject to /WQ Overlay Zone until and unless properties annex to the City. See Waterway Maintenance and Management, Assistance to Private Landowners, below.	**C/F**
Stormwater Development Standards/LID: The City's stormwater development standards requiring water quality treatment of runoff from new development and re-development have been in place since 2006. The City completed a major update of its stormwater development standards in 2014, incorporating a hierarchy of best management practices thereby placing an emphasis on utilizing Low Impact Development (LID) techniques (infiltration and filtration) over off-site LID mitigation or on-site mechanical means to meet the City's standards.	• Track implementation of stormwater development standards including the geographic location, BMP type, and delineated treatment catchment area for all public and private stormwater facilities constructed. • Review data and assess results (e.g. number of on-site LID facilities, on-site mechanical facilities, and off-site LID mitigation) as part of the regular adaptive management process.	**C**
Stormwater Development Standards/Flow Controls: The City's stormwater development standards, adopted in 2006, also include requirements for flow controls applicable to developing sites in certain areas of Eugene that drain to sensitive headwater streams.	• Track implementation of headwater flow controls including the geographic location, BMP type, and delineated flow control catchment area for all public and private facilities constructed to meet headwater flow control requirements. Document in annual stormwater MS4 report. • Review data and assess results (e.g. number of flow control facilities or alternative measures via adjustment review) as part of the regular annual adaptive management process.	**C**

5.3 Restoration and Enhancement

Key findings and potential strategies that are related to waterway restoration and enhancement are listed in Figure 5-3 below and address restoration projects proposed for Amazon Creek under the Corps of Engineers Metro Waterways Study and the City's ongoing bank stabilization efforts. Each row is keyed to indicate the implementation status of the potential strategy using the following codes: **C** = Continue with Current Practices; **P** = Planned; **F** = Future Consideration.

Figure 5-3: Key Finding and Potential Strategies Related to Waterway Restoration and Enhancement

Key Findings	Potential Strategies	Status
Waterway Restoration and Enhancement		
Metro Waterways Study: The US Army Corps of Engineers *Eugene-Springfield Metro Waterways Study* was initiated in 2005 to identify and implement major waterway restoration projects along Amazon Creek. Although the study was not completed and the local partners formally withdrew from the partnership in 2013, the preliminary feasibility study resulted in recommendations for restoration projects along 14 reaches of Amazon Creek.	• Document the City's significant waterway restoration efforts completed to-date and currently under construction. • Integrate the proposed (future) Amazon Creek restoration projects that had been developed by the Corps and its Metro Waterways Study partners into the City CIP and seek additional funding sources where appropriate.	**P**
Streambank Stabilization: The City's *Capital Improvement Plan* (CIP) and budget currently provides funding for streambank stabilization projects. Projects are identified through master planning efforts and on-going communication with field staff and are prioritized for construction using a prioritization matrix.	• Continue to provide funding for streambank stabilization projects and monitor their effectiveness. Ensure as much as possible that funding for streambank stabilization is adequate for taking a proactive, rather than reactive approach to managing these issues.	**C**
Tree Planting: From 2002 through 2014, the City's *Streamside Shading Program* resulted in over 2,500 trees and willow plugs being planted along Amazon Creek and its tributaries. In addition to shading, this streamside planting provides important bank stabilization benefits.	• Continue to support the Parks and Open Space Division's *Streamside Shading Program* and fill-in shading gaps identified in the 2014 *Amazon Creek Streamside Shading Assessment*. • Continue to document tree planting in annual TMDL Implementation Report. • Consider expanding the tree planting effort to additional waterways.	**C/F**

5.4 Maintenance and Management

Key findings and potential strategies that are related to waterway maintenance and management are listed in Figure 5-4 below and address the City's ongoing waterway maintenance efforts, potential assistance to private land owners to promote waterway improvements, and establishment of conveyance easements for maintenance access and emergency response. Each row is keyed to indicate the implementation status of the potential strategy using the following codes: **C** = Continue with Current Practices; **P** = Planned; **F** = Future Consideration.

Figure 5-4: Key Finding and Potential Strategies Related to Waterway Maintenance and Management

Key Findings	Potential Strategies	Status
Waterway Maintenance and Management		
Open Waterway Maintenance: The existing *Open Waterway Maintenance Plan*, which guides management practices for publicly maintained waterways, was developed in 2003 and updated in 2008. This document does not include maintenance direction for newly acquired waterways and is overly complex, which limits its usability by field staff.	• Update and streamline the *Open Waterway Maintenance Plan* to improve its usability and to incorporate recently acquired waterways. This work is currently underway, with an expected completion of 2015.	**P**
Assistance to Private Land Owners: Many of the smaller waterways within Eugene's Stormwater Planning Area are in private ownership. Property owners currently have limited incentives or expertise for maintaining or improving these waterways.	• Consider producing outreach and educational materials for private land owners describing best management practices for maintaining and enhancing waterways that pass through their properties. Materials that have already been produced by other entities may be utilized for this purpose if they exist. • Consider developing a program for providing technical assistance to property owners to help them maintain waterways that pass through their properties and identify funding sources to help support restoration, enhancement, and maintenance projects on private lands. • Coordinate with local watershed councils including the Long Tom Watershed Council on the implementation of their *Urban Waters and Wildlife* initiative. Watershed Councils are uniquely positioned to assist businesses, commercial property owners, farmers, and others in taking voluntary actions to make our local waterways more visible, accessible, and functional.	**F**
Conveyance Easements: Lack of conveyance easements currently limits the City's ability to access, maintain, or deal with flooding emergencies on many of the smaller waterways that cross private properties.	• Identify waterways where maintenance access by City staff would be beneficial and develop a process for establishing formal drainage and conveyance easements along those waterway reaches so that City crews are able to better access for evaluation and maintenance. • Continue the current City practice of evaluating, on a case-by-case basis, the transfer of existing maintenance easements held by other agencies (e.g. Junction City Water Control District) for properties containing waterways that are annexed to the City.	**F/C**

5.5 Monitoring, Evaluation, and Assessment

Key findings and potential strategies that are related to monitoring, evaluation, and assessment of the physical conditions of area waterways and collection of baseline data are listed in Figure 5-5 below. Each row is keyed to indicate the implementation status of the potential strategy using the following codes: **C** = Continue with Current Practices; **P** = Planned; **F** = Future Consideration.

Figure 5-5: Key Finding and Potential Strategies Related to Monitoring, Evaluation, and Assessment

Key Findings	Potential Strategies	Status
Monitoring, Evaluation, and Assessment		
Monitoring Physical Conditions: The City's physical conditions monitoring is currently conducted on 12 reaches of Amazon Creek and a single reach of Spring Creek, once every 3 years (see Section 4.2.1 and the *MS4 Permit Stormwater Monitoring Plan, November 2011*).	• Continue regular physical conditions monitoring using the current methodology and consider expanding monitoring sites to include additional City owned/managed waterway reaches (in addition to what is currently required in the *MS4 Permit Stormwater Monitoring Plan*). • Consider adding a more detailed rapid assessment element (to supplement the existing physical monitoring program), which will allow staff to evaluate and record more detailed information on sedimentation and bank and bed stability issues.	**C/F**
Assessment of Headwater Streams: Limited information exists on the current physical conditions of most headwater streams.	• Consider conducting detailed monitoring of representative headwater streams, using a methodology that identifies and tracks physical condition and related issues such as sedimentation, bank erosion, bed erosion, erosion at culvert outfalls, high flow events, and capacity issues.	**F**
Baseline Flow Data: Limited flow data exists for headwater streams, larger waterways, and major stormwater outfalls.	• Evaluate the need for, and potential uses of, flow monitoring data at key points in the stormwater system. Evaluate the feasibility and cost of installing automated flow monitoring equipment at strategic locations. Potential uses of the data include tracking changes in runoff rates in developing areas and calibrating hydraulic models associating with updates to the *Basin Plan*.	**F**

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