City of Eugene

Stormwater Basin Master Plan

Bethel-Danebo Basin

Volume III of VII

CITY OF EUGENE
STORMWATER
MANAGEMENT PROGRAM

August 2002
Prepared by:
City of Eugene
URS Corporation
Lane Council of Governments

Local Stormwater Planning Can Make a World of Difference

Stormwater Basin Master Plan

Volume III of VII

Bethel Danebo Basin

December 2002

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ACKNOWLEDGEMENTS

The Stormwater Basin Master Plan represents the culmination of a long term planning effort by a multi-agency team consisting of representatives from the City of Eugene, Lane Council of Governments (LCOG), and URS Corporation.

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The information published in this report is subject to revision. Please contact the City of Eugene's Engineering Division for potential changes before proceeding with any engineering design that uses the information published herein.

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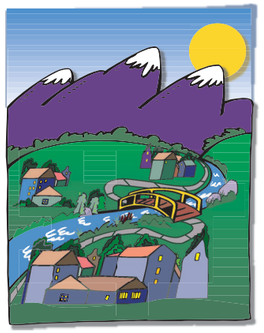
City of Eugene



Vision for a Green Infrastructure

Bethel-Danebo Basin
Stormwater Management Strategy

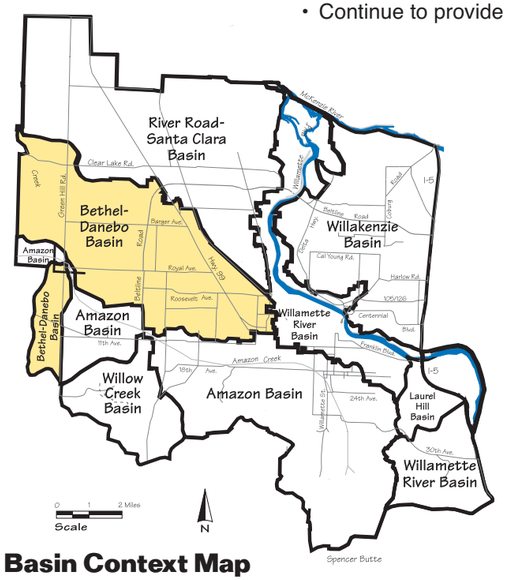
Located in northwest Eugene, the basin is a remnant floodplain of both the Willamette River and Amazon Creek. Abundant rainfall and historic periodic flooding combined with thick clay soils and extremely flat topography resulted in wetland conditions over nearly 90 percent of the basin. Today, most of the basin has been converted to urban uses and is protected from major flood events by a system of regional waterway channels. Most of the remaining vacant lands are designated for residential use and located along the perimeter of the urban growth boundary (UGB). The basin assessment process for this basin revealed:

- Flooding problems are relatively minor under both existing and buildout conditions.
- Untreated stormwater runoff from existing land uses is the primary water quality issue.
- The A3 Channel is designated as "water quality limited" for bacteria and temperature and will be subject to future restrictions by the Department of Environmental Quality.
- Existing waterways, wetlands, and riparian areas will be further impacted by increased runoff volumes, rates, and pollutants.
- Waterway restoration potential exists along most of the waterways.

Strategy

The recommended strategy for this basin is:

- Reduce existing pollutants to the extent feasible through system retrofits, especially in high source areas.
- Minimize future pollutants through on-site development standards.
- Protect waterways through a combination of development standards and other techniques including acquisition.
- Address existing stream bank stabilization problems through capital projects.
- Restore waterways through federal-local partnerships.
- Continue to provide flood protection services basin wide.



Basin Context Map

Bethel-Danebo Basin Facts

- Ranks third among all the basins in total size (9,318 acres).
- Ranks first in the amount of area designated as 100-year floodplain (2,014 acres).
- Ranks second in total length of local open waterways (47 miles) and second in proportion of waterways to basin size.
- Impervious surface area in the UGB is projected to increase from 35% to 50% at buildout.
- Is home to nine plant and animal species listed or being considered for listing as threatened or endangered.
- The A3 Channel is listed by the Oregon Department of Environmental Quality as water quality limited.

August 2002

Comprehensive Plan

Cleaner, Safer, Healthier Environment

Adoption of the ***Comprehensive Stormwater Management Plan*** (CSWMP) in November 1993 ushered in a new vision for managing the City of Eugene's stormwater program. In addition to protecting the community from flooding problems, CSWMP expanded the program to include protection of stormwater quality and related natural resources.

Basin Planning

Bringing CSWMP into Focus

Basin Planning is one of many action items for implementing CSWMP. The basin planning process includes assessing existing conditions, identifying stormwater system problems and opportunities, and recommending management strategies for implementing several CSWMP policies. Each of the City's seven drainage basins offers unique conditions and opportunities for implementing capital projects and development standards. Basin planning, therefore, is a refinement of CSWMP's broader policy direction and represents what is feasible and practical to implement at the stormwater system level.

Other Activities

In addition to Basin Planning, many other city activities are conducted to enhance water quality, protect stormwater-related natural resources, and prevent flooding. A few examples include:

- Erosion control for construction activities
- Education and outreach
- Monitor stormwater discharges of certain industrial uses
- Street sweeping
- Volunteer programs
- Vegetation management

Green Infrastructure

Green Infrastructure uses the beneficial flood control and water quality treatment characteristics of the natural landscapes to help meet stormwater management objectives. When linked with the constructed system, the two work together to form a coordinated drainage system of streams, ponds, streets, and pipes.

Why This Strategy?

Flood Control

- Capital projects are the most cost-effective solutions for correcting existing problems and will be designed to address the incremental effects of new development.

Water Quality

- *Existing Pollution Problem:* Capital projects are the most cost-effective solution for addressing existing conditions, along with other ongoing program activities.
- *Pollution Associated with New Development:* Development standards are most effective for addressing pollutants at their source.

Stormwater-Related Natural Resources

- Capital projects are the most viable method for addressing negative effects of high runoff volumes in open waterways for existing developed areas.
- Stream corridor acquisition can be used to protect a limited number of high-priority waterways.
- Development standards are effective at preventing encroachment into waterways and preserving water quality functions.

More Information

- Visit the City's website at www.ci.eugene.or.us/pw/storm
- Contact Therese Walch at (541) 682-6839

The Management Strategy

Flood Control

Issue: **Some areas do not meet existing drainage system conveyance standards.**

Desired Outcome: Flood protection needs are met basin-wide.

Actions: **Capital Projects – see map**
- Pipe improvements: BD06, BD15
- BD11A – Green Hill Tributary waterway capacity enhancement
- BD100 – Royal Avenue Node infrastructure enhancements

Stormwater-Related Natural Resources

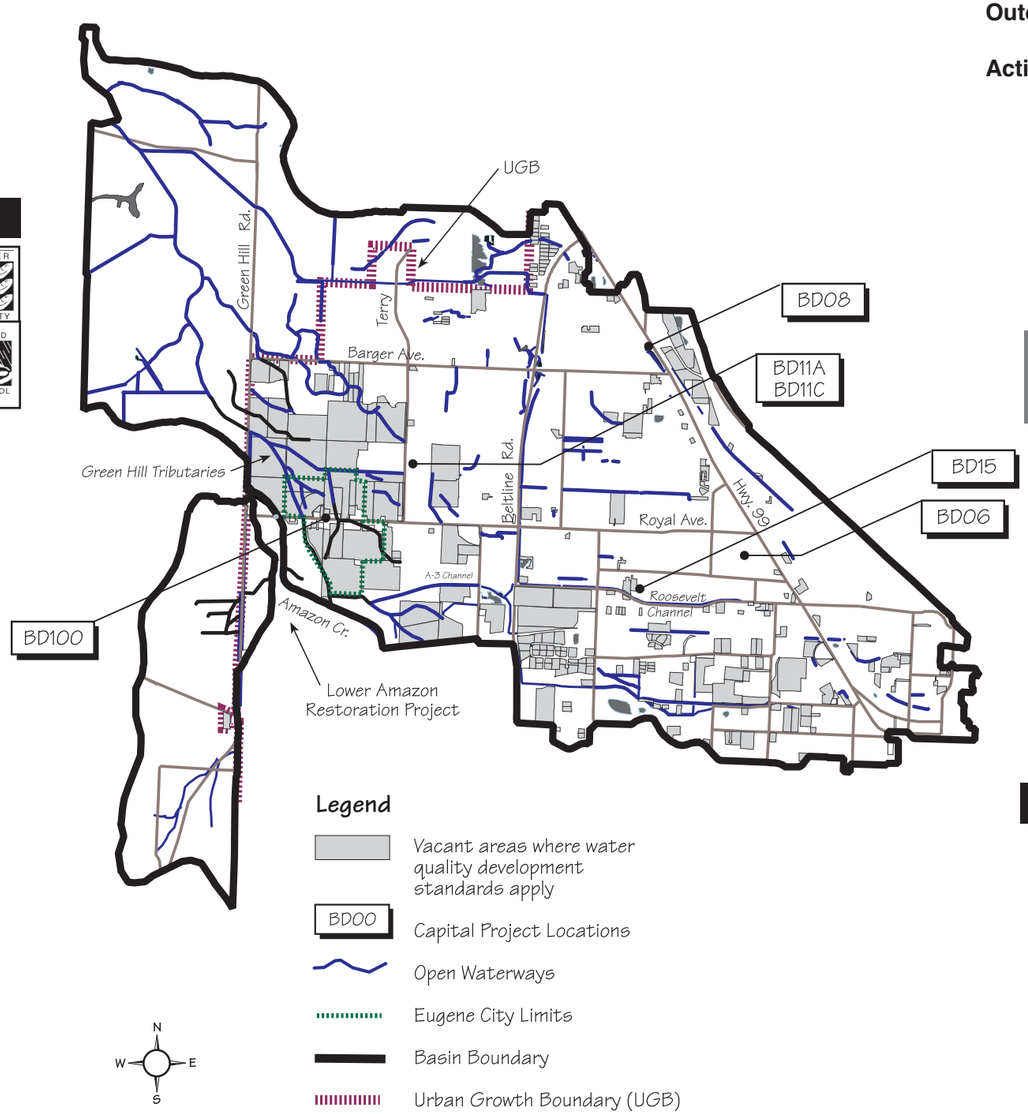
Issue: **Natural resources functions and values are being lost or are degraded due to lack of an overall management and implementation plan.**

Desired Outcome: Maintain and improve the extent and quality of existing stormwater-related natural resources.

Actions: **Capital Projects – see map**
- Yearly budget category – Streambank Stabilization projects.
- Ongoing: Restore waterways through federal-local partnerships (to be identified).

Development Standards – see map
- Prohibit filling/piping of important storm waterways.
- Require streamside setbacks.

Acquisition
- Acquire stream corridors according to the *City's Stream Corridor Acquisition Study.*



Water Quality

Issue: **Runoff from existing development is a major source of pollutants.**

Desired Outcome: Pollutants from existing land uses are reduced.

Actions: **Capital Projects – see map**
- BD08 – Retrofit Empire Pond for water quality enhancement effectiveness.
- BD11C – Green Hill Tributary water quality facility.
- Yearly Budget Item – water quality facilities in high source areas.
- Yearly Budget Category – retrofit tip-ups.
- Yearly Budget Category – outfall stabilization.

Issue: **Runoff from future development will increase pollutant discharges.**

Desired Outcomes: Reduce stormwater pollution from new development.

Actions: **Development Standards – see map**
- New and significant redevelopment projects are required to treat all runoff from City's water quality design standard.
- Incentives – provide incentives for existing development to reduce effective impervious surface areas and treat stormwater runoff.

Other Elements of the Strategy

- General Stormwater Rehabilitation Projects.
- Channel Easement Acquisition.

CITY OF EUGENE STORMWATER MANAGEMENT PROGRAM

SECTION 1 Introduction

Adoption of the City of Eugene's *Comprehensive Stormwater Management Plan* (CSWMP) in November 1993 marked a significant shift in the City's approach to stormwater management. In addition to drainage and flood control services, the stormwater program was expanded to include the protection and enhancement of stormwater quality and related natural resources. Since the previous *Storm Drainage Master Plan* (OTAK, 1990) was developed solely for the purpose of addressing drainage and flood control issues, an update of that Plan was necessary to bring it into compliance with current City policy. As a result, the City initiated a project to develop multiple-objective Stormwater Basin Master Plans.

In addition to CSWMP, other locally adopted policy documents were reviewed for applicability to the Basin Master Planning effort. The following were identified for containing policies related to and supportive of protection of water quality and related natural resources:

1) Eugene/Springfield Metro Area General Plan (1987 Update) in general and, specifically, the following refinement plans:

   - Bethel-Danebo, 1982
   - Eugene Downtown Plan, 1984
   - Eugene Parks and Recreation Plan, 1989
   - Jefferson/Far West, 1983
   - Public Facilities and Services Plan, December 2001
   - Laurel Hill, 1982
   - Riverfront Park Study, 1985
   - River Road-Santa Clara Urban Facilities Plan, 1985
   - South Hills Study, 1974
   - Willakenzie Neighborhood, 1991
   - Willow Creek, 1982

2) Eugene Growth Management Study, 1998

The overall goal of the Stormwater Basin Master Plans was to provide a stormwater management strategy for each basin that proactively addresses the multiple objectives of CSWMP. In addition to flood control, these multiple objectives include:

- Protect and improve water quality.
- Protect natural resources that provide beneficial stormwater functions.
- Use best management practices that promote a green infrastructure.
- Address the unique qualities of each drainage basin.
- Meet federal, state, and local laws and policies (including CSWMP, the Clean Water Act, the Endangered Species Act, and State Underground Injection Control Rules – for these broader topics and other issues, please refer to Volume I).
- Complement other existing BMPs that are part of the City's stormwater program.
- Balance responsibilities community-wide.
- Provide a dynamic and flexible program that can be refined based on a changing regulatory climate.

SECTION 1 Introduction

This report presents the integrated stormwater management strategy (integrated strategy) for the Bethel-Danebo basin. It represents Volume III of a seven volume report generated to summarize and document the city-wide Stormwater Basin Master Plans. Volume I provides an overview of the project, describes the process for developing integrated strategies, and summarizes the information that is presented in detail in the six companion volumes, each of which covers one of the following City's six drainage basins: *Volume II - Amazon Creek, Volume III - Bethel-Danebo, Volume IV – Laurel Hill, Volume V - Willakenzie, Volume VI - Willamette River, Volume VII - Willow Creek.* Volumes II through VII provide more detailed information regarding development of stormwater management strategies for each of the six basins including: characteristics unique to the basin; results of the basin evaluation for flood control, water quality and natural resources; and resulting integrated stormwater management strategies. A basin specific plan was not produced for River Road Santa Clara, pending resolution of inter-jurisdictional issues as well as additional information gathering and analysis.

NOTE: 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. The basin areas as defined in this plan are also further divided into major subbasins and subbasins as described in Section 3.0.

The process conducted to develop integrated strategies for each of the six basins included the following thirteen steps. The details regarding each of these steps are provided in Volume I.

Step 1) Compile information regarding the unique characteristics of each basin that are related to the stormwater drainage system.
Step 2) Identify problems and opportunities associated with the stormwater drainage system with respect to flood control, water quality, natural resources, and maintenance.
Step 3) Develop potential solutions in the form of capital projects and development standards for addressing identified problems.
Step 4) Evaluate and compare potential solutions in terms of feasibility, costs, and effectiveness.
Step 5) Evaluate capital projects to address problems expected under existing conditions.
Step 6) Evaluate capital projects and development standards to address problems expected as a result of future build-out.
Step 7) Select an integrated stormwater management strategy based on the evaluations conducted in steps 5 and 6.
Step 8) Develop a maintenance strategy for the proposed solutions.
Step 9) Obtain feedback regarding integrated stormwater management strategies and the maintenance strategy from the public and refine the strategies as appropriate.
Step 10) Prioritize selected capital projects for implementation and conduct a financial analysis.

Step 11) Develop stormwater basin master plans to summarize the integrated stormwater management strategies including proposed capital projects and development standards.
Step 12) Develop an ordinance to implement the proposed development standards.
Step 13) Develop a best management practices manual to help guide developers in meeting the requirements of the development standards.

The process for conducting these steps is outlined in Figure 1-1. As a result of this process, a mix of capital projects and development standards was proposed for each of the basins. A total of 44 multiple-objective capital projects were selected for the integrated stormwater management strategies city-wide (not including the Santa Clara/River Road basin). Six of these are located in the Bethel-Danebo basin. In addition, development standards were selected for treating the quality of runoff from new development and for protecting open waterways. These standards were proposed city-wide and therefore would apply to the Bethel-Danebo basin when enacted. A development standard was adopted in April 2000 (Open Waterways Ordinance) that prohibited waterways from being filled and/or piped. The ordinance was subsequently appealed and remanded back to the City by the Oregon Court of Appeals (July 2001) and is no longer in effect. Additional methods and options for protecting open waterways are under review. In the meantime, waterway protection efforts will include stream corridor acquisitions and land use approval criteria where applicable.

Information updates related to this plan are provided at the end of this section. The integrated basin strategy specific to the Bethel-Danebo basin is described in the following sections. Section 2.0 provides a summary of the specific characteristics in the Bethel-Danebo basin. Sections 3.0, 4.0, and 5.0 provide summaries of the flood control, water quality, and natural resources evaluations respectively. Section 6.0 describes the resulting integrated basin strategy and provides information regarding the implementation of the strategy including scheduling and financing.

Information Updates

The information contained in this document represents a "snapshot-in-time." The Study Area Characteristics data (Section 2) are current through 1998, and the evaluation data (Sections 3, 4, 5, 6) are current through June, 2001. As conditions in this basin change, the information in this document will need to be updated to reflect those conditions.

The following recent or imminent changes to conditions, information, or the integrated basin strategy are not reflected in this document, but will be addressed in the next update:

- Subbasins BDGH-010, BDGH-020, BDGH-030, and BDGH-040 were refined since the time the models were completed as part of the design process for the conveyance system shown along Barger Drive. The hydrologic model results in Table3-2 reflect the old subbasin delineations. The map (Figure 3-3) reflects the updated subbasin delineations where these subbasins were further delineated into subbasins BDGH-010, BDGH-015, BDGH-020, BDGH-025, BDGH-030, BDGH-035, BDGH-040, and BDGH-045. Updated hydrologic information is available by contacting the City of Eugene Public Works Department Engineering Division.

- Since the modeling work was completed for this plan, additional field survey work was conducted for the pipe system along Bell Ave. The updated field survey information resulted in changes to the model. The model has been rerun to reflect the changes and the changes are incorporated in the model output in Tables 3-1 and 3-2. However, as of the date of this master plan report, the original capital project for this location (BD06) has not been updated to reflect the changes. A capital project fact sheet has been included for BD06 in this document as a place holder and for background information only.
- Model results indicated a need for a flood control capital project in the Greenhill Tributary area. Two capital projects were proposed for this area; one for flood control and one for water quality. These proposed capital projects are described in capital project fact sheets BD11A and BD11C. As these were high priority projects, the City has taken the preliminary designs from these fact sheets and is moving towards final designs. The work that has been done to finalize the designs has resulted in changes to the projects that are not yet reflected in this master plan report.
- Metro Plan and Eugene Land Use Plan amendments related to the Royal node development in the Bethel Danebo stormwater basin are scheduled for adoption in early 2003. Nodal development is a type of compact development that emphasizes higher densities, mixed-land uses, a pedestrian scale, choice of transportation modes, neighborhood cohesiveness and convenience, and livability *(Royal Avenue Specific Plan, January 2002*). Implementation of the Royal node presents significant opportunity to incorporate green infrastructure concepts into the design of the stormwater system within the node. In planning for stormwater infrastructure within the Royal node, refinements have been made to the stormwater model which are not reflected in this master plan, but are available upon request by contacting the City of Eugene Public Works Department Engineering Division.
- The narrative description of existing and future parks and schools in subsections 2.10.1 and 2.10.2 has been updated to the time of printing of this document. Map 12 (Section 2), Parks, Recreation, and Educational Facilities, has not been updated to match. Map 12 changes will be included in the next document update.
- Eugene is participating in a Metropolitan Waterways Restoration project with the Army Corps of Engineers and other metro partners under authority of the Water Resources Development Act. This Study will further define and prioritize needs for waterway restoration throughout the metro area including waterways in the Bethel Danebo basin, and will allow the City to partner with, and cost share with, the Corps and other agencies to optimize the use of local funds for stream restoration. The first phase of this study, the Reconnaissance Phase, was initiated in February 2002. The second phase, Feasibility, is expected to begin in spring 2003. Implementation of on-the-ground projects is anticipated by 2007.
- Relationship to and compliance with the State of Oregon's Underground Injection Well requirements.
- Relationship to Eugene's ESA/Salmon response strategy.
- Updates to rare plant and animal species inventories through the Oregon Natural Heritage Program data base.

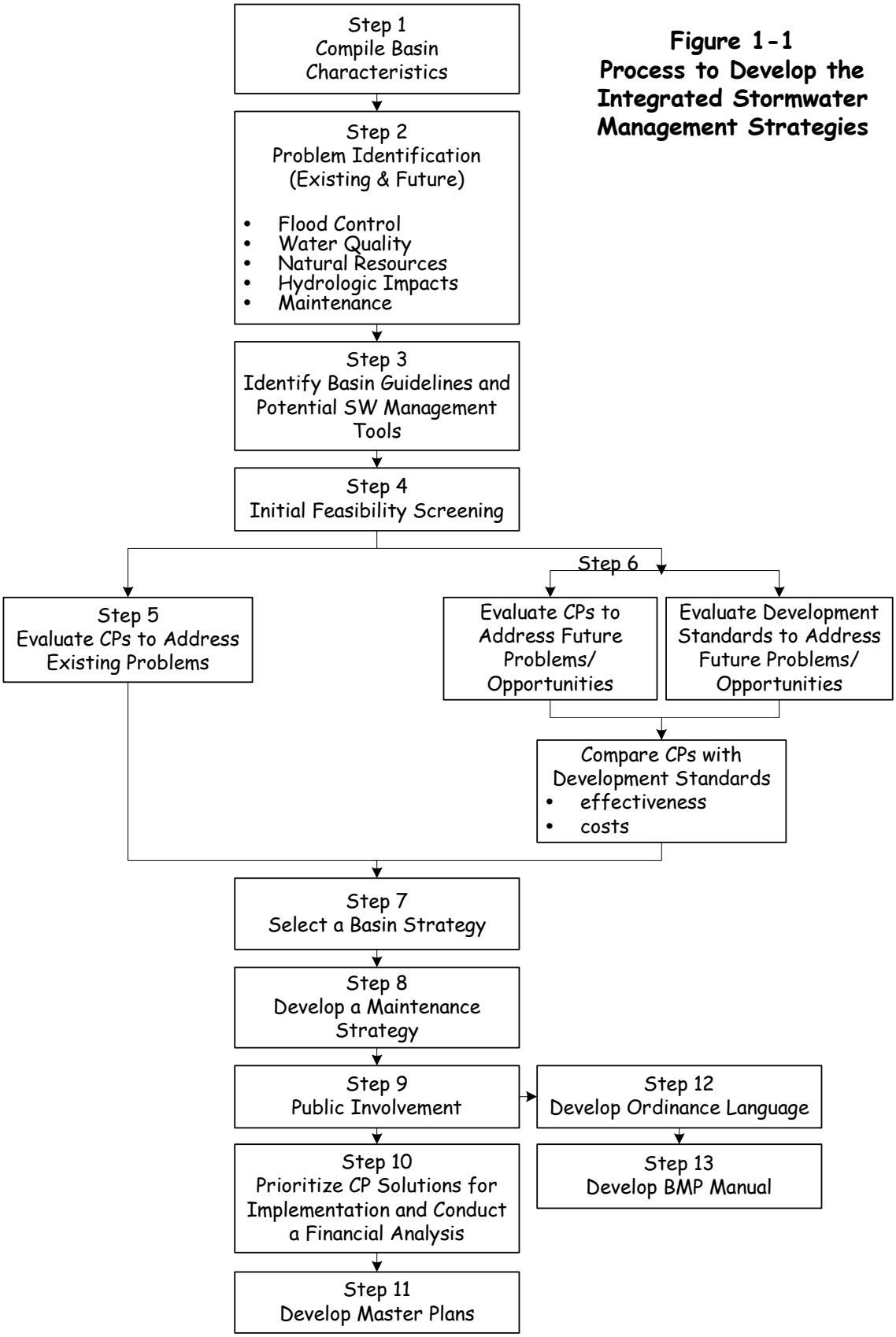


Figure 1-1
Process to Develop the Integrated Stormwater Management Strategies

SECTION 2 Study Area Characteristics

This section provides background information regarding the existing physical characteristics of the Bethel-Danebo basin. This information was used to assess opportunities and constraints for meeting the multiple-objective goals of the Stormwater Basin Master Plans. Specifically this section includes the following information for the basin: location and area; climate; land use and surface cover; land form; topography and slopes; surface water features and drainage system; water quality; rare, threatened and endangered plants, animals and communities; soils; groundwater; and recreational and educational facilities.

2.1 Location and Area

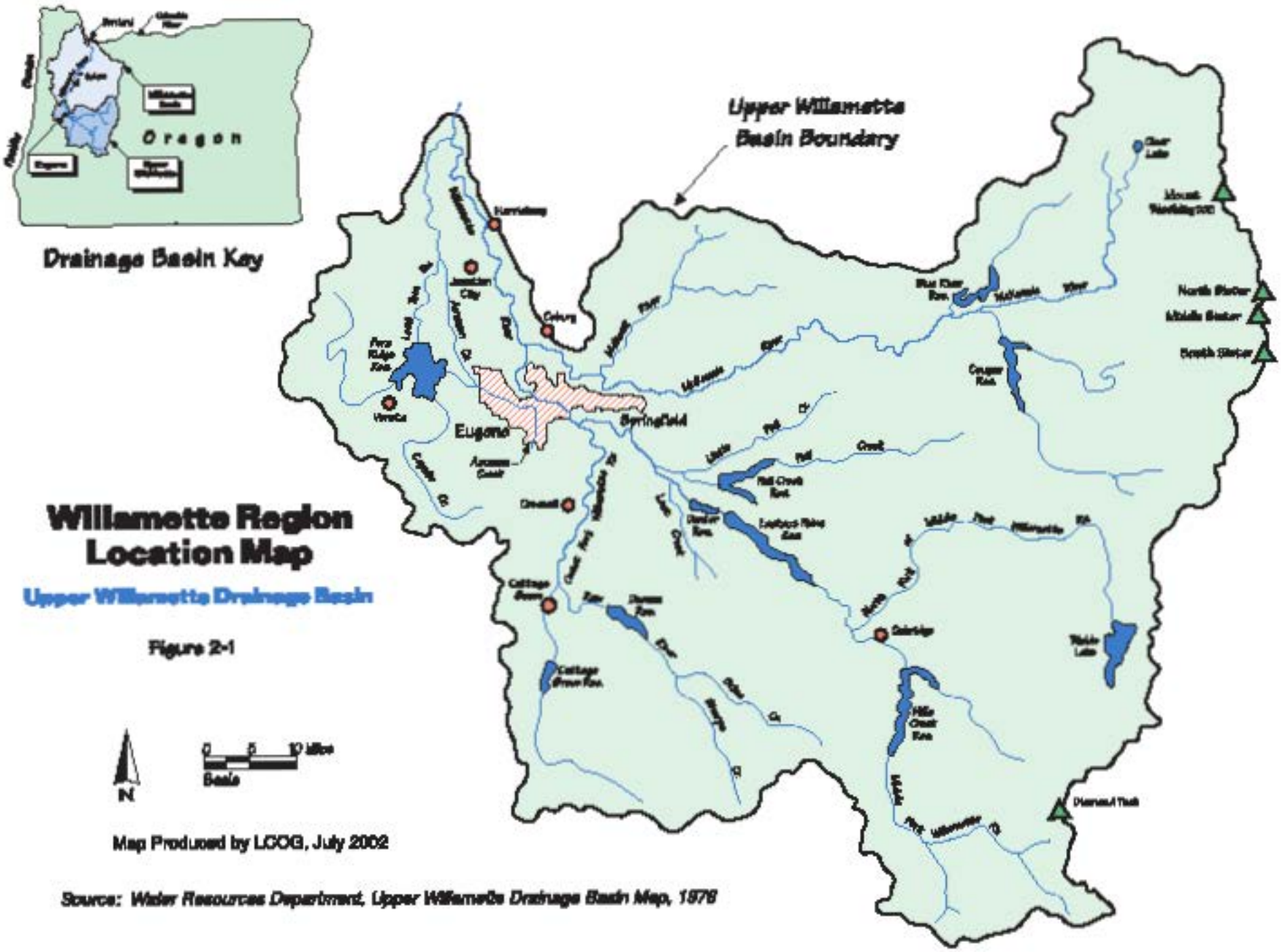
2.1.1 Regional Drainage Context

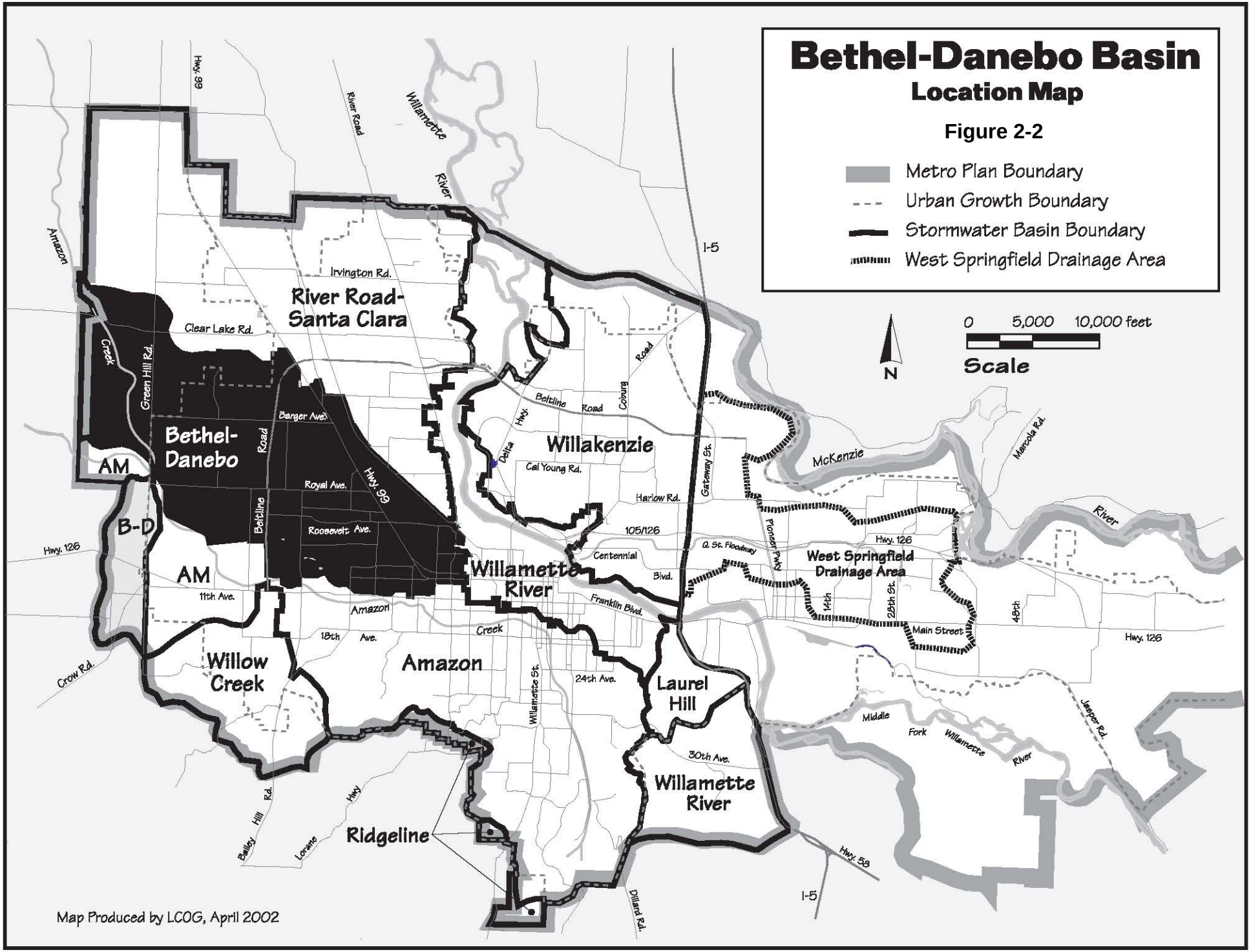
Eugene is located in the western third of the Upper Willamette Drainage Basin as shown on Figure 2-1. Drainage in the southern Willamette Valley is a combination of natural and built systems that have evolved over time. The natural system is composed of rivers, waterways, and a series of interconnected ponds and wetlands. Historically, the natural system had an extensive floodplain that typically experienced over-bank flooding every 1-2 years. The built drainage system includes a series of dams, pipes, and waterways that were built to contain over-bank flooding, and to retain water for recreational and irrigation 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, Coyote Creek, and the Long Tom River. From 1940 to 1960, the U.S. Army Corps of Engineers built nine 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. Runoff from Cottage Grove, Creswell, and South Springfield flows through Eugene via the Willamette River. Approximately 4,800 acres of west Springfield's drainage area, as shown on Figure 2-2, discharges urban runoff into the Q Street Floodway, which is within Eugene's public drainage system. Eugene public drainage system refers to the system of stormwater facilities (i.e., pipes, ditches, open waterways) that Eugene is responsible for operating and maintaining.

2.1.2 City of Eugene

The City of Eugene is currently responsible for managing the stormwater quantity, quality, and related natural resources for the drainage area within its city limits. The area outside of the City limits but within the urban growth boundary (UGB) is expected to be annexed into the city as urban development occurs. Therefore, this Stormwater Basin Master Plan includes both the current city limits and the area within the UGB. The *Eugene-Springfield Metro Area General Plan (Metro Plan)* boundary covers the city limits, the UGB and, in some cases, areas beyond the UGB. For the purposes of characterizing the study area in this chapter, the area covered includes the *Metro Plan* boundary.


Oregon
Drainage Basin Key
Upper Willamette
Basin Boundary
Eugene
Springfield
Coburg
Harrisburg
Junction City
Veneta
Cottage Grove
Dexter
Lowell
Oakridge
Blue River
McKenzie River
Cougar
North Sister
Middle Sister
South Sister
Mount Washington
Diamond Peak
Willamette Region
Location Map
Upper Willamette Drainage Basin
Figure 2-1
N
0 5 10 Miles
Scale
Map Produced by LCOG, July 2002
Source: Water Resources Department, Upper Willamette Drainage Basin Map, 1976


Bethel-Danebo Basin
Location Map
Figure 2-2
Metro Plan Boundary
Urban Growth Boundary
Stormwater Basin Boundary
West Springfield Drainage Area
N
0 5,000 10,000 feet
Scale
River Road-Santa Clara
Willakenzie
Bethel-Danebo
AM
B-D
AM
Willamette River
West Springfield Drainage Area
Willow Creek
Amazon
Laurel Hill
Willamette River
Ridgeline
Hwy. 99
River Road
Willamette River
I-5
Irvington Rd.
Clear Lake Rd.
Green Hill Rd.
Barger Ave.
Royal Ave.
Roosevelt Ave.
Beltline Road
Coburg Road
Hwy. 99
Delta Hwy.
Cal Young Rd.
Harlow Rd.
105/126
Centennial Blvd.
Gateway St.
McKenzie River
Marcola Rd.
Hwy. 126
Q St. Floodway
Florence Pwy
14th
28th St.
48th
Main Street
Franklin Blvd.
Amazon Creek
18th Ave.
11th Ave.
Willamette St.
24th Ave.
30th Ave.
Middle Fork Willamette River
Jasper Rd.
Hwy. 58
Dillard Rd.
Crow Rd.
Bailey Hill Rd.
Lorane Hwy
Map Produced by LCOG, April 2002

2.1.3 Bethel-Danebo Basin

As shown on Figure 2-2, the Bethel-Danebo drainage basin is located between the Amazon Creek Basin (south) and the River Road-Santa Clara Basin (north) and is bounded by the Willamette River at its southeast corner and the *Metro Plan* boundary along its west boundary. With a total area of approximately 9,318 acres, about two-thirds (6,175 acres) is located within the Eugene UGB. The remainder of the basin (3,143 acres) is outside the UGB, and of this area, approximately 880 acres are designated "Urban Reserve" on the *Metro Plan* diagram. The portion outside the UGB is primarily designated for use as agriculture/airport reserve, forest, government/education, parks and open space, and rural residential.

2.2 Climate

The climate in the study area is primarily affected by humid air masses from the west and south, and infrequent influxes of cold, continental air masses from the east. As a result, the year-round climate in Eugene is moderate with relatively cool, wet winters, and warm, dry summers. Average minimum winter temperatures are in the mid-30s with extremes seldom dropping below 10 degrees Fahrenheit (-12.2 Celsius). Average maximum summer temperatures are in the low 80's (26.7 to 28.9 Celsius) with extremes seldom exceeding 100 degrees Fahrenheit (37.8 Celsius). Snowfall constitutes only 2 percent of the annual precipitation in Eugene. Winter snow does not accumulate; however, quick snow melt can contribute to flooding problems throughout the Eugene area.

The National Weather Service records rainfall information at the Mahlon Sweet Airport in Eugene. Average annual precipitation is approximately 46 inches with 86 percent occurring from October to May. Figure 2-3 presents the average monthly rainfall distribution based on the airport's 48-year rainfall record from 1949-1987.

Figure 2-3
Average Monthly Rainfall

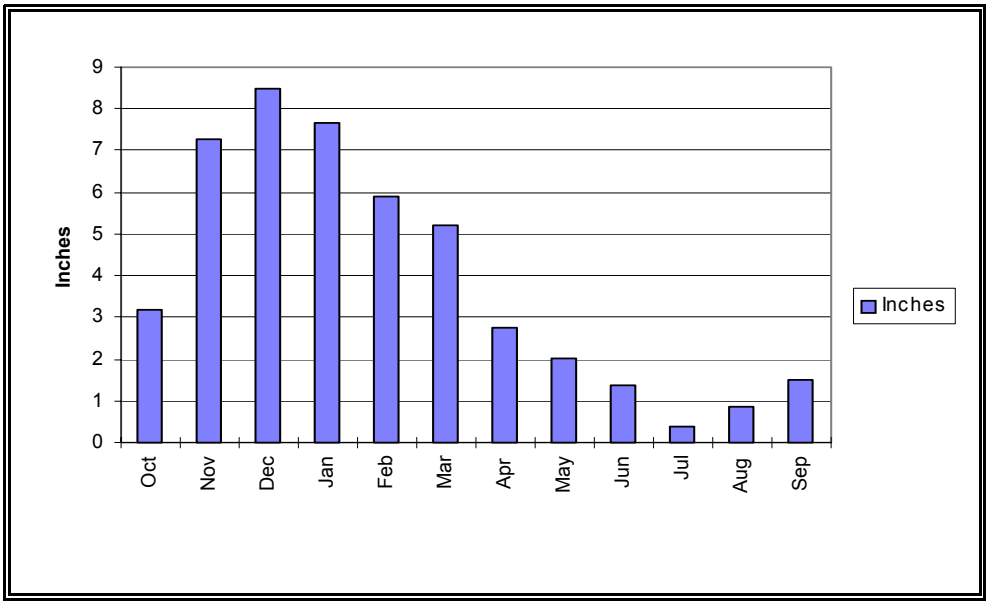


Table 2-1 characterizes a typical storm event for the Eugene area based on the historic 48-year precipitation record measured at the Eugene Airport:

Table 2-1
Average Storm Event

Storm Event Parameter	Average
Volume	0.67 inches
Duration	16.9 hours
Intensity	0.042 inches per hour

Since 1992, rainfall information has been recorded at six rain-gage stations within the Eugene city limits. Comparison of those data with the National Weather Service's Eugene Airport data indicates a significant difference between the two, with the airport data approximately 30 percent higher. For additional information regarding this issue, see Appendix H of Volume I.

Historically, performance of the City's drainage system has been very good. For example, the City's system handled the February 1996 storm event with very few problems even though this event caused widespread flooding in the Willamette River Valley.

2.3 Land Use and Surface Cover

The conversion from undisturbed to developed land uses can significantly affect the quantity and quality of stormwater runoff. Runoff volumes and velocities increase as impervious surface areas increase. Likewise, stormwater quality decreases due to nonpoint source pollution from highways and urban land uses such as commercial, industrial, and residential. The purpose of this section is to describe existing land use and impervious surface conditions within the basin and to forecast changes in these conditions due to buildout of remaining vacant lands according to *Metro Plan* designations. Existing land use data presented in Map 1 are current to November 1998. Buildout data presented in Map 2 are based on current *Metro Plan* designations. See maps at the end of Section 2.

2.3.1 Existing Land Use

As shown in Table 2-2, the current predominant urban land use in the basin is low-density residential (1,900 acres), which covers approximately 20 percent of the total basin area. Approximately 43% (4,007 acres) of the basin is undeveloped or in forest or agriculture use and the majority of it is located outside of the UGB, west of Terry Street and north of Royal Avenue.

This basin also contains significant amounts of commercial (505 acres) and industrial (650 acres) uses. Almost all of the commercial and industrial development can be found in the southeast portion of the basin. Another significant urban land use in the basin is railroad (248 acres) which is primarily contained within the Southern Pacific Rail Yards along the eastern edge of the basin. Less than 1 percent of the basin is now in high-density residential use. Roads and highways currently encompass an additional 12 percent (1,075 acres) of the basin's total area. Park and recreational uses, which consist almost entirely of lands recently acquired for wetland protection under the *West Eugene Wetlands Plan*, cover 6 percent of the basin's area (550 acres).

Table 2-2
Existing Land Use – Bethel-Danebo Basin

Land Use Categories	Acres	Percent of Area
Inside UGB		
Low-Med. Density Residential	1,659	18%
High Density Residential	44	0.5%
Commercial	484	5%
Industrial	507	5.4%
Communication and Utilities	10	0.1%
Parks, Open Space, and Recreation	399	4%
Railroads	242	3%
Schools, Churches, Cemeteries	171	2%
Other Government	106	1%
Agriculture	749	8%
Other Undeveloped Land	844	9%
Streets (R.O.W.)	960	10%
Subtotal	6,175	66%
Outside UGB (In Urban Reserve)		
Low-Med. Density Residential	66	0.7%
Commercial	20	0.2%
Parks, Open Space, & Recreation	151	1.6%
Other Government	6	0.1%
Agriculture	346	3.7%
Timber/Forest	17	0.2%
Other Undeveloped Land	219	2.6%
Streets (R.O.W.)	55	0.6%
Subtotal	880	9.7%
Outside UGB/Urban Reserve)		
Low-Med. Density Residential	174	1.9%
Commercial	1	0%
Industrial	143	1.5%
Communication and Utilities	1	0.5%
Other Government	46	0.5%
Agriculture	1,491	16%
Railroads	6	0.1%
Other Undeveloped Land	341	3.7%
Streets (R.O.W.)	61	0.6%
Subtotal	2,263	24.3%
Grand Total	9,318	100%

Source: LCOG GIS Parcel File 1998.

2.3.2 Buildout Land Use

The primary land use policies covering Bethel-Danebo Basin are contained in the following locally adopted policy documents:

- Eugene-Springfield *Metro Area General Plan* (1987).
- *Bethel-Danebo Refinement Plan* (1982).

- *West Eugene Wetlands Plan* (2000 as amended). Lane County zoning applies to areas outside the UGB and City Codes apply within the UGB. Table 2-3 summarizes the buildout land use for use for the Bethel-Danebo basin.

2.3.2.1 Buildout Land Use Within the UGB

This area includes both the current city limits and the unincorporated UGB. Approximately 66 percent (6,175 acres) of the land in the basin is currently within the UGB. Of this, 1,593 acres are vacant. For the purposes of this plan, the term "vacant acres" refers to lands within the UGB that are expected to develop to urban uses. As shown in Table 2-3, the most significant category of new development will be low-density residential (849 acres), followed by industrial (525 acres) and medium-density residential (105 acres). Approximately 53 acres of new roads will be needed in the basin to serve this projected development.

2.3.2.2 Buildout Land Use Outside the UGB

Thirty-four percent (3,143 acres) of the Bethel-Danebo basin lies outside the UGB. The majority of this land will remain in agriculture use based on current plan designation. Areas outside the UGB are not permitted to develop to urban uses and, therefore, "vacant" acres in the context of urban development does not apply here.

Approximately 880 acres in this area is designated in the *Metro Plan* as "Urban Reserve" which indicates areas where future UGB expansions may likely occur. The "Urban Reserve" designation is contained entirely in the area to the south of the Amazon Diversion Channel and west of Green Hill Road. Recent policy decision by the three Eugene-Springfield metropolitan jurisdictions will result in the removal of this designation as this areas does not meet the State of Oregon's current criteria for such designation.

Table 2-3
Buildout Land Use

Generalized Plan Designation	Designated Acres	
	Total	Vacant* (1998) for future Urban Development
Inside UGB		
Low-Density Residential	2,612	849
Medium-Density Residential	155	105
High-Density Residential and Mixed	18	18
Commercial and Commercial-Residential Mixed	241	43
Industrial and Commercial-Industrial Mixed	1,576	525
Natural Resource, Parks, Open Space	366	-
Government and Education	59	-
Agriculture and Agriculture/Airport Reserve	4	0
Streets (R.O.W.)**	1,144	53
Subtotal	6,175	1,593
Outside UGB		
Rural Residential	73	**0**
Commercial and Commercial-Residential Mixed	1	**0**
Natural Resource, Parks, Open Space	165	**0**
Agriculture and Agriculture/Airport Reserve	340	**0**
Forest	238	**0**
Streets (R.O.W.)**	63	**0**
Subtotal	880	**0**
Outside UGB/Urban Reserve		
Rural Residential	30	**0**
Low-Density Residential	1	**0**
Commercial & Res/Com Mixed	10	**0**
Government and Education	135	**0**
Parks and Open Space	1	**0**
Agriculture & Ag/Airport Reserve	2,024	**0**
Streets (R.O.W)**	62	**0**
Subtotal	2,263	**0**
Grand Total	**9,318**	**1,593**

Source: LCOG and City of Eugene Geographic Information System, 1998

*For purposes of this report, vacant acres apply to lands within the urban growth boundary.

***Notes*: *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 percent of the land area was put into the Streets (Right of Way) category to account for streets that will serve future designated development.*

2.3.3 Surface Cover

Other than precipitation, surface cover is perhaps the single most influential factor that affects the volume, quality, and velocity of stormwater runoff and the ability to treat runoff through filtration and other natural processes. Pervious surfaces are undisturbed natural areas that retain

native prairie or forest vegetation or lands in developed areas that are typically covered with lawn, agricultural fields, or pasture. In both cases, water is free to infiltrate into the ground. Undisturbed natural areas provide significant beneficial stormwater functions. They help reduce the volume and velocity of runoff by facilitating infiltration of precipitation into the ground. Stormwater quality is best in undisturbed natural areas. The vegetative cover associated with undisturbed natural areas is also important for stabilizing steep slopes and streambanks. Pervious surfaces in developed areas also provide stormwater benefits, although to a lesser degree than undisturbed natural areas. The infiltration capacity may be reduced during conversion to urban lawns and agricultural crops. Stormwater quality may also be impacted by lawn care and agricultural practices.

In contrast, impervious surfaces are lands covered by hard surfaces such as rooftops, roads, and parking lots and allow little or no infiltration of water. 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. The transition from undisturbed to developed land uses and densities involves a significant change from pervious to impervious surfaces. As a consequence, adequate facilities must be planned, constructed, and maintained to minimize drainage and flood problems and impacts to water quality and natural resources.

The purpose of this section is to describe surface cover conditions as they exist in 1998 and as they are projected to exist at buildout of the Bethel-Danebo basin urban growth boundary (UGB).

2.3.3.1 Impervious Surfaces

Total impervious surface area for the study area was calculated using a set of impervious surface area factors (ISAF) that were applied to the existing and buildout 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 ISAFs used are provided in Volume I. These factors were derived 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 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 ISAFs for land use categories that were not previously digitized were derived through review of national standards and by calculating the impervious surface area on sample sites.

The amount of existing impervious surface area in the UGB portion of the Bethel-Danebo basin is estimated to be 2,186 acres or 35 percent of the basin's UGB area. [Note: calculations for these data are available from the City of Eugene.] The majority of this impervious surface is found in the eastern two-thirds of the basin, where most of the development has occurred and relatively little vacant land remains. Map 3 depicts the existing generalized impervious surface area in pink. Due to the map scale and data restrictions, developed lots are shown entirely in

pink. These pink areas are a mix of impervious surface and pervious surfaces associated with the land use such as lawns, streetscapes, parking lot planting, and other landscaped areas.

Assuming that future growth in the basin will follow conventional stormwater drainage practices and will develop according to the land use categories depicted on the Eugene-Springfield Metro Plan designations (see Map 2), the amount of impervious acres in the UGB portion of the basin is projected to increase to 3,060 acres, or 50 percent of the basin's UGB area at buildout. [Note: calculations for these data are available from the City of Eugene.]

2.3.3.2 Pervious Surfaces

The majority of the remaining large blocks of pervious surface area in this basin are located west of Terry Street and north of the Southern Pacific Railroad tracks, and are predominantly agricultural use or wetland conditions. The remaining pervious surface is in the form of lawns and landscaped areas associated with developed land uses, parks, and small vacant lots.

Overall, pervious area cover is expected to decrease from the current 65 percent of the UGB portion of the basin (4,014 acres) to 50 percent at UGB buildout. For the purposes of this report, pervious surface areas were identified and grouped into *Forest Cover*, *Landscaping*, and *Other Vegetated Areas* (refer to Figure 2-4) for the following reasons:

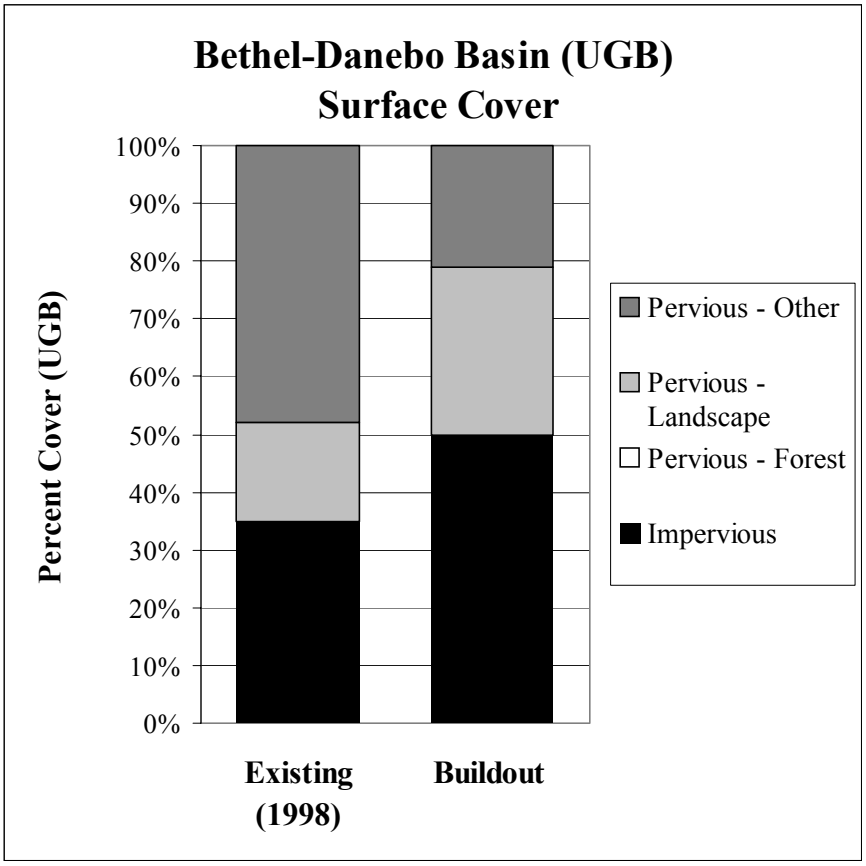
- Forest Cover is highly effective in reducing runoff volumes, and in preventing erosion (e.g., reduces soil impact by slowing down the velocity of precipitation and by intercepting up to 35 percent of it before hitting the ground) and stabilizing steep slopes (established root zones). Areas were included in this category if the forested area exceeded one acre in size. Only 3 percent of the Bethel-Danebo basin is currently in forest cover which is located outside the UGB.

- 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 and is included in the area shaded pink on Map 3. Positive impacts include protection of surface soils, filtration of sediments, and some infiltration (although this is reduced from pre-development conditions). The use of chemical fertilizers, pesticides, and herbicides can cause negative impacts to water quality. The amount of landscaped area in the UGB is projected to increase from the existing 17 percent to 29 percent at UGB buildout.

- Other Vegetated Areas are pervious surfaces not in *forest cover* or *landscaping* use, such as agricultural fields, pasture, vacant lots, prairie wetlands, 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 can be significant contributors of pollutants in this category due to the use of chemical fertilizers, pesticides, herbicides, and fecal coliform due to grazing. This category is expected to decrease from 48 percent of the UGB 21 percent at UGB buildout.

Figure 2-4 compares the percentage of existing and projected surface cover for the UGB portion of the Bethel-Danebo basin.

Figure 2-4
Surface Cover in the Bethel-Danebo Basin UGB



2.4 Landform, Topography, Slopes

The Bethel-Danebo basin drains the west-central portion of the *Metro Plan* Study Area (see Map 4). The basin is essentially flat with only 4 percent of the basin having slopes greater than 10 percent and almost all of this is in the isolated section of the basin along Green Hill Road. Less than 1 percent of the basin has slopes greater than 25 percent which is located outside the UGB and will not likely be developed as urban use.

With the absence of slope in most of the basin, stormwater is likely to pond if soil conditions are such that the water accumulates faster than it can infiltrate into the soil. Curbs, gutters, and pipes have typically been constructed to collect and move the water off site. See Map 4.

Table 2-4
Bethel-Danebo Basin Slope Distribution

Location	Slope Distribution (percent)				
	Slopes 0-5%	Slopes 6-10%	Slopes 11-15%	Slopes 16-25%	Slopes >25%
Within UGB	99%	0%	0%	0%	0%
Outside UGB	84%	4%	4%	6%	2%
Total Basin	94%	2%	1%	2%	1%

2.5 Surface Water Features and Drainage System

This section describes the existing drainage features of the basin including the City's stormwater facilities, open waterways, and wetlands. Refer to Map 5.

2.5.1 Waterways

Pre-settlement (prior to 1855) morphological conditions in the Willamette Valley reflected a network of shallow, broad swales that would often overflow during storm events creating ponded conditions. Today, most of the drainages 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 small storm events. Also, as development has occurred, open channels have in many instances been replaced by a piped system. Stormwater conveyance in the Bethel-Danebo basin is through a combination of open channels and a piped system. In this basin there are still many open channels, although most of them are either human created or significantly altered from historical conditions.

There are about 48 miles of open channels in the Bethel-Danebo basin, compared to 55 miles of drainage pipe. About 65 percent of the open channels are within the UGB. Most of the intact (unfragmented) open channels are within the western portion of the basin both inside and outside of the UGB. Seven primary channels are within the basin, including: Amazon Creek, A-2 Channel, West Beltline Floodway, Marshall Channel, A-3 Channel, Roosevelt Channel, and Green Hill Tributary.

2.5.1.1 Amazon Creek (A Channel)

The major collector for the basin's drainage is Amazon Creek, also referred to as A Channel. The creek enters the basin from the south at the point where the Amazon Diversion Channel carries off a portion of Eugene's drainage to the Fern Ridge Reservoir. Water that is not diverted follows the original creek course through the western section of the basin receiving additional flow from the A-3 channel, the Green Hill Tributary, Marshall Ditch, and the A-2 Channel along the way. Various smaller drainage channels also contribute water to Amazon Creek whether they intersect Amazon Creek itself or one of its tributaries. Amazon Creek exits the basin at its northwest corner. It then flows through Clear Lake and eventually into the Long Tom River due west of Junction City.

Amazon Creek is listed on the Metropolitan Natural Resources Study (NR Study) as a riparian resource (refer to E30/31: Amazon Channel Natural/Urban). A large diversity of vegetation and wildlife characterize this section of Amazon Creek. Similar species are seen along the creek through the urban area; however, larger and denser riparian vegetation and differing adjacent land uses give this area a slightly higher wildlife habitat value.

2.5.1.2 A-2 Channel

The A-2 Channel begins on the east side of the intersection of Jessen Drive and Beltline Road where the West Beltline Floodway combines with piped drainage from the east. The channel immediately flows under Beltline Road and heads west for approximately 1.5 miles paralleling the Eugene City limits north of Jessen Drive. Shortly after exiting the west side of the UGB, the flow continues northwest for over two miles and eventually joins Amazon Creek shortly before it exits the basin boundary.

Like the A and A-3 Channels, the A-2 was constructed as part of the Lower Amazon and Flat Creek Watershed Improvements by the Soil Conservation Service (SCS). It is part of Eugene's storm drainage system and primarily aids in flood control in the flat areas in west Eugene. Potential exists for enhancement of this intermittent stream as both a wildlife and recreational corridor because of its proximity to other area waterways and to Golden Gardens Park on the north side of Barger Drive.

The A-2 Channel is listed on the Metropolitan Natural Resources Study (NR Study) as a riparian resource (refer to E70: Beltline/A-2 Channel).

2.5.1.3 West Beltline Floodway

The West Beltline Floodway is a 1.7 mile long stormwater drainage channel built by the City of Eugene in 1983. The channel begins between Roosevelt Boulevard and Royal Avenue and flows in a northern direction along the east side of Beltline Road. The channel ends at the intersection of Jessen Drive and Beltline Road where the A-2 Channel begins. This waterway is an intermittent, seasonal system that provides drainage for areas east of Beltline Road and north of Royal Ave. The West Beltline Floodway is often referred to in conjunction with the A-2 Channel, of which it is the major upstream tributary.

The West Beltline Floodway is listed on the Metropolitan Natural Resources Study (NR Study) as a riparian resource (refer to E70: Beltline/A-2 Channel).

2.5.1.4 Marshall Channel

Built by the City of Eugene in 1970, this 1.1 mile long floodway begins north of Fairfield School, just east of the intersection of Hughes and Marshall Streets. It flows west along the south side of Marshall Avenue to the confluence with the West Beltline Floodway. The waterway provides stormwater drainage from much of the Bethel Drive area as well as most of the residential development between Royal Avenue and Marshall Avenue. It is referred to as part of the A-2 channel (E-70) in the NR Study.

2.5.1.5 A-3 Channel

Like channels A-2 and A, the SCS constructed the A-3 Channel as part of the Lower Amazon and Flat Creek Watershed Improvement Project. The channel begins at the intersection of Seneca Road and 5th Avenue and flows west for two miles before turning to the north. Within this stretch, the A-3 Channel flows into and out of Bertelsen Slough, a twenty-five acre wetland located east of Bertelsen Road between 1st Avenue and Stewart Road. After making its northern turn, the channel follows along Beltline Road for a short distance and turns west at the confluence with the Roosevelt Channel. The flow continues west until emptying into Amazon Creek just downstream from the Diversion Channel. The total length of the channel is 3.4 miles.

Cattail and reed canary grass are the dominant emergent vegetation of this perennial stream. Pockets of Oregon ash, willow and hawthorne also grow along the banks. The waterway is valued for its wildlife habitat due to its proximity to the Amazon Channel, Bertelsen Slough and the West Eugene Wetlands.

The A-3 Channel is listed on the Metropolitan Natural Resources Study (NR Study) as a riparian resource (refer to E32: A-3 and Roosevelt Channels).

2.5.1.6 Roosevelt Channel

Roosevelt Channel is a 1.4 mile long, constructed channel that begins on the east side of the basin near the intersection of Maple Street and Roosevelt Blvd. The channel flows west along Roosevelt to its intersection with Beltline Road, at which point the channel flows under Beltline, turns southwest for a short distance and enters the A-3 Channel. Like the A-3 Channel, the dominant vegetation consists of cattail and reed canary grass with pockets of Oregon ash, willow and hawthorne.

The Roosevelt Channel is listed on the Metropolitan Natural Resources Study (NR Study) as a riparian resource (refer to E70: Beltline/A-2 Channel).

2.5.1.7 Green Hill Tributary

This 2.3 mile long seasonal waterway provides drainage for a portion of the Bethel neighborhood from Beltline Road on the east to the A Channel on the west. There are two tributaries to this waterway: the east and south. The tributaries for the east fork flow from the intersection of Marshall Avenue and Candlelight Drive and from Royal Avenue through Candlelight Park. This branch flows due west for approximately 1.75 miles and is joined by the south fork. Two south fork tributaries meet at Royal Avenue. The southeast tributary arises near Cone and Glenhaven Streets, while the other tributary flows from the south. After the confluence of the east and south forks, the waterway flows northwest into A Channel shortly before it exits the UGB. Enhancement potential is high because of its proximity to other waterways and to the Bethel neighborhood.

The Green Hill Tributary is listed on the Metropolitan Natural Resources Study (NR Study) as a riparian resource (refer to E72: Marshall Ditch – note this reference name is incorrectly listed in the NR Study).

2.5.2 Wetlands

A comprehensive local inventory and evaluation of wetlands has not been conducted for the entire Bethel-Danebo basin although the West Eugene Wetlands Plan (WEWP) study area does include the southern portion of the basin. Wetland features described in this section are based on the National Wetlands Inventory (NWI) and the WEWP where it applies. The NWI provides basic data about general characteristics and the extent of wetlands. The NWI identifies general wetland boundaries, however, in many instances actual wetland boundaries and features are more extensive than what is identified through this mapping. The WEWP provides a more comprehensive inventory and evaluation of wetlands within the study area.

The Bethel-Danebo basin contains about 717 acres of wetlands that have been identified in the NWI or the WEWP. Although the WEWP only includes the far southern portion of the basin, about 73 percent (521 acres) of all the currently identified wetlands within the Bethel-Danebo basin are within this study area. About 55 percent of all inventoried wetlands are within the UGB although this area comprises about 75 percent of the land area within the basin. Since the southern portion of the basin is the only area where a local wetlands inventory has been conducted, it is probable that there are additional acres of wetlands in the basin.

For wetlands that are part of the WEWP, refer to the Amazon Creek Basin Master Plan.

2.5.3 Piped System

The stormwater pipe system in this basin is moderately extensive, reflecting the basin's mix of highly developed and relatively undeveloped area. Within the UGB there are about 55 miles of public stormwater pipe in the basin. Most of this system is located in residential areas north of Roosevelt Boulevard and east of Danebo Street. The industrial area in the southeast portion of the basin has fewer but larger sized pipes than the residential areas to the north and west. These pipes are larger and carry significantly higher quantities of water than pipes that are typically in residential areas.

2.5.4 Maintaining the Drainage System

Maintenance activities in the Bethel-Danebo basin include occasional cleaning of open waterways and periodic checking and cleaning of catch basins. In several areas, debris accumulates at the open waterway - pipe interface interrupting flow. Waterway maintenance activities are performed to clear debris in order to ensure hydraulic capacity to prevent flooding problems.

The City is under agreement with the Natural Resources Conservation Service (formerly Soil Conservation Service) to maintain the A-2 and A-3 channels.

2.5.5 Floodplain

A flood insurance study for the Federal Emergency Management Agency (FEMA) has been

conducted within the Bethel-Danebo basin. As part of this study areas subject to flooding during the 100-year storm event have been identified. There are about 2,015 acres of floodplain identified in this basin, 65 percent (1,306 acres) of which are outside of the UGB. Nearly all of the designated floodplain area is located in the western portion of the basin. A fairly extensive floodplain is still intact adjacent to Amazon Creek and the Marshall Channel.

2.6 Water Quality

This section provides a description of water quality conditions in the Bethel-Danebo basin. Water quality conditions can vary dramatically depending on time of day, weather conditions, land use activities conducted in the watershed, and location in the water body. Therefore, without significant amounts of data, it is often difficult to adequately evaluate water quality conditions. It is even more difficult to evaluate the water quality impacts of stormwater runoff on receiving waters. Therefore, a variety of available sources of water quality-related information were reviewed in an attempt to provide a general picture of water quality conditions in the basin. The following sources of information were reviewed and are described below:

- Documented water quality problems based on existing chemical data, biological data, and field observations,
- Oregon Department of Environmental Quality's (DEQ's) designations of water quality limited water bodies, and
- Natural and built environmental conditions that influence water quality.

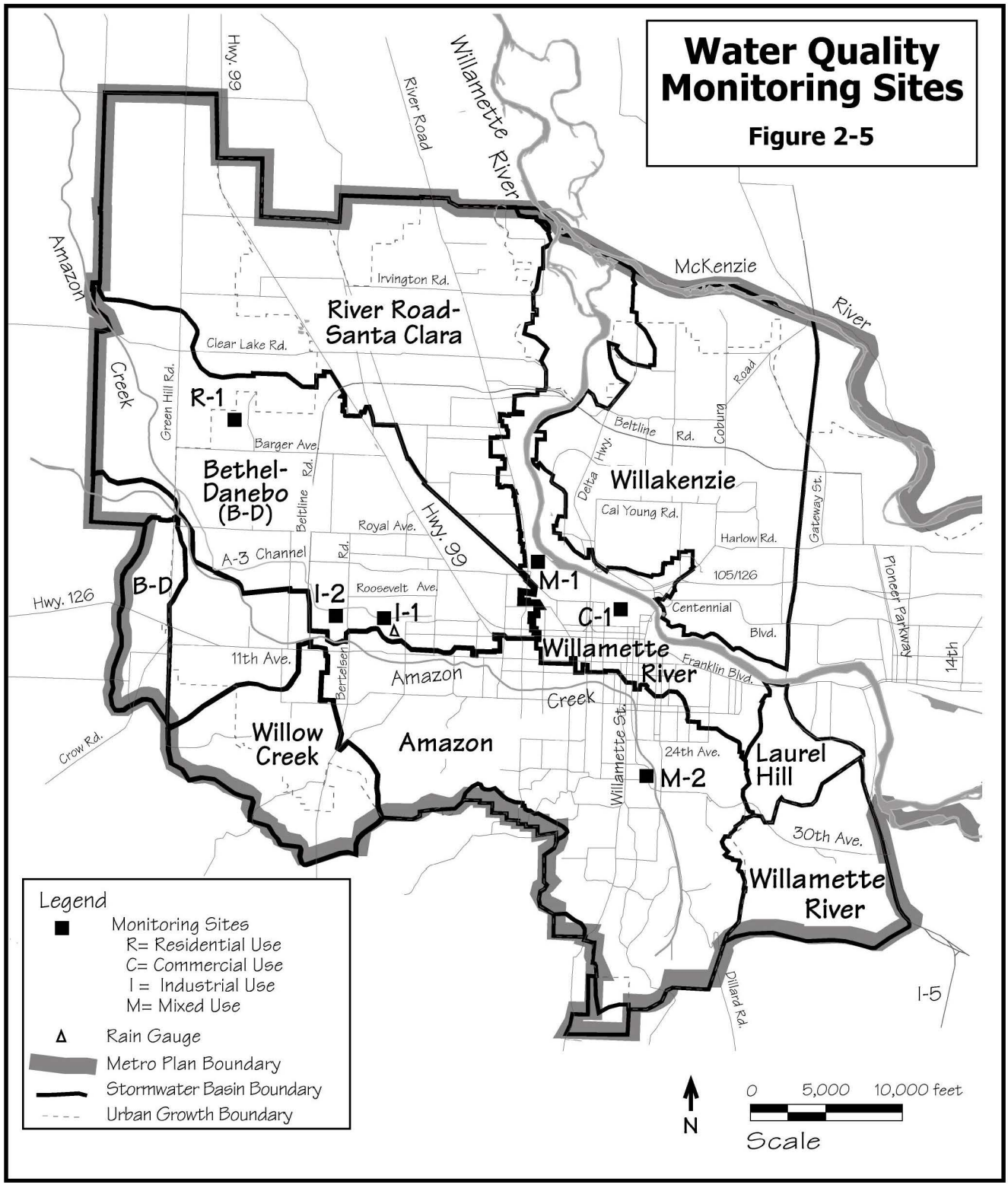
2.6.1 Documented Water Quality Problems

The following subsections describe the water quality problems that have been documented for the Bethel-Danebo basin in terms of chemical stormwater monitoring data, macroinvertebrate sampling, and field observations.

2.6.1.1 Chemical Stormwater Monitoring Data

The City collected and analyzed samples of stormwater runoff from 1992 to 1997 at 6 sampling stations in Eugene (see Figure 2-5). The 6 sampling stations were selected to represent runoff from various land uses. In 1998, the storm event monitoring at the 6 sampling stations was discontinued and a pilot project on the A3 Channel using a basin approach to water quality monitoring was implemented. The revised monitoring plan consisted of collecting monthly composite samples at the original industrial land use station on the A3 Channel (station I1) and collecting samples at selected high source areas in the piped system on the A3 Channel.

The following table provides a summary of the results collected during 1992 to 1997 from the 6 sampling stations. Table 2-5 includes a description of the problem pollutants, typical sources of the pollutants, specific results from Eugene, and potential problems associated with the pollutants. Three of the sampling stations were located in the Bethel-Danebo basin. These stations were as follows:


Water Quality Monitoring Sites
Figure 2-5
Hwy. 99
River Road
Willamette River
McKenzie River
Amazon Creek
Irvington Rd.
River Road-Santa Clara
Clear Lake Rd.
Green Hill Rd.
R-1
Barger Ave.
Bethel-Danebo (B-D)
Beltline Rd.
Royal Ave.
A-3 Channel
Hwy. 99
B-D
Hwy. 126
I-2
Roosevelt Ave.
I-1
11th Ave.
Bertelsen Rd.
Crow Rd.
Willow Creek
Amazon Creek
Amazon
Delta Hwy.
Beltline Rd.
Coburg Road
Willakenzie
Cal Young Rd.
Harlow Rd.
Gateway St.
105/126
Centennial Blvd.
Pioneer Parkway
M-1
C-1
Willamette River
Franklin Blvd.
Willamette St.
24th Ave.
M-2
Laurel Hill
30th Ave.
Willamette River
14th
I-5
Dillard Rd.
Legend
Monitoring Sites
R= Residential Use
C= Commercial Use
I = Industrial Use
M= Mixed Use
Rain Gauge
Metro Plan Boundary
Stormwater Basin Boundary
Urban Growth Boundary
N
0 5,000 10,000 feet
Scale

R-1: A residential land use station located at Coetivy Avenue and Terry Street.
I-1: An industrial land use station located at 5th Avenue and Wallis Street; monitors water quality upstream of Bertlesen Slough.
I-2: An industrial land use station located just west of Bertlesen on the A-3 Channel; monitors water quality downstream of Bertlesen Slough.

Although three of the monitoring stations were located within the Bethel-Danebo basin, all of the other City-wide data were also used to provide general information regarding stormwater quality in Eugene and were used in identifying a stormwater management strategy for this basin.

Table 2-5
Summary of Stormwater Quality Monitoring in Eugene

Pollutant	Description	Sources	Eugene's Results	Potential Problems
Bacteria	- Enterococcus, - Fecal coliform, and - Fecal streptococcus	- Animal Wastes (droppings from wild/domestic animals), - Human Wastes (leaking sanitary sewer pipes, and seepage from septic tanks).	**Results from almost all of the samples significantly exceeded the DEQ standard for water quality**.	These are commonly used indicators of human pathogens. Water contact may cause eye and skin irritations and gastro-intestinal diseases if swallowed.
Heavy Metals	Antimony Arsenic Beryllium Cadmium Chromium Copper Lead Mercury Nickel Selenium Silver Thallium Zinc	- Vehicles (combustion of fossil fuels, improper disposal of car batteries, wear/tear of tires and brake pads), - Metal Corrosion, - Pigments for Paints, - Solder, - Fungicides, - Pesticides, - Wood Preservatives	Cadmium, chromium, copper, lead, nickel, and zinc were typically present in samples. **Copper, lead, and zinc in stormwater samples frequently exceeded DEQ standards for the protection of aquatic life.**	Heavy metals are toxic to freshwater aquatic ecosystems. These metals are considered to be the most significant toxic substances which are commonly found in urban stormwater runoff.
Oil & Grease	A broad group of pollutants including: - Animal fats, and - Petroleum products.	- Food Wastes (animal and vegetable fats from garbage), - Petroleum Products (gas, engine oil, lubricants, etc.).	**Two of fifty-three samples had concentrations which exceeded discharge limitations specified for industrial stormwater discharges (i.e., > 10 mg/L).**	These compounds can coat the surface of the water limiting oxygen exchange, clog fish gills, and cling to waterfowl feathers. When ingested these compounds can be toxic to birds, animals and other aquatic life.
Sediments	Sediments in the water are considered pollutants when they exceed natural concentrations and negatively affect water quality and/or beneficial uses of the water.	- Erosion from increased stream flows, - Construction site runoff, - Landscaping activities, - Agricultural activities, - Logging, - All other activities where the ground surface is disturbed.	**Excess levels were measured at all stations. Results from the urban sampling stations in Eugene were all 40% to 70% higher than results from an open space (i.e., undeveloped) sampling.**	Sediments cause increased turbidity, reduced prey capture for sight feeding predators, clogging of gills/filters of fish and aquatic insects, and blocked light which limits food production available for fish. Sediments also accumulate in stream bottoms which reduces the capacity of the stream (and hence increases the potential for flooding) and covers stream bottom habitats. Sediment also acts as a carrier of toxic pollutants such as metals and organics.
Nutrients	- Nitrate - Ammonia - Kjeldahl Nitrogen - Phosphorus - Orthophosphate	- Landscaping activities, - Yard debris, - Human wastes (leaks from septic tanks and sanitary sewers), - Animal wastes, - Vehicle exhausts, - Agricultural activities, - Detergents (car washing), - Food Processing	**The DEQ guidance value of 0.1 mg/L for total phosphorus was exceeded in 100% of the samples collected.**	Excess levels of nutrients can lead to eutrophication in downstream receiving waters. Problems include surface algal scums, odors, reduced oxygen levels, and dense mats of algae. In addition to water quality problems, these effects have a negative impact to the aesthetic quality of water bodies.

Table 2-5 (continued)

Pollutant	Description	Sources	Eugene's Results	Potential Problems
Organics	There are many organic compounds, however, the synthetic organics are of most concern and include: - Fuels - Solvents - Pesticides - Herbicides.	- Illegal dumping, - Illicit connections, - Spills, - Leaks from drums and storage tanks, - Landscaping activities - Agricultural activities.	Although sampling for these compounds was limited, **nine volatile organic compounds were detected (including one pesticide).**	Most synthetic organics are highly toxic to aquatic life at very low concentrations, and many are carcinogenic (cancer causing) or suspected carcinogens. Diazinon has been identified in many recent studies as one of the causes of toxicity in stormwater.
Litter and other Floatable Debris	- Plastics, - Paper products, - Yard debris, - Tires, - Metal, - Glass.	- Littering, - Dumping, - Spills.	Sampling for litter and floatables was not conducted, however, **specific problem dumping areas have been identified in Eugene** (see notes below).	These pollutants degrade the aesthetic quality of water bodies. In addition, they contribute pollutants as they decompose, and they can reduce the capacity of the water body. Excess yard debris contributes to high levels of nutrients and it reduces oxygen levels as it decomposes.

Based on results from the above monitoring program and the results from state-wide monitoring efforts (ACWA, 1997), industrial and commercial land uses have been identified as significant sources of stormwater pollutants (i.e., high source areas). The Bethel-Danebo basin contains the largest portion of commercial and industrial areas in the City. In general, these land uses are concentrated in the following locations:

- In a large area that is approximately bounded by Roosevelt Blvd. to the north, 7th Ave. to the south, Chambers St. to the east and Beltline Rd. to the west.
- Along Highway 99.
- Along the Northwest Expressway.

2.6.1.2 Findings from Macroinvertebrate Sampling

Aquatic macroinvertebrate sampling is useful in evaluating water quality and ecological integrity. Pronounced changes in biological communities indicate a disruption of healthy environmental conditions and can be useful in identifying cumulative effects of pollutants, habitat alterations, effects from bioaccumulative chemicals, and other impacts that chemical monitoring may not reveal.

No macroinvertebrate sampling has occurred in the Bethel-Danebo basin.

2.6.1.3 Field Observations of Water Quality Problems

In addition to the information obtained from the stormwater monitoring data described above, specific water quality related problems/issues have been observed in this basin as follows:

- *Tip-ups:* Sediment and debris that has been observed to accumulate in tip-ups is likely getting flushed into downstream open waterways during larger storm events.

- *Debris in the Open Waterways:* Significant amounts of trash and debris are dumped into the open waterways in this basin and maintenance access is often limited for removing debris.

- *Outdoor Storage of Hazardous Materials:* In the industrial areas along the A-3 channel, potentially contaminating materials such as fuels are often observed to be stored in outdoor areas where they are exposed to runoff.

- *Sedimentation:* Since the majority of the basin is very flat excess sediments in runoff tend to settle out of the water column due to the low flow velocities. As a result, sedimentation of open channels in this basin is often a problem.

2.6.2 Oregon Department of Environmental Quality Water Quality Limited Designations [303(d) List]

The federal Clean Water Act requires states to maintain a list of water bodies that do not meet water quality standards. These standards are established to protect beneficial uses such as drinking water, fisheries, industrial water supply, recreational, and agricultural uses. This list is called the 303(d) List based on the section of the Clean Water Act that mandates this requirement. The list is meant only as a means of identifying water quality problems and not the causes.

States must monitor water quality and review available data and information to determine if the standards are being met. In Oregon, this responsibility is carried out by the Department of Environmental Quality (DEQ). If available data indicate a water body is not meeting water quality standards, and the data meet listing guidelines, DEQ must assume that the water body is water quality limited. Water bodies with no information, or information incompatible with the EPA guidelines, are not included on the 303(d) list. The 303(d) list is updated and revised every two years. Once a water body is included on the 303(d) list, DEQ is required to develop a total maximum daily load (TMDL) requirement for both point and non-point sources of the pollutants of concern. It is anticipated that DEQ will develop TMDL requirements for all designated water quality limited water bodies in the State of Oregon sometime within the next ten years.

With respect to the Bethel-Danebo basin, the A-3 channel is included on the 303(d) list for toxics. The specific toxics that the A-3 has been listed for include arsenic, PAHs, semi-volatile organics, and volatile organics. These have primarily been found in contaminated sediments but, more recently, some toxics, such as arsenic, trace metals, pesticides, and PAHs have been found in the water column as well.

2.6.3 Natural and Built Conditions

Evaluating the natural and built conditions that influence water quality can be useful in indirectly assessing water quality conditions in the basin. As urbanization occurs, negative impacts to the health of receiving waters result from changes in the quality of stormwater runoff. Natural features such as riparian areas, wetlands, and open drainage systems have the ability to treat stormwater pollutants, prevent waterway scour by slowing down runoff rates, settle out sediments, and protect stream banks from erosion. However, with research showing that water quality degradation occurs at relatively low levels of imperviousness (10-20 percent), the

implications of development on water quality are significant.[1] Figures 2-6, 2-7, and 2-8 examine natural and built conditions relative to the other Eugene drainage basins.

Figure 2-6
Extent of Open Drainage System in the Bethel-Danebo Basin (UGB)

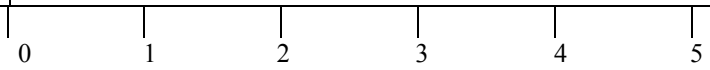
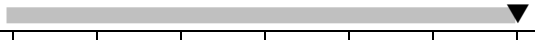
Miles per Square Mile Of Open Drainage System in the Bethel-Danebo Basin	Bethel-Danebo Basin [▼] Relative to The Range in Other Eugene Basins (miles/sq mile)
3.2	

Figure 2-7
Extent of Area as a Percentage of the Bethel-Danebo Basin (UGB)

Factors	Percent in Bethel-Danebo Basin	Bethel-Danebo Basin [▼] Relative to the Range in other Eugene Basins
Remaining Vacant Lands*	**26%**	
Existing Impervious Surface Area	**35%**	
Projected Impervious Surface Area	**50%**	
Wetlands	**8%**	
100-Year Floodplain	**22%**	

**Vacant land* includes tax-lotted areas currently in vacant, agricultural, and timber uses.

Figure 2-8
Extent of 100-Year Floodway Fringe that is Vacant in the Bethel-Danebo Basin

Percent of 100-Yr. Floodway Fringe Vacant* in the Bethel-Danebo Basin	Bethel-Danebo Basin [▼] Relative to The Range in other Eugene Basins
60%	

**Vacant land* includes tax-lotted areas currently in vacant, agricultural, and timber uses.

2.6.4 Conclusions

A summary of the above findings suggest that degraded water quality conditions exist in the Bethel-Danebo basin as follows:

[1] Tom Schueler, et al. *Site Planning for Urban Stream Protection: The Importance of Imperviousness*, 1995.

- Based on the analysis of stormwater runoff samples collected from Eugene and other urban areas in Oregon, the pollutants of concern that were identified are as follows:
  - Total Suspended Solids (TSS)
  - Nutrients
  - Heavy Metals
  - Bacteria
  - Oil and Grease
  - A3 Channel's 303(d) listing of toxics: arsenic, PAHs, semi-volatile organics, volatile organics
- Commercial and industrial areas have shown to be the most significant contributors of specific stormwater pollutants. A large proportion of the City's industrial and commercial land uses are located in this basin.
- At 35 percent, the basin currently has levels of imperviousness that are expected to degrade water quality. Projections indicate that the impervious surface area will increase to 50 percent, which is second highest for all of the basins.
- The A-3 Channel is designated as *water quality limited* for toxics including arsenic, PAHs, semi-volatile organics, and volatile organics.
- Sediment and debris that has been observed to accumulate in tip-ups is likely getting flushed into downstream open waterways during larger storm events.
- Significant amounts of trash and debris are dumped into the open waterways in this basin.
- In the industrial and commercial areas, potentially contaminating materials are often stored in outdoor areas where they are exposed to runoff.
- Due to the lack of topographic relief, sedimentation of open channels is often a problem in this basin.

2.7 Rare, Threatened, and Endangered Plants, Animals, and Communities

Stormwater management decisions and practices can affect rare, threatened, and endangered plant and animal species. Local populations can be reduced or even eliminated as a result of decisions to pipe a waterway, install upstream detention, or to allow significant increases in runoff due to new development. The purpose of this section is to describe the known rare species and communities located in the study area so that the details of these resources can be consulted prior to any final decisions.

Table 2-6 indicates rare plant and animal species that have been observed in the Bethel-Danebo basin and that appear on the Oregon Natural Heritage Program's data base. Specific locations of these species are available through the Oregon Natural Heritage Database Program. Due to the WEWP and The Nature Conservancy's interest in the Willamette Valley Wet Prairies, the most extensive surveys for rare plant and animal species have occurred in the Willow Creek, Amazon Creek, and Bethel-Danebo basins. As a consequence, more species information is known about these areas than in the other basins; however, given the relatively high level of urban development in the remaining basins, the occurrence of rare species is likely to be low when compared with basins within the WEWP Boundary.

In March 1999, the National Marine Fisheries Service (NMFS) listed spring-run Chinook salmon as a threatened species under the Endangered Species Act (ESA). It includes all naturally spawned populations of Spring Chinook in the Clackamas River, and in the Willamette River and its tributaries above Willamette Falls, Oregon. Because runoff from Eugene discharges either directly or indirectly to the Willamette River, the listing will affect the City's stormwater management program and practices.

A species that is listed as *threatened* means it is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Protective regulations, known as 4(d) rules have been developed that are deemed necessary and advisable to provide for the conservation of the species. These rules spell-out the take prohibitions that pertain to Spring Chinook and focus on the type of activities that are likely to lead to a take. The City is in the process of reviewing its own processes, procedures, and development standards for identifying and adjusting those that may not be compatible with the 4(d) rules.

Table 2-6 displays the inventoried rare plants and animal species within the Bethel-Danebo basin.

Table 2-6
Rare Plants and Animals in Bethel-Danebo Basin

Species/Communities	Federal		State		TNC Rank		Associated	ONHP
	Listed	Candidate	Listed	Candidate	Global	State	Habitat	List
White-topped aster (*Aster curtus)*		SOC	T		G3	S2	Prairie	1
Timwort (*Cicendia quadrangularis)*					G4	S2	Wet Prairie	2
Western meadowlark (*Sturnella neglecta*)		SOC			G5	S5	Prairie	4
Willamette valley daisy (*Erigeron decumbens* var. *decumbens)*	E		E		G4T1	S1	Prairie	1
Shaggy horkelia (*Horkelia congesta ssp. Congesta)*		SOC		C	G4T1	S2	Prairie	1
Bradshaw's lomatium (*Lomatium bradshawii)*	E		E		G2	S2	Wet Prairie	1
Kincaid's lupine (*Lupinus sulphureus ssp. Kincaidii*)	T		T		G5T2	S2	Upland Prairie	1
Fenders Blue Butterfly (*Icaricia icarioides fenderi*)	E				G5	S1	Upland Prairie	1
Western pond turtle (*Clemmys marmorata marmorata*)		SOC		SC	G3	S2	Riparian/Wetlands	2

KEY: *Federal and State (E=Endangered, T=Threatened, C=Candidate throughout its range, SOC=Species of Concern, SC=Sensitive/Critical, SV=Sensitive/Vulnerable, *=Under Consideration for Protective Status).* ***TNC Rank*** *(State Rank: 1=critically imperiled, 2=imperilled, 3=rare, uncommon or threatened but not immediately imperiled, 4=not rare and apparently secure, and 5=demonstrably secure, widespread. Global Rank: The number is prefixed by a "G" and for the state an "S". A "T" ranks subspecific species on a global scale (but not on state scale).* ***ONHP List*** *(List 1= threatened or endangered throughout their range, List 2= threatened or endangered in Oregon but more stable elsewhere, List 3 = need more information, List 4=species of concern but are not currently threatened or endangered.)*

2.8 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. This section describes the key soil parameters relative to stormwater issues and the distribution of those parameters in the Bethel-Danebo basin. All soils data were obtained from the *USDA Soil Survey of Lane County*. Refer to Tables 2-7 to 2-9 and Maps 6 to 10 for a description of the soil mapping units and relevant stormwater related data found in the Bethel-Danebo basin.

2.8.1 Permeability

Soil permeability measures the rate of water movement through the soil horizon. This factor is important in managing stormwater quantity and quality. Soils with slow permeability rates are more likely to result in higher stormwater runoff volumes than soils of high permeability. Under these conditions, larger and more extensive stormwater facilities are needed to accommodate new development where space permits. In more densely developed areas, slow permeable soils may be better suited to stormwater conveyance and storage facilities than infiltration facilities. Storage facilities could include detention ponds and treatment ponds where time is desired for settling and filtering purposes.

Over 56 percent of the soils in the Bethel-Danebo basin are rated as moderately slow and 32 percent are rated very slow. Generally, soils rated very slow are located in the western most portion of the basin following the general alignment of the historic Amazon Creek. Pockets of very rapid permeability exist in the central and northern portions of the basin.

Table 2-7
Soil Permeability in the Bethel-Danebo Basin

Location	Permeability (percent)						
	Very Rapid	Moderately Rapid	Moderate	Moderately Slow	Slow	Very Slow	Total
Within UGB	6%	0%	0%	72%	2%	20%	100%
Outside UGB and within Urban Reserve	0%	0%	1%	15%	34%	50%	100%
Outside UGB and Outside Urban Reserve	6%	0%	0%	28%	7%	59%	100%
Total Basin	5%	0%	0%	56%	6%	33%	100%

Source: USDA Soil Survey of Lane County Area, Oregon, 1987.

2.8.2 Runoff Potential

Soil groups have been rated according to their runoff potential under nonvegetated and saturated conditions. Runoff potential measures a soil's capacity to permit infiltration and, therefore, can be used to describe the degree of runoff expected during storm events. For example, soils rated "low runoff potential" are more likely to have high infiltration rates and, conversely, soils rated "high runoff potential" are more likely to have very slow infiltration rates. Hydrologic

stormwater models often use this parameter in conjunction with slope and surface cover factors for estimating surface flows under undeveloped conditions.

As shown on Map 7, soils of the Bethel-Danebo basin demonstrate a range of runoff potential from moderately low to high. Undeveloped areas support mostly soils with moderately high to high runoff rates. The following table displays the distribution of soils by rate of runoff for the basin:

Table 2-8
Runoff Potential in the Bethel-Danebo Basin

Location	Runoff Potential (percent)				
	High	Moderately High	Moderately Low	Low	Total
Within UGB	36%	58%	6%	0%	100%
Outside UGB and within Urban Reserve	65%	35%	0%	0%	100%
Outside UGB and Outside Urban Reserve	69%	24%	7%	0%	100%
Total Basin	48%	47%	5%	0%	100%

Source:USDA Soil Survey of Lane County Area, Oregon, 1987.

2.8.3 Erodible Soils

Highly erodible soils have significant stormwater management implications. If not properly protected during construction and land clearing activities, erosion and sedimentation from these soils can have the following negative effects:

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

As shown on Map 8, only 6 percent of the soils in the basin are highly or moderately erodible. Most of these soils coincide with the steep slopes in the isolated section of the basin along Green Hill Road, which lies outside the UGB.

The City's erosion prevention program has designated highly erodible soils as one of the criteria for sensitive area designation. Construction sites containing these soils are required to obtain an erosion prevention permit so that appropriate management measures can be designed and implemented to prevent and/or minimize erosion impacts.

2.8.4 Unstable Slopes

Very few soils subject to slumping are found in the Bethel-Danebo basin, and almost all are located on the slopes of the southwestern-most section of the basin, which lies outside the UGB. Refer to Map 10 Soil Types.

2.8.5 Hydric Soils

Hydric soil is 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. The Oregon DEQ has not yet established such standards for discharging into wetlands.

Map 9 displays the basin's hydric soils (about 39 percent of the basin) and the NWI wetlands in the basin. Although field checking is needed to confirm the presence of wetlands in these areas, wetlands should be suspected to exist for planning purposes. Siting of future stormwater facilities and stormwater management actions should be chosen carefully so as to not alter the hydrologic regime of wetlands by either adding or taking away water. The following table displays the percent of hydric soils found in the basin:

Table 2-9
Hydric Soils in the Bethel-Danebo Basin

Location	Hydric Soils
Within UGB	32%
Outside UGB	53%
Total Basin	39%

Source:USDA Soil Survey of Lane County Area, Oregon, 1987.

2.9 Groundwater

Two aspects related to groundwater need to be given special consideration when planning for stormwater management. The first relates to the regional aquifer that underlies much of the lower Willamette Valley basin. This aquifer is the source of drinking water for rural residents and several nearby communities (i.e., Springfield, Coburg, Junction City) and has also been investigated as a potential future source of water for Eugene. For this reason, consideration needs to be given to the effects that stormwater management can have on groundwater quality and quantity.

A substantial supply of groundwater exists in this basin at depths of 10-150 feet. This shallow and unconfined aquifer is vulnerable to contamination from surface and subsurface activities. Previous studies and reports (Winkler, 1993) indicate that the shallow aquifer has been contaminated in certain areas with nitrates and industrial chemicals. There is little use of groundwater for drinking water purposes in the Bethel-Danebo basin. Water service is supplied to all new development within the city limits and most existing residents. Areas of the Bethel-Danebo basin that lie outside the UGB rely on groundwater for domestic use, although the aquifer in these areas are “generally poorly permeable, yield water slowly to wells, or contain brackish water” (GEM Consulting, Inc., 1993). Because the underlying aquifer of the Bethel-Danebo basin generally flows to the northwest toward Veneta and Junction City, there are potential negative effects to the quantity and quality of groundwater due to infiltration practices.

The other groundwater issue relates to the depth of the seasonal high water table. Map 11 shows the depth of the high water table during the wet season. This information is linked to soil type and comes from the *USDA Soil Survey of Lane County* (1987). A high water table (less than three feet below the ground's surface) will play a significant role in determining both how stormwater disperses and what types of stormwater facilities might work well in a given area. In general, a high water table will contribute to high runoff levels and can limit the effectiveness of infiltration facilities.

The high water table for the majority of the Bethel-Danebo basin is less than two feet deep during winter months. This condition is generally not suitable for infiltration facilities. Pockets of areas where the high water table is greater than six feet deep can be found along the eastern edge of the basin and west of Beltline Road to Terry Street between Barger Avenue and Maxwell Road.

2.10 Recreational and Educational Facilities

The CSWMP multiple-objectives approach to stormwater management includes recreational and educational facilities. Recreational facilities, such as trails and parks, are compatible with and are often located within areas that are prone to flooding. Drainage can provide corridors for hiking and biking trails as well as for conveying stormwater runoff. Areas within parks can be used as storm event overflow areas with minimal property repair cost. Drainage and wetlands provide opportunities for classroom study and open space recreation and, therefore, their proximity to schools have educational benefits. The following section describes existing and future parks, trails, recreational, and educational facilities within proximity to the Bethel-Danebo basin. Refer to Map 12.

2.10.1 Existing and Planned Educational Facilities

The Bethel-Danebo basin currently contains a total of ten public schools including six elementary schools (Clear Lake, Danebo, Fairfield, Malabon, Meadow View, Prairie Mountain), two middle schools (Cascade, Shasta) and one high school (Willamette). Two new schools are either under construction or scheduled to begin construction in the near future (Kalapuya High School, Meadow View Middle School). The schools combined cover approximately 125 acres. Nearby waterways and wetland resources could be integrated into the site design and used for educational purposes.

There are extensive opportunities for utilization of the stormwater drainage system and related facilities for education in conjunction with school curriculums. All of the existing schools in the basin are located within a reasonable walk (½ mile) of an open waterway or a wetland.

2.10.2 Existing and Planned Park and Recreational Facilities

The majority of the publicly owned "park" land in the Bethel-Danebo basin is land that was acquired over the last several years by the BLM for wetland protection. This wetland resource land is located in the southern portion of the basin and totals approximately 500 acres. Golden Gardens (37 acres), Petersen Barn Park (18 acres), Candlelight Park (12 acres), Bethel

Community Park (33 acres) and six smaller neighborhood parks combine for an additional 125 acres of park land in the basin.

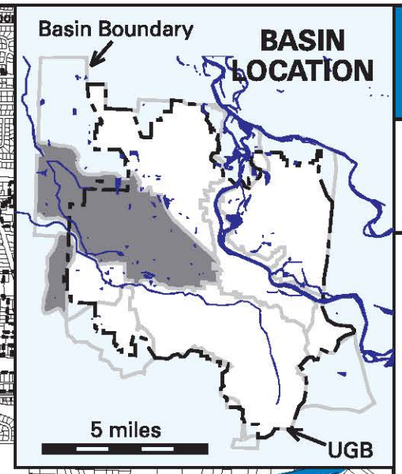
Much of the developed portion of the Bethel-Danebo basin is currently served with on-street bicycle lanes and routes. A bicycle path along Beltline Road from Highway 99 to Roosevelt Boulevard will be completed within the next two years. Oregon Department of Transportation (ODOT) is constructing a bike path along Beltline Road from Highway 99 to Roosevelt Boulevard. A path along the A-2 channel from Beltline Road to Green Hill Road is also planned under TransPlan and could be constructed in conjunction with waterway enhancements. This bicycle corridor would have great potential for stormwater education.

Future park and open space acquisitions in the basin could be sited to be compatible with the stormwater system, potentially providing an area for stormwater storage and filtration. The siting of a community center, bike paths, and parks in proximity to stormwater features and related natural areas would also provide easy access for educational purposes, making a cooperative effort possible to involve students and citizens in monitoring and maintaining the nearby resources.

In November, 1998, voters in Eugene passed a $25.3 million general obligation bond measure for purposes of purchasing new parkland, developing parks, and renovating existing facilities. In the Bethel-Danebo basin, two neighborhood parks and one community park will be developed with these funds. Funding is also identified for the purchase of one neighborhood park. These plans are consistent with the Parks, Open Spaces and Natural Areas Study (1996).

Bethel-Danebo Basin

Existing Land Use *



L E G E N D

- Low-Med. Density Residential
- Med.-High Density Residential
- Commercial (Services & Trade)
- Industrial (Except Sand & Gravel)
- Railroads
- Communication and Utilities
- Parks, Open Space, and Recreation (Except Golf)
- Schools, Churches, & Cemetaries
- Other Government
- Agriculture
- Timber/Forest
- Other Undeveloped Land
- Waterways and Ponds

- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

* Landuse Data Current to November 1998

0 3000 ft

N

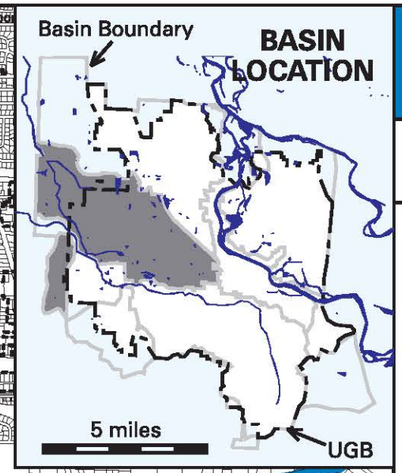
Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 1

Bethel-Danebo Basin

Projected Land Use *



L E G E N D

- Rural Residential
- Low-Density Residential
- Med.-Density Residential and MDR Mixed Use
- High-Density Residential and HDR Mixed Use
- Commercial & Commercial-Residential Mixed Use
- Industrial & Commercial-Industrial Mixed Use
- Natural Resource, Parks and Open Space
- Education and University Research
- Government
- Agriculture and Ag/Airport Reserve
- Forest
- Waterways and Ponds

- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

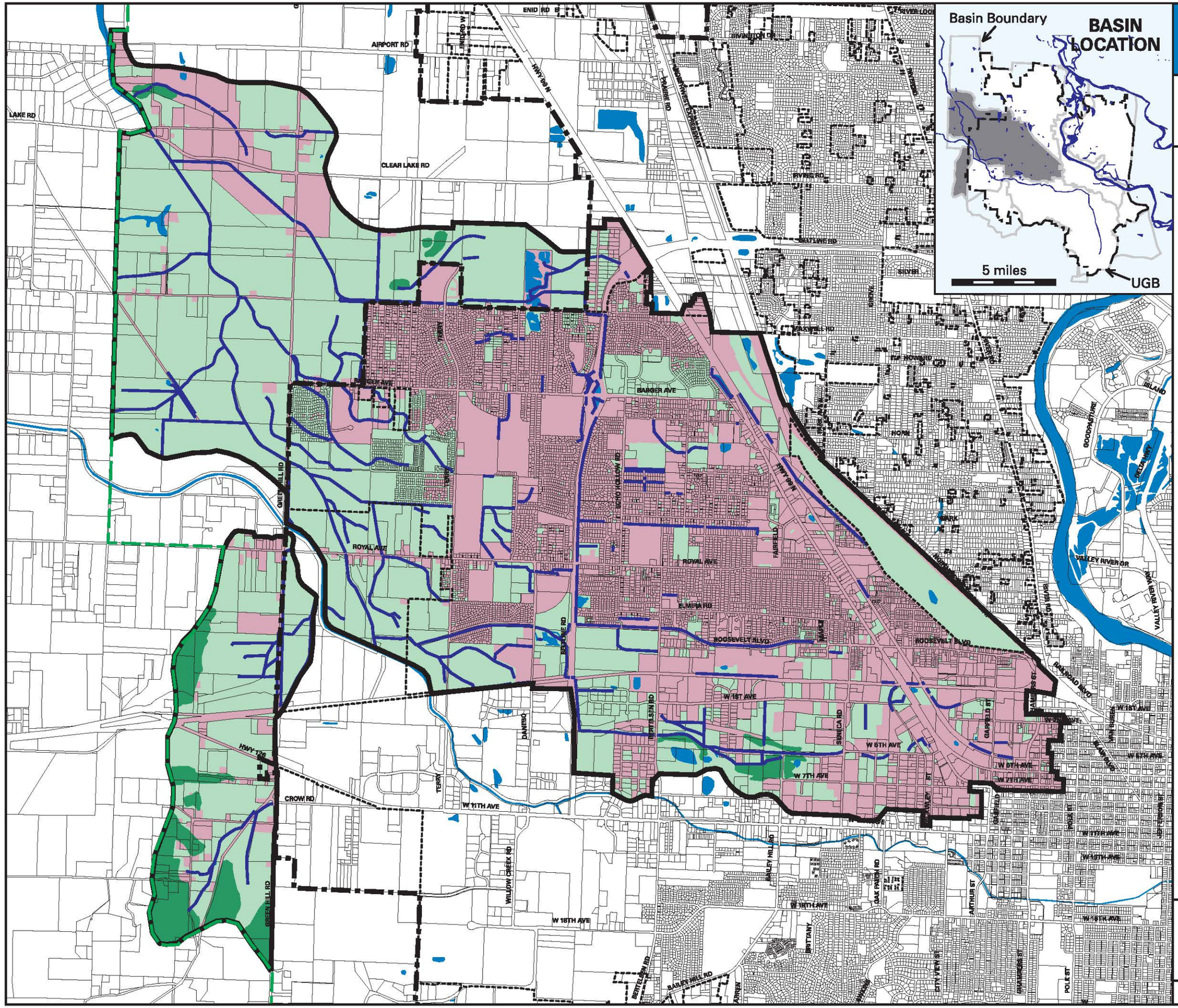
* Projected Land Use according to Metro Area General Plan, as updated to 1998, with revisions to reflect public acquisition of lands for wetland protection.

0 3000 ft

Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 2



Bethel-Danebo Basin

Surface Cover*

L E G E N D

- Impervious Surface Areas
- Generalized Forest Cover
- Other Vegetated Areas
- Waterways and Ponds
- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

* The Impervious Surface Areas category is derived from the 1998 Landuse layer, and includes all developed parcels and road right-of-way. The actual percentage of impervious surface present on each parcel varies by land use category (see table in text for breakdown). Generalized Forest Cover is based on 1994 Aerial Photographs, and includes all forest patches over one acre in size.

0 3000 ft

N

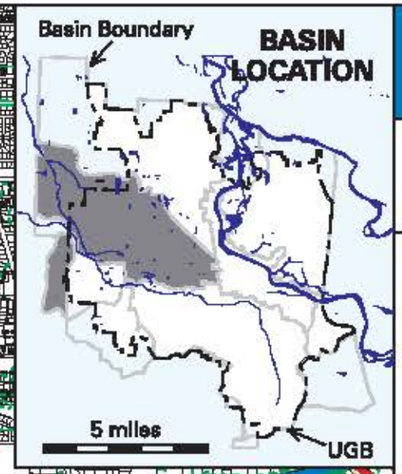
Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 3

Bethel-Danebo Basin

Slope and Topography *



L E G E N D

- 0 - 5% Slopes
- 5 - 10% Slopes
- 10 - 15% Slopes
- 15 - 25% Slopes
- > 25% Slopes
- Waterways and Ponds
- 100-foot contours
- 20-foot contours
- Intermediate contours
- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

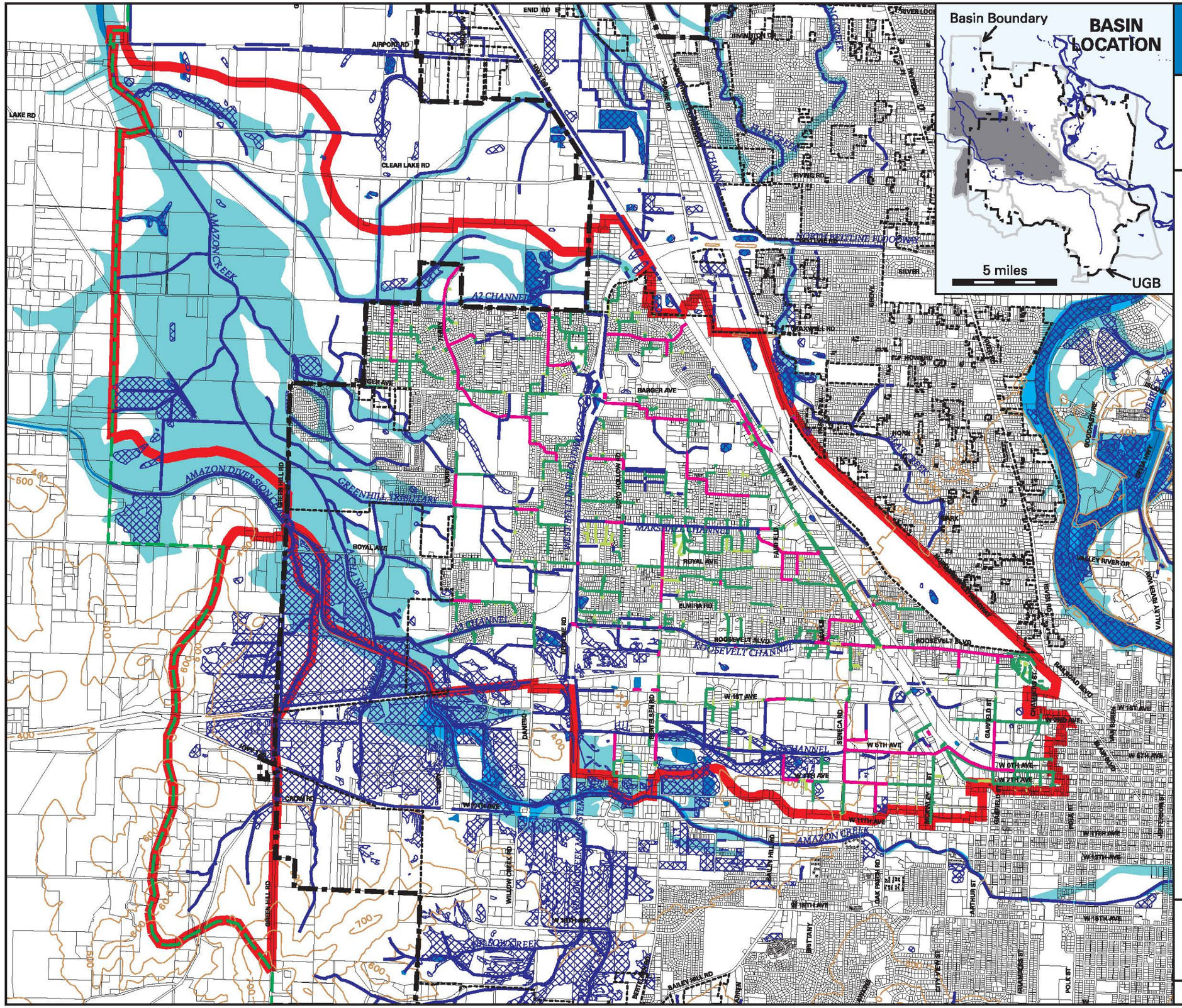
* Slopes and Contours derived from enhanced 10-meter USGS Digital Elevation Models (DEMs)

0 3000 ft

Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 4



Bethel-Danebo Basin

Surface Water and Drainage System Features

L E G E N D

- 100-yr Floodplain (Hazard Zone A) *
- Floodway (from FEMA maps)
- Waterways and Ponds *
- Wetlands (from West Eugene Wetlands Plan & National Wetland Inventory)
- Storm Pipes 36"+ in Basin*
- Storm Pipes <36" in Basin*
- Storm Pipes in Basin, size unknown*
- 100-foot Contour Lines
- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

* from City of Eugene data

0 3000 ft

N

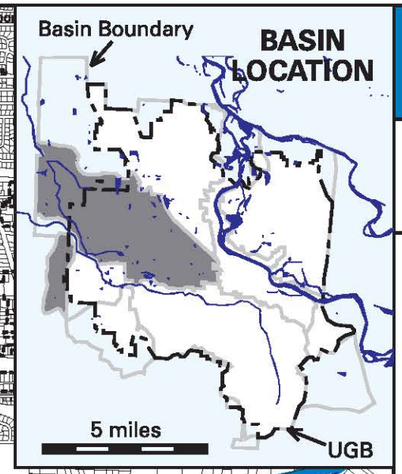
Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 5

Bethel-Danebo Basin

Soil Permeability *



L E G E N D

- Very Rapid
- Moderately Rapid
- Moderate
- Moderately Slow
- Slow
- Very Slow
- Variable
- Pits and Water Bodies from Soil Layer (no data)
- Waterways and Ponds

- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

* from USDA Soil Conservation Service data

0 3000 ft

N

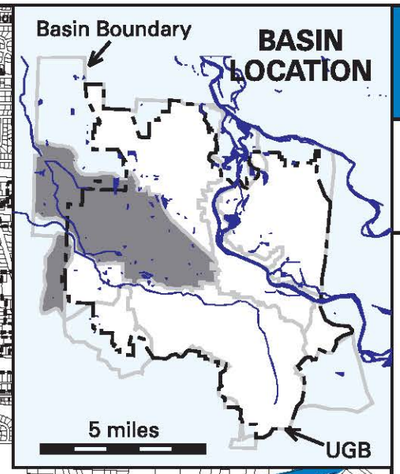
Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 6

Bethel-Danebo Basin

Soil Runoff Potential *



L E G E N D

- Low
- Moderately Low
- Moderately High
- High
- Pits and Water Bodies from Soil Layer (No data)
- Waterways and Ponds

- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

* from USDA Soil Conservation Service data

0 3000 ft

N

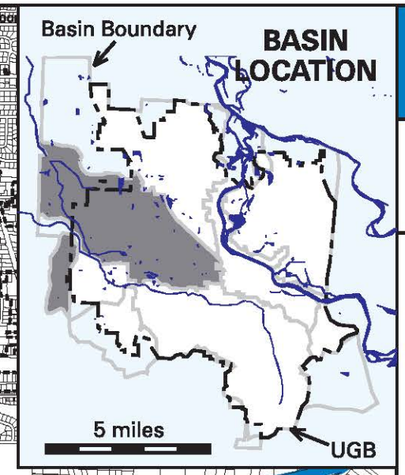
Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 7

Bethel-Danebo Basin

Highly Erodible Soils *



L E G E N D

- Highly Erodible Soils
- Moderately Erodible Soils
- All Other Soils
- Waterways and Ponds
- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

* Derived by LCOG from USDA Soil Conservation Service data

0 3000 ft

N

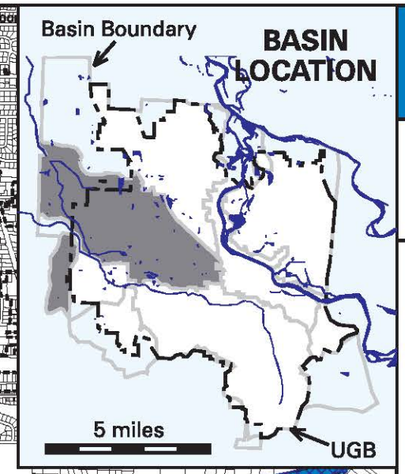
Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 8

Bethel-Danebo Basin

Hydric Soils *



L E G E N D

- Hydric Soils
- All Other Soils
- Waterways and Ponds
- Wetlands (from West Eugene Wetlands Plan & National Wetland Inventory)
- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

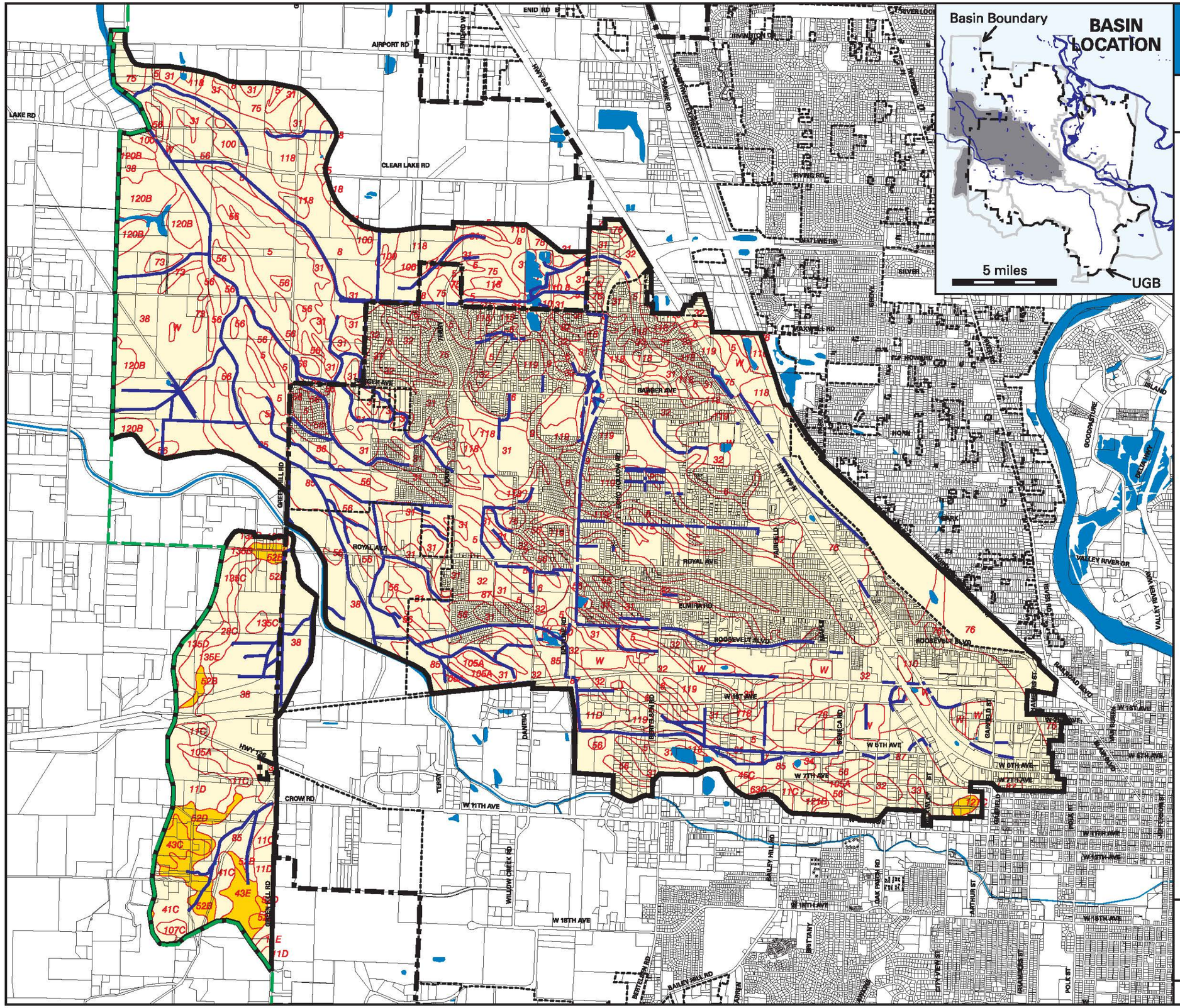
* from USDA Soil Conservation Service data

0 3000 ft

Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 9



Bethel-Danebo Basin

Soil Types *

L E G E N D

Soils subject to slumping

All other soil types

5, AWBRIG SILTY CLAY LOAM
6, AWBRIG-URBAN LAND COMPLEX
8, BASHAW CLAY
9, BASHAW-URBAN LAND COMPLEX
11C, BELLPINE SILTY CLAY LOAM, 3-12% SLOPES
11D, BELLPINE SILTY CLAY LOAM, 12-20% SLOPES
11E, BELLPINE SILTY CLAY LOAM, 20-30% SLOPES
28C, CHEHULPUM SILT LOAM, 3-12% SLOPES
31, COBURG SILTY CLAY LOAM
32, COBURG-URBAN LAND COMPLEX
33, CONSER SILTY CLAY LOAM
34, COURTNEY GRAVELLY SILTY CLAY LOAM
38, DAYTON SILT LOAM, CLAY SUBSTRATUM
41C, DIXONVILLE SILTY CLAY LOAM, 3-12% SLOPES
41E, DIXONVILLE SILTY CLAY LOAM, 12-30% SLOPES
43C, DIXONVILLE-PHILOMATH-HAZELAIR COMPLEX, 3-12% SLOPES
43E, DIXONVILLE-PHILOMATH-HAZELAIR COMPLEX, 12-35% SLOPES
45C, DUPEE SILT LOAM, 3-20% SLOPES
52B, HAZELAIR SILTY CLAY LOAM, 2-7% SLOPES
52D, HAZELAIR SILTY CLAY LOAM, 7-20% SLOPES
56, HOLCOMB SILTY CLAY LOAM
63C, JORY SILTY CLAY LOAM, 2-12% SLOPES
73, LINSLAW LOAM
75, MALABON SILTY CLAY LOAM
76, MALABON-URBAN LAND COMPLEX
85, NATROY SILTY CLAY LOAM
87, NATROY-URBAN LAND COMPLEX
100, OXLEY GRAVELLY SILT LOAM
105A, PENGRA SILT LOAM, 1-4% SLOPES
107C, PHILOMATH SILTY CLAY, 3-12% SLOPES
110, PITS
118, SALEM GRAVELLY SILT LOAM
119, SALEM-URBAN LAND COMPLEX
120B, SALKUM SILT LOAM, 2-6% SLOPES
121B, SALKUM SILTY CLAY LOAM, 2-8% SLOPES
127C, URBAN LAND-HAZELAIR-DIXONVILLE COMPLEX, 3-12% SLOPES
135C, WILLAKENZIE CLAY LOAM, 2-12% SLOPES
135D, WILLAKENZIE CLAY LOAM, 12-20% SLOPES
135E, WILLAKENZIE CLAY LOAM, 20-30% SLOPES
W, WATER

Waterways and Ponds

Bethel-Danebo Basin Boundary

Urban Growth Boundary

Eugene City Limits

Streams and Channels in Basin

Metropolitan Plan Boundary

* from USDA Soil Conservation Service data

0 3000 ft

N

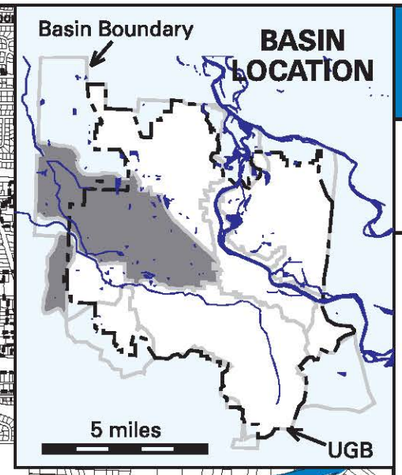
Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 10

Bethel-Danebo Basin

High Water Table *



L E G E N D

- Soils with Shallow Water Table (generally less than 2 feet during winter months)
- Other Soils (water table generally 6 feet or deeper)
- Pits and Water Bodies from Soil Layer (no data)
- Waterways and Ponds
- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Eugene City Limits
- Streams and Channels in Basin
- Metropolitan Plan Boundary

* from USDA Soil Conservation Service data

0 3000 ft

N

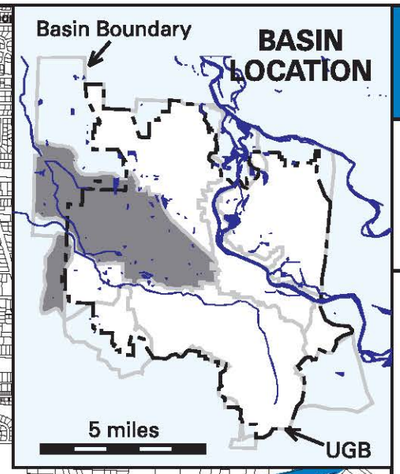
Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 11

Bethel-Danebo Basin

Park, Recreation & Education Facilities



LEGEND

EXISTING

- Parks
- Schools (Pub. & Pvt.)
- Golf Courses
- Public Ownership for Wetland Protection *
- Protected Wetlands in Private Ownership *
- Bikeways in Basin
- Trails

FUTURE

- Parks in Basin **
- Bikeways in Basin ***
- Trails **
- Waterways and Ponds
- Bethel-Danebo Basin Boundary
- Urban Growth Boundary
- Streams and Channels in Basin

* WEWP, 1992; Ownership data, 1998.

** Eugene Parks & Recreation Plan, 1989; Parks, Open Spaces, and Natural Areas Study, 1996.

*** Draft TransPlan Update, November 1997.

0 3000 ft

N

Map Produced by LCOG 2/99

Map based on imprecise source data, subject to change

MAP 12

To identify flood control problems and opportunities, a flood control evaluation was completed for the surface water features and drainage system elements of the Bethel-Danebo basin that is described in Section 2.5 and illustrated on Map 5. Section 3.1 describes the extents of the drainage system evaluated, the process used to identify flooding problems and a general description of each problem. Section 3.2 describes the capital project alternatives and development standard alternatives that were proposed to address the flooding problems. Section 3.3 describes the selected flood control alternatives.

3.1 Evaluation of Flood Control Under Existing and Expected Future Conditions

To develop a flood control strategy for the Bethel-Danebo basin, a computer model was used to evaluate hydrologic/hydraulic conditions of the public storm drainage system. The storm system was evaluated under both existing and buildout land use conditions using XP-SWMM model software. In general, the evaluation concentrates on the significant components of the public drainage system; typically all storm sewer pipes with a diameter of 36" or greater and major roadway crossings and open waterways. The computer model of the Bethel Danebo basin includes four of the five major stormwater conveyance systems in the basin: the A-2 Channel, the Greenhill Tributary, the A-3 Channel, and the Roosevelt Channel. The fifth major conveyance system, the A Channel, was not evaluated in detail. A short portion of the A Channel is included in the Amazon Creek basin model in order to develop the downstream boundary conditions for A-3 Channel and the Greenhill Tributary conveyance systems. The extents of the each conveyance system covered in the model are described below:

A-2 Channel
The extent of the A-2 Channel that was modeled includes the upstream end of the A-2 Channel at the intersection of Jessen Drive and Beltline Road downstream to its interception with the Eugene City limits just west of Ohio Street. Also included are the West Beltline Floodway and the Marshall Channel as described in Section 2.5.1.3 and 2.5.1.4. Other significant drainage components modeled include storm pipes with a diameter of 36" or greater that drain to these three systems.

Greenhill Tributary
The extent of the Greenhill Tributary that was modeled includes:

- The east fork to its confluence with the south fork as described in Section 2.5.1.7.
- The southeast tributary of the south fork as described in Section 2.5.1.7.
- The Greenhill Tributary from the convergence of the east and south forks to its confluence with the Amazon Creek (i.e., the A Channel).
- Storm pipes with a diameter of 36" or greater that discharge to the east fork.

A-3 Channel and Roosevelt Channel
The entire reach of the A-3 Channel and Roosevelt Channel (as described in Sections 2.5.1.5 and 2.5.1.6) are included in the basin model, along with majority of the tributary storm pipes that have a diameter of 36" or greater.

The four major storm conveyance systems were evaluated under both existing and buildout land use conditions. The Bethel-Danebo basin drainage system is shown on Figures 3-2 through 3-8.

Figure 3-1 is an index map that illustrates the relative locations of Figures 3-2 through 3-8. Modeled drainage segments and locations of the proposed capital projects are also illustrated on Figures 3-2 through 3-8.

The City-wide summary in Volume I contains detailed information regarding the process and sources of information that were used for identifying flooding problems and opportunities. Section 3 of Volume I specifically includes detailed information regarding the following:

- Model selection process.
- Sources of model input data.
- Model calibration.
- Design storm selection process.

This section of the Bethel-Danebo basin master plan report provides a summary of the basin specific hydrologic and hydraulic data used in the models and a summary of the basin specific model results with respect to flood control.

3.1.1 Hydrologic Data

The Bethel-Danebo basin was subdivided into 5 major subbasins. The major subbasin boundaries are presented on Figure 3-1. Four of the five major subbasins were further divided into 93 subbasins for modeling purposes (the AC major subbasin was not further evaluated as described above). The subbasin boundaries presented on Figures 3-2 through 3-8 were delineated based on both topography and the storm drainage system layout. The subbasin boundaries were digitized into the City's GIS so that hydrologic data could be generated for each subbasin.

Seven-character names were assigned to each subbasin. The first two characters represent a two-letter abbreviation for the major basin; in this case BD for Bethel-Danebo. The second two characters represent a two-letter abbreviation for the major subbasin. The 5 major subbasins in the Bethel-Danebo basin are as follows:

A2 = A-2 Channel Major Subbasin
A3 = A-3 Channel Major Subbasin
GH = Greenhill Tributary Major Subbasin
RC = Roosevelt Channel Major Subbasin
AC = A Channel Major Subbasin

The last three characters of the subbasin name consist of numbers, starting with 010 and generally increasing in increments of 10 for each additional subbasin. For example, the first two subbasins in the A-2 Channel major subbasin of the Bethel-Danebo basin are BDA2-010 and BDA2-020. In addition, each subbasin has an associated inlet node number. The hydrologic component (i.e., RUNOFF block) of XP-SWMM was used to generate a stormwater runoff hydrograph for each subbasin. This hydrograph was routed by the hydraulic component (i.e., the EXTRAN block) of XP-SWMM to model the storm drainage system. The subbasin inlet node is the point where the subbasin hydrograph enters the storm drainage system for routing.

The following parameters were required for each subbasin in the hydrology component of XP-SWMM.

1. Subbasin name or number.
2. Channel or pipe inlet node number into the storm drainage system.
3. Subbasin area (acres).
4. Hydraulically connected impervious percentage for both existing and future land use scenarios (percent).
5. Average ground slope (dimensionless, ft/ft).
6. Subbasin width (feet).
7. Manning's roughness coefficient for impervious areas.
8. Manning's roughness coefficient for pervious areas.
9. Depression storage for impervious areas (inches of water over subbasin).
10. Depression storage for pervious areas (inches of water over subbasin).
11. Green-Ampt soil infiltration parameters: average capillary suction (inches) saturated hydraulic conductivity (inches/hour), and initial moisture deficit (volume air/volume voids).

Table 3-2 (provided at the back of this section) provides the major hydrologic information for each of the Bethel-Danebo subbasins. Specifically, the table provides the information for parameters 1 – 5 listed above and the expected increase in impervious surface under future conditions. More detailed hydrologic information, including information described for parameters 1 – 11, can be found in Appendix E of Volume I. Table 3-2 also provides peak runoff discharge information for each modeled subbasin.

3.1.2 Bethel-Danebo Basin Hydraulic Data

The primary purpose of the modeling was to evaluate the capacity of the storm drainage system. The evaluation of the storm drainage system included a hydraulic analysis of the major storm pipes, culverts, and open channels which convey stormwater discharges. Information for the piped system was obtained from the City's GIS. Information for the culverts and open channel segments was compiled from previous flood control and natural resource studies and supplemented with field surveys where deemed necessary. In order to analyze the hydraulic capacity of the storm drainage system, the hydraulic component of XP-SWMM required the following parameters for each pipe, culvert or open channel section:

1. Conduit name.
2. Upstream node number.
3. Downstream node number.
4. Conduit size (diameter for pipes and culverts; and cross-section dimensions for open channels).
5. Conduit length.
6. Conduit material for pipes and culverts.
7. Upstream and downstream invert elevations.
8. Upstream and downstream ground surface elevations.
9. Channel roughness coefficients (for open channels).

For the Bethel-Danebo basin, the model was used to evaluate the capacity of approximately 75 open waterway and 127 pipe/culvert/bridge segments under existing and future land use conditions. Table 3-3 (provided at the back of this section) provides the major hydraulic information for each of the modeled conduits in the Bethel-Danebo basin. Specifically, the table provides the information for parameters 1 – 6 listed above in addition to the drainage area for each conduit, the relevant design storm, and the model results for the relevant design storm. Model results are presented in terms of peak flows and maximum water surface elevations. The results for all storm events that were routed through the models (i.e., 10-year, 25-year, 50-year, and 100-year storms) can be found in Appendix E of Volume I. The hydraulic information provided in Table 3-3 and in Appendix E of Volume I are organized by major conveyance systems (i.e., the A-2 Channel, the Greenhill Tributary, the A-3 Channel, and the Roosevelt Channel) and0 are presented following a general sequence from downstream to upstream.

3.1.3 Flooding Problems Identified by the Model

This section provides a general description of model-identified flooding problems. The model results are summarized in Table 3-3 which includes peak flows and water surface elevations for the relevant design storm under both existing and future conditions. The last column in the table indicates which conduits are expected to be deficient and when (i.e., under existing and/or future land use conditions). For pipe segments and roadway crossings, surcharging was considered to be acceptable and flooding problems were only identified if the models showed water getting out of the system and into the streets. For open waterways, deficiencies were identified when the depth of the design flow exceeded the tops of the channel banks.

In general, very few flooding problems were identified in the A-2 Channel and the A-3 Channel drainage systems. Specifically, in the A-2 system, two pipe segments are expected to be deficient under existing conditions for the 10-year storm. These segments are located along Bell Ave. Only one segment in the A-3 Channel was identified as deficient; segment BDRC030C, a 48" CSP culvert that runs under a private driveway east of Bertlesen Road in the Roosevelt Channel, is expected to be deficient for the 10-year design storm under buildout conditions.

Seven open channel segments and one pipe segment were identified as deficient for the 10-year design storm in the Greenhill Tributary. All flooding problems are expected to occur on the east fork under existing and/or buildout land use conditions. Most open channel deficiencies are expected to occur on the open waterway between Delores Court and Terry Street. Segment BDGH066 (approximately 177 feet of 15” pipe) connecting storm pipes on Delores Court with the east fork, is expected to be deficient for the 10-year design storm under existing land use conditions. Each of these problems is described in more detail in Section 3.2 in association with the proposed capital project to address the problem.

3.1.4 Other Identified Flooding Related Problems

In addition to flooding problems identified as a result of system modeling, other flooding-related problems have been identified through field observations of maintenance staff. In general, these problems in the Bethel-Danebo basin included flooding associated with tip-ups. A tip-up is a

negatively sloped pipe segment that conveys stormwater discharges from a deeper pipe system to an open waterway with a higher elevation. In many cases, the negative slope of the tip-up causes sediment and debris buildup resulting in localized flooding problems. Typically, the existing tip-ups do not have adequate access for maintenance. These problems are described in more detail in Section 3.2 in association with the proposed capital project to address the problem.

3.2 Development of the Flood Control Strategy

As shown in the Stormwater Basin Master Planning process flow chart in Figure 1-1, Step 1 included a compilation of basin characteristics. These basin characteristics are summarized in Section 2.0 of this document. Step 2 in the process included problem identification under both existing and buildout land use conditions. The evaluation was focused on the major components of the public drainage system and the expectation was that the system would convey the design storm associated with drainage area. The results of this step for flood control are provided in Section 3.1 above. The next step included the development of potential stormwater management tools (i.e., capital projects or development standards) to address the identified problems. These stormwater management tools were developed as a result of an all-day basin assessment meeting. The meeting was attended by a large multi-disciplinary group of people including staff with experience in water quality, engineering, maintenance, natural resources, planning, and groundwater resources. Preliminary ideas were developed based on the goals and objectives of the project. This section describes the capital projects and flood control development standards that were proposed to address the identified flooding problems.

3.2.1 Capital Project Alternatives

All existing and future flooding problems identified through modeling and observations, and the proposed capital projects to address these problems are presented in Table 3-1. The locations of these proposed capital projects are illustrated on Figures 3-2 through 3-8. As shown in Table 3-1, 3 capital projects were proposed to address the expected flooding problems identified based on modeling results in the Bethel-Danebo basin. Table 3-1 also lists when the flooding problem is expected to occur (i.e., under existing or future conditions). Note that the flooding problems listed in Table 3-1 are associated with segment names. To locate a segment, one should first look up the upstream node and downstream node associated with the segment in Table 3-3, then pinpoint the segment on Figures 3-2 through 3-8.

Table 3-1
Capacity Deficiencies Identified Through Modeling and Proposed Capital Projects to Address Them

Expected Flooding Problems		Capital Project Alternatives Considered for Addressing Capacity Deficiencies	Selected Flood Control Capital Project
Segment Name	**When Deficient**		
A-2 Channel Major Subbasin			
BDA2400J	10-yr existing	BD06 – Increase Pipe Sizes Along Bell Ave.	**BD06 -** This project would address the only two flooding problems that were identified by the model for the A-2 system. It should be noted that when the model was run for this system, problems were noted in the Bell Ave. vicinity. A preliminary capital project was proposed. Upon further analysis of the pipe system in this area, questions arose regarding the accuracy of the elevation and pipe size data. Survey crews went out to re-survey this system and found that pipe inverts and sizes were somewhat different than the original data. The system has since been remodeled with the updated information. However, the preliminary capital project for this location has not been updated as of the publishing of this basin master plan. Therefore, the capital project fact sheet provided in the appendix for BD06 is out of date and reflects the old data. The location of the capital project is illustrated on Figure 3-6.
Roosevelt Channel Major Subbasin			
BDRC030C	10-yr future	BD15 – Culvert Improvement on Roosevelt Channel	**BD15 –** This capital project includes replacing the 48" CSP with a bridge and reconstructing the channel to match the size and shape of the downstream open waterway to eliminate the expected flooding problems. The location of the capital project is illustrated on Figure 3-6.
Greenhill Tributary Major Subbasin			
BDGH066 BDGH075B BDGH075C BDGH062B BDGH075A BDGH075D BDGH075E BDGH100A	10-yr existing 10-yr future	BD11A – Greenhill Tributary Drainage Improvements	**BD11A -** The capital project proposed to address these flooding problems consists of replacing undersized culverts/pipes and modifying the open waterway to eliminate the expected flooding problems. Once completed, the capital project is expected to provide not only flood control and channel stabilization benefits, but also water quality and natural resources benefits for the Greenhill Tributary. The location of the capital project is illustrated on Figure 3-3.

In addition to the flooding problems identified as a result of basin modeling, the following capital project was proposed to address other identified flooding problems.

Citywide Annual Budget Line Item - Tip-ups – There are 17 tip-ups that have been identified as potential causes of flooding problems in this basin. Tip-up retrofits were proposed to address potential maintenance-related flooding issues at these locations. The tip-up retrofits that are proposed include manhole or vault-like structures that will allow for the capture and removal of sediments/debris and will also allow for maintenance access. The tip-up locations that have been identified in this basin are as follows:

1) BDA2140B - located at the north end of Golden Garden Road.
Node 58233 to 58235
*Page 16 of 97
Tip-up offset = 3.8 ft

2) BDA2290C - located adjacent to Willamette H.S.
Node 69021 to 60488
*Page 29 of 97
Tip-up offset = 2.79 ft

3) BDA3110D - located along 1st just east of Wallis.
Node 63307 to 63359
*Page 31 of 97
Tip-up offset = 0.99 ft

4) BDRC050B - located at the upstream end of the Roosevelt Channel.
Node 61837 to 61977
*Page 29 of 97
Tip-up offset = 0.19 ft

5) BDGH120E - located at Terry Street.
Node 61601 to 61605
*Page 19 of 97
Tip-up offset = 1.59 ft

6-8) BDA3130A, BDA3150A, and BDA3180A - all located at the upstream end of the A-3 Channel.
Nodes 63364, 63335, and 63351 to node 63305
*Page 42 of 97
Tip-up offset =1.34, 0.77, 1.16 ft respectively

9) Node 60536 to 60456
Located just east of Baxter St., south of Marshall, and north of Hawthorne.
*Page 29 of 97
Tip-up offset = 0.52 ft

10) Node 66893 to 61737
Drains into an open waterway running north along Beltline.
*Page 19 of 97
Tip-up offset = 1.5 ft

11) Node 61759 to 61738
Drains into a ditch which drains to the Roosevelt Channel south of Marcum and east of Fergus.
*Page 19 of 97

Tip-up offset = 2.4 ft

12) Node 58242 to 58243
Drains from Jessen Drive into the open waterway along Highway 99.
*Page 27 of 97
Tip-up offset = 2.3 ft

13) Node 66280 to 61733
Originates from Hilton Dr. and drains into the open waterway which parallels Beltline.
*Page 19 of 97
Tip-up offset = 1.6 f

14) Node 63635 to 63623
Drains to the west under SPRR and into an open waterway located just north of 5th Ave.
*Page 42 of 97
Tip-up offset = 1.9 ft

15) Node 66171 to 58856
Located on Cody St. between Dewey St., and Devos St.
*Page 17 of 97
Tip-up offset = 2.8 ft

16) Node 62228 to 62234
Located at the west end of Side St. draining west to the open waterway that runs along the Burlington Northern Railroad ROW.
*Page 41 of 97
Tip-up offset = 3.5 ft

17) Node 58861 to 58848
Located at the south end of Mangan Street draining east to an open waterway.
*Page 19 of 97
Tip-up offset = 2.4 ft

**Note: The page number listed above refers to the page number in the City of Eugene Wastewater and Stormwater Index Maps Books.*

In addition to the proposed capital projects listed above, a separately planned and funded City project is described below as it will also provide flood control benefits within the Bethel-Danebo basin.

BD100 – Royal Avenue Nodal Development - The Royal Avenue Nodal Development project is a 2000-acre pilot project being developed by the City for the purposes of demonstrating nodal development design concepts. While the primary purpose of the project is to link land use and transportation systems more effectively in order to reduce vehicle miles traveled, a secondary purpose is to demonstrate an alternative stormwater design system. Key stormwater concepts being considered include: integration and enhancement of existing open waterway features as multiple-use corridors for conveyance, recreation and open space; alternative street drainage systems including vegetated swales; requirements for on-site treatment of runoff by commercial and high density residential land uses; and construction of neighborhood treatment facilities.

3.2.2 Development Standard Alternatives

In addition to capital project alternatives, development standard alternatives were evaluated for addressing those problems that are expected to occur as a result of future buildout conditions. The two flood control development standards that were evaluated for the Bethel-Danebo basin were as follows:

- *Require post-development peak flows to equal pre-development peak flows* – This standard would require developers to ensure that post-development peak flow rates would not exceed pre-development peak flow rates from their sites for the flood control design storm of concern. This requirement could be met through the use of reduced effective impervious areas, infiltration, or detention.

- *Require post-development peak flows to equal available capacity* – This standard would require developers to ensure that post-development peak flow rates would not exceed the design capacity of the existing public stormwater conveyance system that would be accepting these flows. This standard would allow developers to take advantage of available surplus capacity where it exists in the public system. This standard would require that the City conduct hydraulic analyses in order to provide information to developers regarding available capacity. This requirement could also be met through the use of reduced effective impervious areas, infiltration, or detention. This standard is currently required where there are no model results and capital projects are not proposed.

3.3 Selected Alternatives

Capital projects were selected to address all of the flooding problems expected to occur under existing conditions. When several capital project options were proposed for addressing the same flooding problem, one capital project option was chosen as a result of a capital project selection and prioritization process that was implemented for this project (see Section 4.0 and Appendix J of Volume I).

For addressing flooding problems expected to occur under future buildout conditions, the capital project and development standards alternatives were compared in terms of both costs and effectiveness. For the Bethel-Danebo basin, the capital project alternatives were estimated to be more cost effective than the development standard alternatives for the following reasons:

- Of the eight flooding problems identified on the Greenhill Tributary, three of the flooding problems are expected to occur under existing as well as buildout land use conditions. The segments that are expected to be deficient under buildout conditions are generally adjacent to the segments that are expected to have flooding problems under existing land use conditions. For this reason, a capital project is recommended at this location (BD11A), regardless of which approach is taken. Therefore, implementing of a flood control development standard to address future deficiencies would not be the most cost effective solution.
- Although the 48" CSP culvert (BDRC030C) that runs under a private driveway east of Bertlesen Road in the Roosevelt Channel is expected to be deficient under future land use conditions, the culvert is significantly surcharged for the 10-year design storm under existing

land use conditions. The proposed capital project at this location (BD15) involves replacing the culvert with a bridge. The replacement will eliminate not only the flooding problem under buildout conditions, but also the significant surcharging conditions under existing land uses. The bridge will also provide natural resources benefits through the expansion and enhancement of the riparian corridor. Implementing a flood control development standard to address this problem would not provide these additional benefits.

- The two flooding problems identified on Bell Ave. are both expected to occur under existing land use conditions in addition to buildout conditions. Therefore, development standards alone would not be expected to resolve this problem and a capital project (BD06) would be required at this location regardless of which approach is taken.
- An issue associated with new development is adverse impacts to waterways from the increase in volume of stormwater discharged to them. Increased flow volumes can result in erosion, downcutting and riparian habitat degradation. Detention systems designed solely for flood control would not address this issue of hydrologic (volume) impacts due to new development.

In summary, the selected flood control alternatives to address the expected flooding problems under both existing and future conditions for this basin include each of the capital projects listed below. For more detail regarding each of these projects, capital project fact sheets are provided in the Appendix. The full range of flood control, water quality and natural resource capital projects are listed in Section 6.3 and shown on Figures 3-2 through 3-8.

- **Citywide Annual Budget Line Item – Tip-Ups:** Retrofit the existing tip-ups located throughout the basin with a sedimentation manhole that provides maintenance access.

- **Capital Project BD06 – Increase Pipe Sizes Along Bell Ave.:** Increase pipe sizes along Bell Ave. to eliminate the expected flooding problems (Note: The fact sheet that is provided in the appendix for this project is not up-to-date as of the date of this document and does not reflect the new survey information that was obtained for this system. It has been provided for general information purposes. See details regarding information updates in Section 1.0).

- **Capital Project BD11A – Greenhill Tributary Drainage Improvements:** Replace undersized culverts/pipe and modify the open waterway to eliminate the expected flooding problems. (Note: As of the date of this master plan report, the City is in the process of finalizing the detailed design for this capital project. Therefore, the capital project fact sheet is likely to be out-of date. It has been provided for general information purposes.)

- **Capital Project BD15 – Culvert Replacement in the Roosevelt Channel:** Replace the existing 48” diameter culvert with a bridge to eliminate the expected flooding problems.

- **Capital Project BD100 – Royal Ave. Nodal Development:** Plan for: 1) the integration and enhancement of existing open waterway features as multiple-use corridors for conveyance, recreation and open space; 2) street drainage systems including vegetated

swales; 3) on-site treatment of runoff; and 4) construction of neighborhood facilities in the Royal Ave. Nodal development.

- **Multiple Objective Stormwater Capital Improvement Program:** In general, all stormwater capital projects, including water quality and natural resources projects, will consider flood control objectives when feasible and appropriate.

TABLE 3-2
MAJOR HYDROLOGIC INPUT/OUTPUT DATA FOR THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)					Average Subbasin Slope (ft/ft)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			Existing Land Use		Future Land Use		Increase [1] (%)		10-Year	25-Year-W[2]	25-Year-S[3]	50-Year	100-Year	10-Year	25-Year-W[2]	25-Year-S[3]	50-Year	100-Year
			Mapped	Effective	Mapped	Effective												
Bethel Danebo - A2 Channel																		
BDA2-010	58209	61.6	17.0	14.5	25.1	21.3	6.9	0.007	12	9	10	23	30	15	11	15	31	38
BDA2-020	58709	37.5	40.0	34.0	42.0	35.7	1.7	0.003	12	12	15	26	30	12	13	16	26	31
BDA2-030	58689	84.0	38.0	32.3	45.1	38.3	6.0	0.000	19	20	29	35	41	22	23	33	39	46
BDA2-040	58205	39.2	33.0	28.1	38.9	33.1	5.1	0.008	12	12	14	26	32	13	13	16	30	36
BDA2-050	58207	113.1	0.0	0.0	10.9	9.3	9.3	0.005	3	2	0	3	6	10	9	12	23	28
BDA2-060	58673	40.7	44.0	37.4	45.1	38.3	0.9	0.005	13	13	18	30	35	13	13	18	30	36
BDA2-070	58680	40.1	43.0	36.6	47.1	40.0	3.5	0.010	16	15	18	34	41	17	16	19	37	44
BDA2-080	66164	110.7	38.0	32.3	38.9	33.1	0.8	0.003	31	32	42	67	79	31	32	43	68	80
BDA2-090	58950	70.3	45.0	38.3	45.1	38.3	0.0	0.004	22	21	31	50	59	22	21	31	50	59
BDA2-100	60245	56.1	45.0	38.3	47.1	40.0	1.8	0.005	15	15	24	34	40	16	16	25	36	41
BDA2-110	58645	78.5	38.0	32.3	41.1	34.9	2.6	0.002	17	18	29	37	43	19	19	31	40	46
BDA2-120	80004	51.4	14.0	11.9	23.1	19.6	7.7	0.009	8	6	7	16	21	11	8	11	23	30
BDA2-130	80007	109.8	18.0	15.3	28.0	23.8	8.5	0.006	34	35	30	58	71	39	40	40	74	88
BDA2-140	58946	68.0	35.0	29.8	45.1	38.3	8.6	0.001	16	16	23	34	40	20	20	30	41	48
BDA2-150	58875	56.6	50.0	42.5	51.1	43.4	0.9	0.008	18	19	28	39	46	19	19	28	40	47
BDA2-160	80009	70.4	41.0	34.9	60.0	51.0	16.2	0.001	19	19	28	36	42	25	26	38	46	54
BDA2-170	80010	28.5	33.0	28.1	48.0	40.8	12.8	0.001	6	6	9	13	15	8	8	13	17	20
BDA2-180	80015	13.5	32.0	27.2	46.0	39.1	11.9	0.003	4	4	5	8	9	5	5	6	10	12
BDA2-190	58894	56.3	37.0	31.5	48.0	40.8	9.4	0.001	13	12	20	30	34	16	16	26	37	42
BDA2-200	58893	58.6	50.0	42.5	55.1	46.8	4.3	0.005	17	17	28	42	48	18	19	31	45	52
BDA2-210	58853	49.2	16.0	13.6	60.0	51.0	37.4	0.003	5	5	8	13	16	18	18	29	41	48
BDA2-220	80017	85.3	20.0	17.0	62.9	53.5	36.5	0.006	13	12	17	30	36	33	33	52	81	94
BDA2-230	69700	13.9	40.0	34.0	54.0	45.9	11.9	0.000	3	3	5	7	9	4	4	7	9	11
BDA2-240	69714	34.1	53.0	45.1	61.1	51.9	6.9	0.001	13	13	18	25	29	14	14	20	27	32
BDA2-250	69732	211.5	34.0	28.9	62.0	52.7	23.8	0.001	47	48	69	91	107	77	79	114	135	158
BDA2-260	80018	69.6	4.0	3.4	58.0	49.3	45.9	0.001	2	2	3	5	6	23	23	36	43	49
BDA2-270	80022	26.3	59.0	50.2	58.9	50.1	0.0	0.001	9	9	15	21	24	9	9	15	21	24
BDA2-280	66548	42.2	46.0	39.1	48.9	41.6	2.5	0.000	12	12	18	24	28	13	13	20	25	29
BDA2-290	58883	77.9	38.0	32.3	44.0	37.4	5.1	0.001	21	21	29	44	52	23	24	34	49	58
BDA2-300	60488	65.4	30.0	25.5	40.0	34.0	8.5	0.001	17	17	20	33	39	20	21	26	40	47
BDA2-310	60565	60.7	40.0	34.0	45.1	38.3	4.3	0.001	17	17	23	32	37	18	19	26	34	40
BDA2-320	60238	39.9	45.0	38.3	47.1	40.0	1.8	0.001	10	11	17	25	29	11	11	18	26	30
BDA2-330	60216	56.9	44.0	37.4	45.1	38.3	0.9	0.002	15	16	24	31	36	16	16	24	31	37
BDA2-340	60123	39.7	45.0	38.3	45.1	38.3	0.0	0.002	10	11	17	22	25	10	11	17	22	25
BDA2-350	80025	12.6	41.0	34.9	42.9	36.5	1.7	0.002	3	3	5	9	10	3	3	5	9	11
BDA2-360	60107	33.9	38.0	32.3	40.0	34.0	1.7	0.002	9	8	13	20	24	9	9	13	21	25
BDA2-370	67069	54.5	35.0	29.8	45.1	38.3	8.6	0.000	13	13	19	26	31	16	16	24	31	37
BDA2-380	66573	139.9	43.0	36.6	44.0	37.4	0.9	0.001	37	38	55	69	81	38	39	56	70	82
BDA2-390	60461	41.1	44.0	37.4	44.0	37.4	0.0	0.002	15	15	19	32	38	15	15	19	32	38
BDA2-395	60454	67.1	49.0	41.7	52.9	45.0	3.4	0.001	22	23	32	44	51	23	24	35	46	54
BDA2-400	68451	66.1	46.0	39.1	47.1	40.0	0.9	0.001	23	24	31	51	60	24	24	32	52	61
BDA2-405	60541	21.5	65.0	55.3	70.0	59.5	4.3	0.003	10	10	14	23	26	11	11	15	24	28

TABLE 3-2 (continued)
MAJOR HYDROLOGIC INPUT/OUTPUT DATA FOR THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)					Average Subbasin Slope (ft/ft)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			Existing Land Use		Future Land Use		Increase [1] (%)		10-Year	25-Year-W[2]	25-Year-S[3]	50-Year	100-Year	10-Year	25-Year-W[2]	25-Year-S[3]	50-Year	100-Year
			Mapped	Effective	Mapped	Effective												
BDA2-408	69935	63.8	52.0	44.2	58.9	50.1	5.9	0.001	21	21	30	36	43	23	23	33	39	46
BDA2-410	80027	21.7	37.0	31.5	46.0	39.1	7.7	0.001	6	6	8	12	14	7	7	10	14	16
BDA2-420	60101	37.6	43.0	36.6	47.1	40.0	3.5	0.001	11	12	16	23	27	12	12	17	25	29
BDA2-430	61733	61.2	40.0	34.0	44.0	37.4	3.4	0.001	17	17	23	30	36	18	18	25	32	38
Bethel Danebo - A3 Channel																		
BDA3-010	61607	71.8	1.0	0.9	4.0	3.4	2.6	0.002	0	0	1	1	2	2	2	3	5	6
BDA3-020	61608	137.4	22.0	18.7	48.0	40.8	22.1	0.007	23	22	30	52	62	43	43	64	98	114
BDA3-030	61694	67.0	19.0	16.2	38.0	32.3	16.2	0.003	17	17	15	29	35	24	24	27	45	53
BDA3-040	80050	157.9	26.0	22.1	62.9	53.5	31.4	0.064	56	52	50	107	134	83	81	106	192	227
BDA3-050	modpt	43.5	49.0	41.7	64.0	54.4	12.8	0.003	13	13	21	29	34	17	17	27	36	41
BDA3-060	63147	36.3	65.0	55.3	68.9	58.6	3.4	0.008	15	14	23	38	44	16	15	24	40	47
BDA3-070	63207	36.0	32.0	27.2	56.0	47.6	20.4	0.000	7	7	11	13	16	11	12	16	19	23
BDA3-080	63129	105.9	14.0	11.9	22.0	18.7	6.8	0.008	18	18	16	33	42	22	23	24	46	56
BDA3-090	67158	103.3	23.0	19.6	36.0	30.6	11.1	0.024	22	21	24	46	57	29	28	37	67	80
BDA3-100	63276	63.4	18.0	15.3	58.0	49.3	34.0	0.001	13	13	12	23	28	26	27	37	53	62
BDA3-110	63359	72.1	43.0	36.6	66.0	56.1	19.6	0.001	21	21	29	38	45	29	29	42	50	59
BDA3-120	63326	73.0	30.0	25.5	44.0	37.4	11.9	0.038	19	18	22	40	49	24	24	32	55	65
BDA3-130	63364	39.2	42.0	35.7	66.0	56.1	20.4	0.001	15	15	18	31	37	19	19	27	44	51
BDA3-150	63349	76.8	54.0	45.9	67.1	57.0	11.1	0.004	28	28	40	52	61	33	34	48	60	70
BDA3-160	66631	95.5	29.0	24.7	62.9	53.5	28.9	0.005	28	27	30	49	57	43	44	59	77	90
BDA3-180	63369	67.9	52.0	44.2	66.0	56.1	11.9	0.001	23	24	35	48	56	28	30	43	57	66
BDA3-190	63811	85.7	55.0	46.8	67.1	57.0	10.3	0.001	28	28	41	49	57	33	34	47	55	65
BDA3-200	63822	43.8	40.0	34.0	65.1	55.3	21.3	0.003	18	17	21	35	42	23	23	31	49	57
BDA3-210	63826	59.7	61.0	51.9	68.0	57.8	6.0	0.002	24	25	36	50	59	26	27	40	54	63
BDA3-220	63800	88.9	60.0	51.0	68.9	58.6	7.6	0.001	33	34	49	61	72	37	38	56	67	78
BDA3-230	63795	75.8	41.0	34.9	65.1	55.3	20.5	0.002	26	26	32	48	57	35	35	49	65	75
Bethel Danebo - Greenhill Tributary																		
BDGH-010[4&5]		38.9	2.6	2.2	4.3	3.7	1.5	0.001										
BDGH-020[5]	80029	110.9	4.0	3.4	42.4	36.0	32.6	0.001	5	5	5	9	12	26	28	35	42	49
BDGH-030[5]	80031	182.9	1.0	0.9	41.2	35.0	34.2	0.001	6	5	2	8	12	44	45	61	72	85
BDGH-040[5]	80033	26.5	2.0	1.7	41.2	35.0	33.3	0.003	2	2	1	3	4	8	8	11	17	20
BDGH-050	80037	45.2	0.0	0.0	41.2	35.0	35.0	0.000	3	3	1	3	5	13	14	18	26	30
BDGH-060	80071	39.1	3.0	2.6	41.2	35.0	32.5	0.001	3	3	2	4	6	11	12	16	23	28
BDGH-062	70559	72.1	3.0	2.6	41.2	35.0	32.5	0.001	4	4	3	7	9	19	20	28	38	44
BDGH-064	80064	38.4	1.4	1.2	41.2	35.0	33.8	0.001	2	3	1	3	5	11	11	16	23	27
BDGH-066	70560	5.7	54.1	46.0	54.1	46.0	0.0	0.003	2	2	3	5	6	2	2	3	5	6
BDGH-068	70539	15.8	54.1	46.0	54.1	46.0	0.0	0.003	6	6	8	12	14	6	6	8	12	14
BDGH-070	59949	18.1	34.0	28.9	37.6	32.0	3.1	0.001	5	5	6	10	12	5	5	7	11	13
BDGH-075	80069	39.3	34.0	28.9	41.2	35.0	6.1	0.001	10	10	13	21	25	12	12	16	24	29
BDGH-080	70177	50.5	23.0	19.6	37.6	32.0	12.5	0.003	9	9	11	19	23	13	13	19	28	33
BDGH-090	59945	80.8	29.0	24.7	43.5	37.0	12.4	0.003	20	21	25	43	52	27	28	36	59	69
BDGH-100	60212	40.3	40.0	34.0	43.5	37.0	3.0	0.004	10	10	16	24	28	11	11	17	26	30

TABLE 3-2 (continued)
MAJOR HYDROLOGIC INPUT/OUTPUT DATA FOR THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Subbasin Name	Inlet Node	Subbasin Area (acres)	Impervious Area (%)					Average Subbasin Slope (ft/ft)	Subbasin Peak Flow (cfs) Existing Land Use Conditions					Subbasin Peak Flow (cfs) Future Land Use Conditions				
			Existing Land Use		Future Land Use		Increase [1] (%)		10-Year	25-Year-W[2]	25-Year-S[3]	50-Year	100-Year	10-Year	25-Year-W[2]	25-Year-S[3]	50-Year	100-Year
			Mapped	Effective	Mapped	Effective												
BDGH-110	60196	108.3	28.0	23.8	49.4	42.0	18.2	0.002	22	22	30	45	53	34	35	51	66	77
BDGH-120	80041	137.1	4.0	3.4	24.7	21.0	17.6	0.002	4	3	5	10	13	20	20	33	51	59
BDGH-130	69068	54.3	36.0	30.6	41.2	35.0	4.4	0.004	14	15	20	31	36	16	17	22	34	40
Bethel Danebo - Roosevelt Channel																		
BDRC-010	61727	94.9	21.0	17.9	60.0	51.0	33.2	0.002	27	27	24	48	58	45	44	60	98	115
BDRC-020	61741	54.6	44.0	37.4	62.9	53.5	16.1	0.001	17	17	23	30	35	22	22	31	37	44
BDRC-030	61743	38.9	35.0	29.8	47.1	40.0	10.3	0.002	14	13	15	28	33	16	16	20	34	40
BDRC-040	61959	168.9	42.0	35.7	50.0	42.5	6.8	0.001	52	53	71	102	120	59	60	83	115	135
BDRC-050	61977	63.3	40.0	34.0	58.0	49.3	15.3	0.001	21	22	26	42	50	27	28	37	55	64
BDRC-055	69952	224.8	27.0	23.0	58.9	50.1	27.2	0.002	44	44	60	85	100	81	82	117	141	165
BDRC-060	66603	28.2	54.0	45.9	64.0	54.4	8.5	0.001	11	11	16	25	29	13	13	18	28	33
BDRC-070	62329	38.4	48.0	40.8	57.1	48.5	7.7	0.001	15	15	19	31	37	16	17	23	36	42
BDRC-080	62317	92.2	53.0	45.1	65.1	55.3	10.3	0.011	35	36	49	71	84	41	42	59	82	96
Bethel Danebo - A Channel																		
BDAC-010[4]		176.8	2.0	1.7	28.0	23.8	22.1	0.003										

Note.
1. Increase in effective impervious percentage from existing land use conditions to future land use conditions
2. W = Winter
3. S = Summer
4. These subbasins were not included in the detailed model.
5. Subbasins have been refined in this area and updated hydrologic information is available by contacting the City of Eugene Public Works Department, Engineering Division.

TABLE 3-3
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
Bethel Danebo - A2 Channel												
BDA2010A	58209	80001	Natural	840	100	699	901	365.9	361.6	366.5	362.0	
BDA2010E	58709	58209	48" CSP	1029	10	29	32	365.0	364.9	365.5	365.2	
BDA2010Erd	58709	58209	Roadway	1029		0	0	364.9	364.9	365.2	365.2	
BDA2020A	58689	58709	42" CSP	830	10	19	22	367.4	365.0	367.5	365.5	
BDA2020Ard	58689	58709	Roadway	830		0	0	365.0	365.0	365.5	365.5	
BDA2010B	80002	58209	Natural	1540	100	659	855	368.8	365.9	369.7	366.5	
BDA2040A	58205	80002	60" CSP	390	10	13	22	367.4	367.4	368.0	368.0	
BDA2040Ard	80002	58205	Roadway	390		0	0	367.4	367.4	368.0	368.0	
BDA2040B	58204	58205	60" CSP	665	10	3	9	367.4	367.4	368.0	368.0	
BDA2040Brd	58205	58204	Roadway	665		0	0	367.4	367.4	368.0	368.0	
BDA2040C	58207	58204	48" CSP	250	10	3	10	367.4	367.4	368.0	368.0	
BDA2040Crd	58207	58204	Roadway	250		0	0	367.4	367.4	368.0	368.0	
BDA2060A	58673	80002	60" CSP	725	10	108	110	368.4	367.4	368.7	368.0	
BDA2060Ard	58673	80002	Roadway	725		0	0	367.4	367.4	368.0	368.0	
BDA2060B	58680	58673	72" CSP	884	10	96	98	370.4	368.4	370.5	368.7	
BDA2060Brd	58680	58673	Roadway	884		0	0	368.4	368.4	368.7	368.7	
BDA2110A	58658	58680	54" CSP	973	10	17	18	370.6	370.4	370.7	370.5	
BDA2110Ard	58680	58658	Roadway	973		0	0	370.6	370.6	370.7	370.7	
BDA2110B	58658	58645	24" CSP	166	10	17	19	370.6	372.5	372.6	370.7	
BDA2110Brd	58658	58645	Roadway	166		0	0	370.6	370.6	370.7	370.7	
BDA2070A	58683	58680	60' CSP	1641	10	64	65	372.9	370.4	373.0	370.5	
BDA2070Ard	58683	58680	Roadway	1641		0	0	370.4	370.4	370.5	370.5	
BDA2080A	66164	58683	48" CSP	40	10	64	66	374.9	374.4	374.9	374.4	
BDA2080Ard	66164	58683	Roadway	40		0	0	372.9	372.9	373.0	373.0	
BDA2080B	66164	58668	60" CSP	280	10	36	37	375.0	374.9	375.0	374.9	
BDA2080Brd	58668	66164	Roadway	280		0	0	375.0	375.0	375.0	375.0	
BDA2080C	68474	58668	60" CSP	1272	10	36	36	375.3	375.0	375.3	375.0	
BDA2080Crd	68474	58668	Roadway	1272		0	0	375.0	375.0	375.0	375.0	
BDA2080D	58950	68474	54" CSP	501	10	36	36	375.5	375.3	375.5	375.3	
BDA2080Drd	58950	68474	Roadway	501		0	0	375.3	375.3	375.3	375.3	
BDA2090A	60231	58950	42" CSP	960	10	15	16	375.8	375.5	375.8	375.5	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDA2090Ard	60231	58950	Roadway	960		0	0	375.5	375.5	375.5	375.5	
BDA2090B	60245	60231	36" CSP	1068	10	15	16	377.0	375.8	377.1	375.8	
BDA2090Brd	60245	60231	Roadway	1068		0	0	375.8	375.8	375.8	375.8	
BDA2010C	80003	80002	Natural	56	100	536	716	368.8	368.8	369.7	369.7	
BDA2010D	80004	80003	Natural	480	100	535	717	368.9	368.8	369.8	369.7	
BDA2120A	80007	80004	Natural	2050	100	524	704	369.4	368.9	370.3	369.8	
BDA2130B	80009	80007	Natural	1050	10	17	23	379.3	375.3	379.4	375.4	
BDA2140A	58235	80007	Natural	200	10	33	37	370.7	367.9	370.8	368.5	
BDA2140B	58946	58235	42" CSP	350	10	33	37	372.9	371.9	373.2	372.0	
BDA2140Brd	58946	58235	Roadway	350		0	0	370.7	370.7	370.8	370.8	
BDA2140C	58875	58946	42" CSP	1690	10	18	18	373.5	372.9	373.8	373.2	
BDA2140Crd	58875	58946	Roadway	1690		0	0	372.9	372.9	373.2	373.2	
BDA2130A	80010	80007	Natural	2000	100	463	652	372.0	369.4	372.9	370.3	
BDA2170A	80014	80010	Natural	700	100	457	648	373.3	372.0	374.2	372.9	
BDA2170B	80015	80014	Bridge	135	100	457	650	373.5	373.3	374.3	374.2	
BDA2180A	58854	80015	Natural	550	100	454	647	373.7	373.5	374.6	374.3	
BDA2190B	58894	58854	84" CSP	445	10	64	106	372.7	372.7	373.2	373.1	
BDA2190Brd	58894	58854	Roadway	445		0	0	372.7	372.7	373.1	373.1	
BDA2190C	58893	58894	84" CSP	2163	10	55	93	373.5	372.7	374.5	373.2	
BDA2190Crd	58893	58894	Roadway	2163		0	0	372.7	372.7	373.2	373.2	
BDA2200A	58853	58893	84" CSP	469	10	46	79	373.8	373.5	374.8	374.5	
BDA2200Ard	58853	58893	Roadway	469		0	0	373.5	373.5	374.5	374.5	
BDA2200B	72463	58853	72" CSP	590	10	43	70	375.2	374.0	375.9	374.8	
BDA2200Brd	72463	58853	Roadway	590		0	0	373.8	373.8	374.8	374.8	
BDA2200C	72470	72463	72" CSP	705	10	43	70	376.2	375.2	376.9	375.9	
BDA2200Crd	72470	72463	Roadway	705		0	0	375.2	375.2	375.9	375.9	
BDA2200D	72474	72470	72" CSP	440	10	43	70	376.6	376.2	377.4	376.9	
BDA2200Drd	72470	72474	Roadway	440		0	0	376.6	376.6	377.4	377.4	
BDA2210A1	72474	72515	36" CSP	20	10	22	35	377.6	383.5	383.7	377.8	
BDA2210A2	72515	72474	36" CSP	20	10	22	35	383.5	377.6	383.7	377.8	
BDA2210Ard	72515	72474	Roadway	20		0	0	376.6	376.6	377.4	377.4	
BDA2210B1	58997	72515	36" CSP	40	10	22	35	385.5	383.5	387.0	383.7	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDA2210B2	58997	72515	36" CSP	40	10	22	35	385.5	383.5	387.0	383.7	
BDA2210Brd	58997	72515	Roadway	40		0	0	383.5	383.5	383.7	383.7	
BDA2210C	69700	58997	Natural	900	10	54	92	385.5	385.5	387.0	387.0	
BDA2220A	80017	69700	36" CSP	146	10	13	33	386.7	385.5	387.4	387.0	
BDA2220Ard	80017	69700	Roadway	146		0	0	385.5	385.5	387.0	387.0	
BDA2230A	69714	69700	60" CSP	869	10	55	88	385.8	385.5	388.0	387.0	
BDA2230Ard	69714	69700	Roadway	869		0	0	385.5	385.5	387.0	387.0	
BDA2240A	69732	69714	60" CSP	809	10	44	74	386.2	385.8	389.0	388.0	
BDA2240Ard	69732	69714	Roadway	809		0	0	385.8	385.8	388.0	388.0	
BDA2260A	80018	58854	Natural	1160	25	247	286	373.9	373.0	374.3	373.5	
BDA2260B	80019	80018	Natural	260	25	246	267	374.2	373.9	374.5	374.3	
BDA2260C	80020	80019	15x24 M baskhnd culvert	110	25	247	267	374.2	374.2	374.6	374.5	
BDA2260D	80021	80020	Trapezoid	400	25	247	267	374.5	374.2	374.8	374.6	
BDA2270A	80022	80021	13x26 M baskhnd culvert	129	25	247	267	374.5	374.5	374.9	374.8	
BDA2280A	66548	80022	66" CSP	776	10	60	68	374.4	374.1	374.8	374.5	
BDA2280Ard	66548	80022	Roadway	776		0	0	374.1	374.1	374.5	374.5	
BDA2280B	58883	66548	60" CSP	1303	10	50	58	375.7	374.4	376.0	374.8	
BDA2280Brd	58883	66548	Roadway	1303		0	0	374.4	374.4	374.8	374.8	
BDA2290A	69242	58883	60" CSP	27	10	31	36	379.8	375.7	379.8	376.0	
BDA2290Ard	58883	69242	Roadway	27		0	0	375.7	375.7	376.0	376.0	
BDA2290B	69021	69242	Natural	1500	10	31	36	385.5	379.8	385.7	379.8	
BDA2290C	60488	69021	54" CSP	12	10	32	37	385.5	385.5	385.7	385.7	
BDA2290Crd	60488	69021	Roadway	12		0	0	385.5	385.5	385.7	385.7	
BDA2300A	68209	60488	48" CSP	1121	10	16	18	385.7	385.5	385.9	385.7	
BDA2300Ard	68209	60488	Roadway	1121		0	0	385.5	385.5	385.7	385.7	
BDA2300B	60565	68209	42"CSP	634	10	16	18	385.9	385.7	386.1	385.9	
BDA2300Brd	60565	68209	Roadway	634		0	0	385.7	385.7	385.9	385.9	
BDA2270B	80023	80022	Trapezoid	500	25	187	199	374.7	374.5	375.0	374.9	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDA2270C	80024	80023	15x24 M baskhnd culvert	90	25	186	198	374.7	374.7	375.0	375.0	
BDA2270D	60115	80024	Natural	1300	25	186	197	376.1	374.7	376.2	375.0	
BDA2320A	60238	60115	36" CSP	154	10	25	26	376.2	375.9	376.3	376.0	
BDA2320Ard	60238	60115	Roadway	154		0	0	375.9	375.9	376.0	376.0	
BDA2320B	60216	60238	36" CSP	1353	10	15	15	379.9	376.2	379.9	376.3	
BDA2320Brd	60216	60238	Roadway	1353		0	0	376.2	376.2	376.3	376.3	
BDA2320C	60123	60115	Natural	1290	25	165	175	378.5	376.1	378.6	376.2	
BDA2340A	80025	60123	Natural	630	10	141	149	378.6	378.3	378.7	378.4	
BDA2350A	60118	80025	Natural	840	10	119	125	380.0	378.6	380.1	378.7	
BDA2350B	59972	60118	66" CSP	512	10	120	126	381.0	380.0	381.2	380.1	
BDA2350Brd	59972	60118	Roadway	512		0	0	380.0	380.0	380.1	380.1	
BDA2350C	60107	59972	60" CSP	97	10	120	126	381.9	381.0	382.0	381.2	
BDA2350Crd	60107	59972	Roadway	97		0	0	381.0	381.0	381.2	381.2	
BDA2360A	67069	60107	Natural	1250	10	115	121	383.1	381.9	383.3	382.0	
BDA2380A	66573	67069	48" CSP	1309	10	35	36	383.9	383.1	384.1	383.3	
BDA2380Ard	66573	67069	Roadway	1309		0	0	383.1	383.1	383.3	383.3	
BDA2370A	60462	67069	Natural	600	10	77	79	383.3	383.1	383.4	383.3	
BDA2370B	60463	60462	54" CSP culvert	55	10	76	79	384.5	383.3	384.6	383.4	
BDA2370Brd	60463	60462	Roadway	55		0	0	383.3	383.3	383.4	383.4	
BDA2370C	60460	60463	Natural	570	10	77	79	385.7	384.5	385.7	384.6	
BDA2390A	60461	60460	54" CSP	102	10	77	80	386.2	385.7	386.3	385.7	
BDA2390Ard	60461	60460	Roadway	102		0	0	385.7	385.7	385.7	385.7	
BDA2390B	60455	60461	Natural	1000	10	65	68	387.2	386.2	387.3	386.3	
BDA2395A	60454	60455	48" CSP culvert	45	10	65	68	387.7	387.2	387.9	387.3	
BDA2395Ard	60454	60455	Roadway	45		0	0	387.2	387.2	387.3	387.3	
BDA2395B	60456	60454	Natural	700	10	47	48	387.9	387.7	388.1	387.9	
BDA2395C	68451	60456	48" CSP	1037	10	48	49	389.2	387.9	389.4	388.1	
BDA2395Crd	68451	60456	Roadway	1037		0	0	387.9	387.9	388.1	388.1	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDA2400A	60541	68451	36" CSP	1086	10	10	10	389.7	389.2	389.8	389.4	
BDA2400Ard	60541	68451	Roadway	1086		0	0	389.2	389.2	389.4	389.4	
BDA2400B	60550	68451	36" CSP	472	10	18	19	389.6	389.2	389.8	389.4	
BDA2400Brd	60550	68451	Roadway	472		0	0	389.2	389.2	389.4	389.4	
BDA2400C	62088	60550	36" CSP	365	10	18	19	389.9	389.6	390.1	389.8	
BDA2400Crd	62088	60550	Roadway	365		0	0	389.6	389.6	389.8	389.8	
BDA2400D	62089	62088	36" CSP	336	10	18	19	390.3	389.9	390.5	390.1	
BDA2400Drd	62088	62089	Roadway	336		0	0	390.3	390.3	390.5	390.5	
BDA2400E	62090	62089	30" CSP	170	10	17	18	390.7	390.3	390.8	390.5	
BDA2400Erd	62089	62090	Roadway	170		0	0	390.7	390.7	390.8	390.8	
BDA2400F	62024	62090	30" CSP	275	10	17	18	393.4	390.7	393.5	390.8	
BDA2400Frd	62024	62090	Roadway	275		0	0	390.7	390.7	390.8	390.8	
BDA2400G	62023	62024	3.5' x 2' Box culvert	28	10	17	18	393.6	393.4	393.6	393.5	
BDA2400Grd	62023	62024	Roadway	28		0	0	393.4	393.4	393.5	393.5	
BDA2400H	62022	62023	30" CSP	311	10	17	18	394.9	393.6	395.0	393.6	
BDA2400Hrd	62022	62023	Roadway	311		0	0	393.6	393.6	393.6	393.6	
BDA2400I	62093	62022	3.5' x 2' Box culvert	28	10	17	18	394.9	394.9	395.0	395.0	
BDA2400Ird	62093	62022	Roadway	28		0	0	394.9	394.9	395.0	395.0	
BDA2400J1	62094	62093	21" CSP	308	10	9	9	396.0	394.6	396.2	395.0	10yr - Existing
BDA2400J2	62094	62093	21" CSP	308	10	9	9	396.0	394.6	396.2	395.0	10yr - Existing
BDA2400Jrd	62094	62093	Roadway	308		0	0	396.0	396.0	396.2	396.2	
BDA2400K1	62025	62094	21" CSP	27	10	9	9	396.0	396.0	396.2	396.2	
BDA2400K2	62025	62094	21" CSP	27	10	9	9	396.0	396.0	396.2	396.2	
BDA2400Krd	62025	62094	Roadway	27		14	18	396.0	396.0	396.2	396.2	
BDA2400L1	62095	62025	21" CSP	109	10	10	11	396.5	396.0	396.8	396.2	
BDA2400L2	62095	62025	21" CSP	109	10	10	11	396.5	396.0	396.8	396.2	
BDA2400Lrd	62095	62025	Roadway	109		0	0	396.0	396.0	396.2	396.2	
BDA2400M	69935	62095	30" CSP	353	10	20	22	397.4	396.5	398.0	396.8	
BDA2400Mrd	62095	69935	Roadway	353		0	0	396.5	396.5	396.8	396.8	
BDA2410A	80027	80025	Natural	680	10	23	25	378.6	378.6	378.7	378.7	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDA2410B	60102	80027	Natural	580	10	19	21	378.7	378.6	378.8	378.7	
BDA2420A1	60101	60102	48" CMP culverts	120	10	10	11	378.7	378.7	378.8	378.8	
BDA2420A2	60101	60102	48" CMP culverts	120	10	10	11	378.7	378.7	378.8	378.8	
BDA2420Ard	60101	60102	Roadway	120		0	0	378.7	378.7	378.8	378.8	
BDA2430A	61733	60101	Natural	700	10	13	14	378.7	378.7	378.8	378.8	
Bethel Danebo - A3 Channel												
BDA3010A	61607	80044	Natural	2400	100	522	665	381.6	381.5	381.7	381.6	
BDA3020A1	61608	61607	6' x 10' Concrete Box culvert	100	100	270	337	381.7	381.6	382.0	381.7	
BDA3020A2	61608	61607	6' x 10' Concrete Box culvert	100	100	270	337	381.7	381.6	382.0	381.7	
BDA3020Ard	61608	61607	Roadway	100		0	0	380.9	380.9	381.1	381.1	
BDA3020B	67113	61608	Natural	2470	100	537	658	382.3	381.7	382.9	382.0	
BDA3030A1	61694	67113	6' x 10' Concrete Box culvert	83	100	271	332	382.5	382.3	383.1	382.9	
BDA3030A2	61694	67113	6' x 10' Concrete Box culvert	83	100	271	332	382.5	382.3	383.1	382.9	
BDA3030Ard	61694	67113	Roadway	83		0	0	381.3	381.3	381.8	381.8	
BDA3030B	80045	61694	Natural	850	100	528	646	382.9	382.5	383.6	383.1	
BDA3030C	80050	80045	Natural	1600	100	321	446	384.6	382.9	385.1	383.6	
BDA3040A	80051	80050	Natural	32	100	277	347	384.7	384.6	385.2	385.1	
BDA3040B	80052	80051	Natural	350	100	277	346	385.1	384.7	385.5	385.2	
BDA3040D	modpt	80052	Natural	1100	10	13	16	384.2	384.1	384.5	384.5	
BDA3040C	63147	80052	Natural	2370	100	269	336	387.6	385.1	388.2	385.5	
BDA3060A	63130	63147	Natural	470	100	257	321	387.8	387.6	388.4	388.2	
BDA3070A	63207	63147	36" CSP	892	10	6	11	386.6	386.6	387.2	387.1	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDA3070Ard	63147	63207	Roadway	892		0	0	386.6	386.6	387.2	387.2	
BDA3080A	63129	63130	7' x 10' Concrete Box culvert	96	100	257	321	388.1	387.8	388.7	388.4	
BDA3080Ard	63129	63130	Roadway	96		0	0	386.8	386.8	387.3	387.3	
BDA3080C1	80055	80054	Natural	750	100	245	310	390.7	390.7	391.5	391.5	
BDA3080C2	80056	80055	Natural	750	100	301	378	390.8	390.7	391.5	391.5	
BDA3080D	63309	80056	Natural	700	100	372	470	390.8	390.8	391.6	391.5	
BDA3090A	67158	63309	7' x 10' Concrete Box culvert	96	100	408	516	391.2	390.8	392.1	391.6	
BDA3090Ard	67158	63309	Roadway	96		0	0	389.7	389.7	390.3	390.3	
BDA3090B	63276	67158	Natural	1300	100	381	480	392.6	391.2	393.2	392.1	
BDA3110D	63359	63307	36" CSP	160	10	20	28	392.2	392.0	393.0	392.6	
BDA3110DRD	63359	63307	Roadway	160		0	0	392.0	392.0	392.6	392.6	
BDA3110C	63307	63275	Natural	1300	10	17	25	392.0	391.8	392.6	392.5	
BDA3110A	63275	63276	42" CMP	160	10	18	26	391.8	391.7	392.5	392.1	
BDA3110Ard	63275	63276	Roadway	160		0	0	391.7	391.7	392.1	392.1	
BDA3100A	63303	63276	Natural	600	100	346	415	392.9	392.6	393.5	393.2	
BDA3120A	63326	63303	42" CSP	140	10	18	23	392.0	391.9	392.5	392.4	
BDA3120Ard	63326	63303	Roadway	140		0	0	391.9	391.9	392.4	392.4	
BDA3100B	63305	63303	Natural	1900	100	337	387	394.4	392.9	394.8	393.5	
BDA3150C	63349	63332	42" CSP	27	10	27	32	393.7	393.6	394.4	394.4	
BDA3150Crd	63349	63332	Roadway	27		0	0	393.6	393.6	394.4	394.4	
BDA3150B	63332	63335	60" CSP	275	10	53	74	393.6	393.5	394.4	394.1	
BDA3150Brd	63332	63335	Roadway	275		0	0	393.5	393.5	394.1	394.1	
BDA3150A	63335	63305	48" CSP	80	10	53	74	393.5	393.3	394.1	393.8	
BDA3150Ard	63305	63335	Roadway	80		0	0	393.5	393.5	394.1	394.1	
BDA3160A	66631	63332	48" CSP	693	10	26	42	393.9	393.6	395.2	394.4	
BDA3160Ard	66631	63332	Roadway	693		0	0	393.6	393.6	394.4	394.4	
BDA3180A	63351	63305	48" CSP	70	10	48	59	393.5	393.3	394.1	393.8	
BDA3180Ard	63305	63351	Roadway	70		0	0	393.5	393.5	394.1	394.1	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDA3180B	63369	63351	48" CSP	889	10	48	58	394.6	393.5	395.8	394.1	
BDA3180Brd	63369	63351	Roadway	889		0	0	393.5	393.5	394.1	394.1	
BDA3180C	63810	63369	48" CSP	939	10	26	32	395.1	394.6	396.3	395.8	
BDA3180Crd	63810	63369	Roadway	939		0	0	394.6	394.6	395.8	395.8	
BDA3180D	63811	63810	42" CSP	400	10	27	31	395.8	395.1	396.7	396.3	
BDA3180Drd	63811	63810	Roadway	400		0	0	395.1	395.1	396.3	396.3	
BDA3130A	63364	63305	66" CSP	90	10	102	128	393.5	393.3	394.1	393.8	
BDA3130Ard	63305	63364	Roadway	90		0	0	393.5	393.5	394.1	394.1	
BDA3130B	63822	63364	60" CSP	2417	10	89	109	396.7	393.5	399.2	394.1	
BDA3130Brd	63822	63364	Roadway	2417		0	0	393.5	393.5	394.1	394.1	
BDA3200A	63826	63822	60" CSP	949	10	73	89	397.5	396.7	400.6	399.2	
BDA3200Ard	63826	63822	Roadway	949		0	0	396.7	396.7	399.2	399.2	
BDA3210A	63800	63826	60" CSP	1774	10	53	66	398.6	397.5	402.0	400.6	
BDA3210Ard	63800	63826	Roadway	1774		0	0	397.5	397.5	400.6	400.6	
BDA3220A	63797	63800	48" CSP	722	10	24	32	399.0	398.6	402.5	402.0	
BDA3220Ard	63797	63800	Roadway	722		0	0	398.6	398.6	402.0	402.0	
BDA3220B	63795	63797	42" CSP	713	10	25	32	400.3	399.0	403.4	402.5	
BDA3220Brd	63795	63797	Roadway	713		0	0	399.0	399.0	402.5	402.5	
Bethel Danebo - Greenhill Tributary												
BDGH050A1	80036	80070	36" CMP	45	25	72	91	371.0	369.5	371.7	370.7	
BDGH050A2	80036	80057	36" CMP	45	25	60	68	371.0	369.5	371.7	370.7	
BDGH050B	80035	80036	Natural	30	25	100	162	370.5	370.5	371.7	371.7	
BDGH050C	81000	80035	Natural	1875	10	85	151	371.7	370.0	372.3	371.0	
BDGH050D	81001	81000	Natural	120	25	90	177	372.0	371.8	372.9	372.6	
BDGH050E	80037	81001	Natural	20	25	90	177	372.0	372.0	373.0	372.9	
BDGH060	80071	80038	Natural	835	10	16	34	372.2	372.1	373.2	373.0	
BDGH060B	80040	80071	Natural	835	10	13	26	372.4	372.2	373.3	373.2	
BDGH062A	80065	80064	Natural	205	10	67	101	373.7	373.6	374.5	374.4	
BDGH062B	81005	80065	Natural	597	10	68	101	374.7	373.7	375.4	374.5	10-yr Future
BDGH062C	70559	81005	Natural	58	10	68	101	374.8	374.7	375.5	375.4	
BDGH064A1	81002	80037	3.4' x 5.1' Rectangle	15	10	47	78	372.0	371.9	372.9	372.7	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDGH064A2	81002	80037	3.4' x 5.1' Rectangle	15	10	35	64	372.0	371.9	372.9	372.7	
BDGH064Ard	81002	80037	Roadway	2700		0	0	371.9	371.9	372.7	372.7	
BDGH064B	81003	81002	Natural	22	10	82	142	372.0	372.0	372.9	372.9	
BDGH064C	80038	81003	Natural	26	10	82	142	372.1	372.0	373.0	372.9	
BDGH064D	81004	80038	Natural	32	10	68	109	372.2	372.1	373.0	373.0	
BDGH064E	81015	81004	Natural	395	10	69	109	373.2	372.2	374.0	373.0	
BDGH064F	80064	81015	Natural	437	10	69	109	373.6	373.2	374.4	374.0	
BDGH066	70560	70559	15" CSP	117	10	2	2	374.9	374.8	375.5	375.5	10-yr Existing
BDGH066rd	70560	70559	Roadway	117		0	4	374.8	374.8	375.5	375.5	
BDGH068	70539	70538	24" CSP	67	10	6	6	375.2	375.2	375.9	375.9	
BDGH068rd	70539	70538	Roadway	67		0	0	375.2	375.2	375.9	375.9	
BDGH070	59949	68192	27" CSP	335	10	4	5	375.3	375.2	376.0	376.0	
BDGH070rd	59949	68192	Roadway	335		0	0	375.2	375.2	376.0	376.0	
BDGH075A	81007	70559	Natural	545	10	64	84	375.2	374.8	375.9	375.5	10-yr Future
BDGH075B	70538	81007	Natural	55	10	64	84	375.2	375.2	375.9	375.9	10-yr Existing
BDGH075C	81009	70538	Natural	173	10	60	80	375.2	375.2	375.9	375.9	10-yr Existing
BDGH075D	81010	81009	Natural	22	10	60	80	375.2	375.2	375.9	375.9	10-yr Future
BDGH075E	80039	81010	Natural	35	10	60	81	375.2	375.2	375.9	375.9	10-yr Future
BDGH075F1	68192	80039	54" CSP	57	10	20	26	375.2	375.2	376.0	375.9	
BDGH075F2	68192	80039	48" CSP	57	10	15	20	375.2	375.2	376.0	375.9	
BDGH075F3	68192	80039	54" CSP	57	10	18	24	375.2	375.2	376.0	375.9	
BDGH075G	80069	68192	4' x 8' Concrete Box Culvert	549	10	50	66	375.3	375.2	376.1	376.0	
BDGH075Grd	80069	68192	Roadway	549	10	0	0	375.2	375.2	376.0	376.0	
BDGH080A	70170	80039	42" CSP	520	10	8	12	375.2	375.2	376.0	375.9	
BDGH080Ard	70170	80039	Roadway	520		0	0	375.2	375.2	375.9	375.9	
BDGH080B	70177	70170	42" CSP	520	10	8	12	375.2	375.2	376.0	376.0	
BDGH080Brd	70177	70170	Roadway	520		0	0	375.2	375.2	376.0	376.0	
BDGH090	59945	80069	Rectangle	296	10	42	57	375.4	375.3	376.2	376.1	
BDGH090rd	59945	80069	Roadway	296		0	0	375.3	375.3	376.1	376.1	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDGH100A	60116	59945	Natural	990	10	8	8	375.4	375.4	376.2	376.2	10-yr Future
BDGH100B	60210	60116	48" CSP Culvert	100	10	10	10	375.4	375.4	376.2	376.2	
BDGH100Brd	60210	60116	Roadway	100		0	0	375.4	375.4	376.2	376.2	
BDGH100C	60212	60210	36" CSP	632	10	10	11	376.5	375.4	376.6	376.2	
BDGH100Crd	60212	60210	Roadway	632		0	0	375.4	375.4	376.2	376.2	
BDGH110A	60111	59945	Natural	1660	10	20	30	375.9	375.4	376.5	376.2	
BDGH110B	60196	60111	48" CMP Culvert	44	10	20	33	376.1	375.9	376.7	376.5	
BDGH110BRD	60196	60111	Roadway	44		0	0	375.9	375.9	376.5	376.5	
BDGH120A1	80041	80040	48" CMP Culvert	41	10	7	14	372.4	372.4	373.4	373.3	
BDGH120A2	80041	80040	48" CMP Culvert	41	10	6	14	372.4	372.4	373.4	373.3	
BDGH120B	80042	80041	Natural	2070	10	12	12	373.3	372.4	373.6	373.4	
BDGH120C	80043	80042	72" CMP Culvert	24	10	13	14	373.4	373.3	373.6	373.6	
BDGH120D	61605	80043	Natural	560	10	13	15	376.0	373.4	376.1	373.6	
BDGH120E	61601	61605	42" CSP	50	10	14	15	376.2	376.0	376.3	376.1	
BDGH120Erd	61601	61605	Roadway	50		0	0	376.2	376.2	376.3	376.3	
BDGH130	69068	61601	42" CSP	152	10	14	15	376.2	376.2	376.3	376.3	
BDGH130rd	69068	61601	Roadway	152		0	0	376.2	376.2	376.3	376.3	
Bethel Danebo - Roosevelt Channel												
BDRC010A	80046	80045	66" CSP	19	25	175	216	382.9	382.2	384.1	383.0	
BDRC010Ard	80045	80046	Roadway	19		0	0	382.7	382.7	383.5	383.5	
BDRC010B	67117	80046	Natural	450	25	176	216	383.2	382.9	384.3	384.1	
BDRC010C1	61727	67117	60" CSP	132	50	101	123	384.3	383.7	385.5	384.6	
BDRC010C2	61727	67117	60" CSP	132	50	101	121	384.3	383.7	385.5	384.6	
BDRC010Crd	61727	67117	Roadway	132		0	0	383.1	383.1	383.8	383.8	
BDRC010D	80047	61727	Natural	1360	25	158	192	384.4	383.7	384.7	383.8	
BDRC020A	61732	80047	36" CSP	110	10	15	19	384.3	384.2	385.0	384.9	
BDRC020Ard	61732	80047	Roadway	110		0	0	384.2	384.2	384.9	384.9	

TABLE 3-3 (continued)
HYDRAULIC PERFORMANCE OF THE BETHEL DANEBO STORM DRAINAGE SYSTEM

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				When Deficient
								Existing Land Use		Future Land Use		
	US	DS				Existing	Future	US	DS	US	DS	
BDRC020B	80049	61732	Natural	520	10	16	20	384.6	384.3	385.1	385.0	
BDRC020C	61741	80049	Natural	1300	10	16	21	386.7	384.6	387.0	385.1	
BDRC010E1	80048	80047	6' X 6' Concrete box culvert	49	25	74	89	384.2	384.1	384.8	384.7	
BDRC010E2	80048	80047	6' X 6' Concrete box culvert	49	25	75	90	384.2	384.1	384.8	384.7	
BDRC010Erd	80048	80047	Roadway	49		0	0	384.2	384.2	384.9	384.9	
BDRC010F	67120	80048	Natural	1130	25	149	178	384.7	384.2	385.3	384.8	
BDRC030A	61743	67120	78" CSP	110	25	151	178	385.3	384.7	386.0	385.3	
BDRC030Ard	61743	67120	Roadway	110		0	0	384.8	384.8	385.4	385.4	
BDRC030B	61934	61743	Natural	1500	10	136	162	385.8	385.3	386.4	386.0	
BDRC030C	61935	61934	48" CSP	105	10	139	165	388.4	385.8	390.2	386.4	10-yr Future
BDRC030Crd	61935	61934	Roadway	105		0	0	385.8	385.8	386.4	386.4	
BDRC030D	61959	61935	Natural	800	10	142	185	388.5	388.4	390.3	390.2	
BDRC040A	61977	61959	Natural	2400	10	119	162	390.3	388.5	391.1	390.3	
BDRC050B	69260	61977	54" CSP	126	10	41	77	390.5	390.3	391.5	391.1	
BDRC050Brd	69260	61977	Roadway	126		0	0	390.3	390.3	391.1	391.1	
BDRC050C	69952	69260	54" CSP	1973	10	41	78	392.3	390.5	394.9	391.5	
BDRC050Crd	69952	69260	Roadway	1973		0	0	390.5	390.5	391.5	391.5	
BDRC050A	66603	61977	60" CSP	1520	10	58	66	392.0	390.3	392.5	391.1	
BDRC050Ard	66603	61977	Roadway	1520		0	0	390.3	390.3	391.1	391.1	
BDRC060A	62329	66603	48" CSP	1336	10	48	55	395.1	392.0	395.5	392.5	
BDRC060Ard	62329	66603	Roadway	1336		0	0	392.0	392.0	392.5	392.5	
BDRC070A	62317	62329	48" CSP	2018	10	34	40	398.7	395.1	398.9	395.5	
BDRC070Ard	62317	62329	Roadway	2018		0	0	395.1	395.1	395.5	395.5	

Bethel-Danebo Basin Drainage System

INDEX MAP

This index map shows the layout of the Bethel-Danebo basin into seven geographic areas depicted on Figures 3-2 through 3-8. These figures contain detailed drainage system information for areas within the city limits and urban growth boundary (UGB).

L E G E N D

- Eugene City Limits
- Urban Growth Boundary
- Eugene Plan Boundary

Basin Map Coverage

(Alternating color borders to distinquish overlapping areas.)

Bethel-Danebo Basin Major Subbasins

- A2 = A2 Channel
- A3 = A3 Channel
- AC = A Channel
- GH = Green Hill
- RC = Roosevelt Channel

N W E S

EUGENE

1 inch equals 0.80 miles

0.4 0 0.4 0.8 Miles

Produced by LCOG -August 2002
/betheldanebo/subareas_bd_index.apr

Figure 3-1

River Road
Santa Clara Basin

No Map

MERRYMAN RD

A Channel

AIRPORT RD

GREENHILL DR

AIRPORT RD

W END RD

River Road
Santa Clara Basin

KOKKELER

A Channel

A2 Channel

A2-000

CLEAR LAKE RD

A2-050

Figure 3-3

Bethel-Danebo Basin Drainage System

Legend

- Drainpipe - Modeled
- Drainpipe - Not Modeled
- Waterway - modeled
- Waterway - not modeled

Major Subbasins on this map

- A2 = A2 Channel

AB-123 Subbasin ID's within Major Subbasins

- Modeled Point
- *12345* Modeled Reference Numbers

Capital Projects

- BDxx Water Quality
- BDxx Natural Resources
- BDxx Flood Control

- Other Water Features
- Acquisition Corridor
- Urban Growth Boundary
- Eugene City Limits

Due to the scale of these maps, the display of some modeled pipe segments may either hide other nearby pipes, or appear connected when they are not.
To verify actual connections please refer to Table 3-3.

N
W E
S

EUGENE

1 inch equals 1,000 feet

500 0 500 1,000 Feet

Produced by LCOG - August 2002
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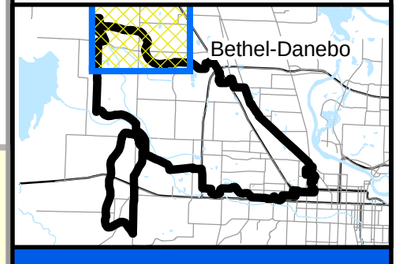

Figure 3-2

Figure 3-2

No Map

Figure 3-4

Figure 3-5

A2-000

A2-010

A2-020

A2-030

A2-040

A2-050

A2-060

A2-070

A2-080

A2-110

A2-120

GH-010

GH-020

GH-030

GH-040

GH-050

GH-060

GH-062

GH-064

GH-066

GH-068

GH-070

GH-075

GH-080

GH-090

AC-010

BD11A

BD11C

A2 Channel

A Channel

Amazon Diversion Channel

Greenhill Tributary

BODENHAMER DR

BARGER AVE

HILLAIRE

W HILLAIRE

E HILLAIRE

HEMMENWAY

GREEN HILL RD

PRAIRIE RD

SUGAR PINE

COETIVY

NORTH WAY

DANELAND

AVALON

W PORT

PORT LA VETA

ASTOVE

IRWIN WAY W

IRWIN WAY E

DE VOS

TERRY ST

80001 58209 80002 80003 80004 58207 58204 58205 58673 58658 58645 58680 58709 58689 58683 66164 58668 68474 80057 80036 80070 80035 81003 80037 81000 81001 81002 81004 80038 81015 80064 80065 81005 70559 70560 70539 81010 81007 81009 70538 68192 80039 80069 59945 60116 59949 70177 70170 80071

At the time of document production, a floodplain analysis was underway for Amazon Creek from the Southern Pacific Railroad crossing to Greenhill Road. The results of this analysis will be included in the next basin plan update. For status on the floodplain analysis contact Public Works Department, Engineering Division.

Bethel-Danebo Basin Drainage System

Legend

- Drainpipe - Modeled
- Drainpipe - Not Modeled
- Waterway - modeled
- Waterway - not modeled

Major Subbasins on this map

- A2 = A2 Channel
- GH = Green Hill
- AC = A Channel
- AB-123 — Subbasin ID's within Major Subbasins
- Areas where subbasin boundaries and model output data have been revised and updated. See contact reference below.*

Contact the City of Eugene Publuc Works Department, Engineering Division for updated information.

- Modeled Point
- 12345 — Modeled Reference Numbers

Capital Projects

- BDxx Water Quality
- BDxx Natural Resources
- BDxx Flood Control

- Other Water Features
- Acquisition Corridor
- Urban Growth Boundary
- Eugene City Limits

Due to the scale of these maps, the display of some modeled pipe segments may either hide other nearby pipes, or appear connected when they are not. To verify actual connections please refer to Table 3-3.

N W E S

EUGENE

1 inch equals 1,000 feet

500 0 500 1,000 Feet

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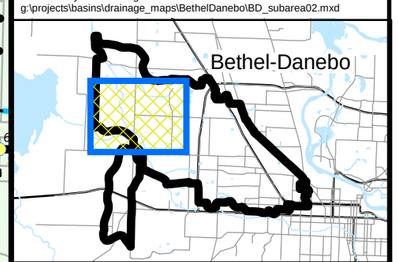

Figure 3-3

Bethel-Danebo Basin Drainage System

River Road Santa Clara Basin

Figure 3-3

Figure 3-6

Legend

- Drainpipe - Modeled
- Drainpipe - Not Modeled
- Waterway - modeled
- Waterway - not modeled

Major Subbasins on this map

- A2 = A2 Channel
- GH = Green Hill
- RC = Roosevelt Channel

AB-123 Subbasin ID's within Major Subbasins

- Modeled Point
- 12345 Modeled Reference Numbers

Capital Projects

- BDxx Water Quality
- BDxx Natural Resources
- BDxx Flood Control

- Other Water Features
- Acquisition Corridor
- Urban Growth Boundary
- Eugene City Limits

Due to the scale of these maps, the display of some modeled pipe segments may either hide other nearby pipes, or appear connected when they are not.
To verify actual connections please refer to Table 3-3.

N W E S

1 inch equals 1,000 feet

500 0 500 1,000 Feet

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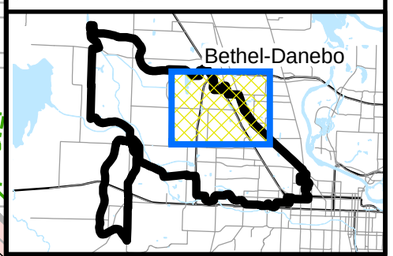
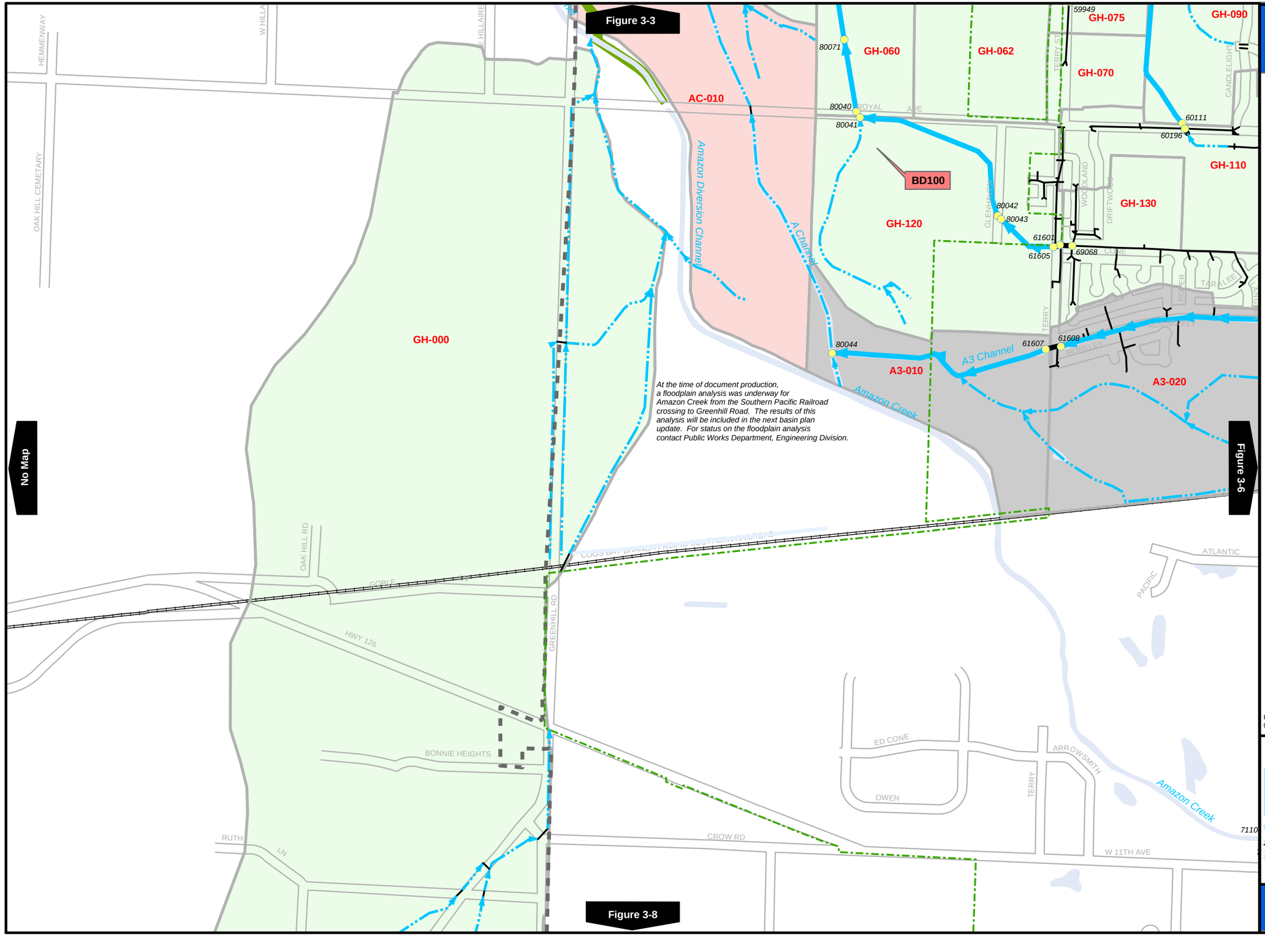


Figure 3-4

Bethel-Danebo Basin Drainage System



Legend

- Drainpipe - Modeled
- Drainpipe - Not Modeled
- Waterway - modeled
- Waterway - not modeled

Major Subbasins on this map

- A2 = A2 Channel
- GH = Green Hill
- AC = A Channel
- A3 = A3 Channel

AB-123 Subbasin ID's within Major Subbasins

- Modeled Point
- *12345* Modeled Reference Numbers

Capital Projects

- BDxx Water Quality
- BDxx Natural Resources
- BDxx Flood Control

- Other Water Features
- Acquisition Corridor
- Urban Growth Boundary
- Eugene City Limits

Due to the scale of these maps, the display of some modeled pipe segments may either hide other nearby pipes, or appear connected when they are not.
To verify actual connections please refer to Table 3-3.

N W E S

EUGENE

1 inch equals 1,000 feet

500 0 500 1,000 Feet

Produced by LCOG -August 2002
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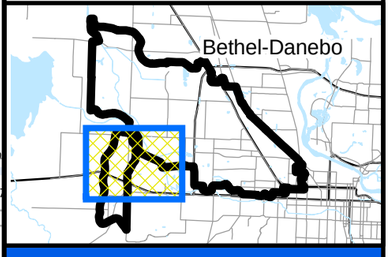
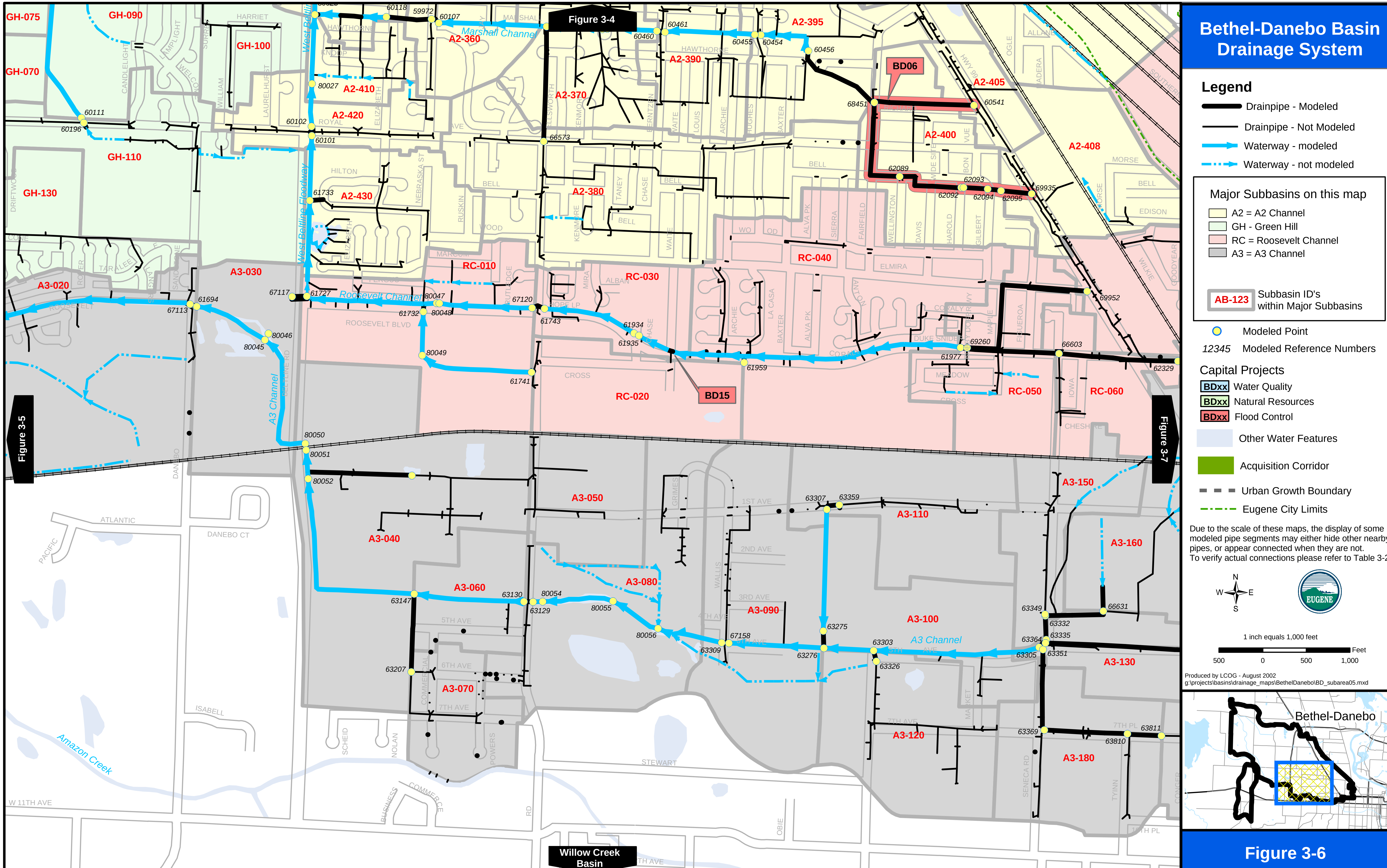


Figure 3-5



Bethel-Danebo Basin Drainage System
Legend
Drainpipe - Modeled
Drainpipe - Not Modeled
Waterway - modeled
Waterway - not modeled
Major Subbasins on this map
A2 = A2 Channel
GH - Green Hill
RC = Roosevelt Channel
A3 = A3 Channel
AB-123 Subbasin ID's within Major Subbasins
Modeled Point
12345 Modeled Reference Numbers
Capital Projects
BDxx Water Quality
BDxx Natural Resources
BDxx Flood Control
Other Water Features
Acquisition Corridor
Urban Growth Boundary
Eugene City Limits
Due to the scale of these maps, the display of some modeled pipe segments may either hide other nearby pipes, or appear connected when they are not.
To verify actual connections please refer to Table 3-2.
N
W
E
S
EUGENE
1 inch equals 1,000 feet
500 0 500 1,000 Feet
Produced by LCOG - August 2002
g:\projects\basins\drainage_maps\BethelDanebo\BD_subarea05.mxd
Bethel-Danebo
Figure 3-6
Figure 3-4
Figure 3-5
Figure 3-7
Willow Creek Basin
BD06
BD15
Marshall Channel
Roosevelt Channel
West Bertelsen Floodway
A3 Channel
Amazon Creek
GH-075
GH-090
GH-070
GH-100
GH-110
GH-130
A2-360
A2-395
A2-390
A2-405
A2-370
A2-410
A2-420
A2-400
A2-408
A2-430
A2-380
RC-010
RC-030
RC-040
RC-020
RC-050
RC-060
A3-020
A3-030
A3-040
A3-050
A3-060
A3-070
A3-080
A3-090
A3-100
A3-110
A3-120
A3-130
A3-150
A3-160
A3-180
ROOSEVELT BLVD
W 11TH AVE
STEWART

Bethel-Danebo Basin Drainage System

River Road/ Santa Clara Basin

Willamette River Basin

Amazon Creek Basin

Figure 3-6

A2-408

RC-055

RC-050

RC-060

RC-070

RC-080

A3-150

A3-160

A3-200

A3-230

A3-130

A3-210

A3-220

A3-190

A3-180

69935

62095

69952

66603

62329

62317

63795

63797

63800

63349

66631

63332

63364

63335

63305

63351

63822

63826

63369

63811

63810

PARK

HARDY

HAWTHORNE

KNOOP

KNAPP

MERIL

BAUER

TATUM

HANSEN

CROCKER

BRIARCLIFF

HOLEMAN

HOMASON

BAILEY

RASOR

MORSE

BELL

EDISON

WOOD

HAIG

PERSHING

ROOSEVELT BLVD

CROSS

CRANE

CROSS ST

CHESHIRE

7TH PL

8TH AVE

BROADWAY

9TH PL

10TH AVE

W 11TH AVE

1ST AVE

2ND AVE

3RD AVE

4TH AVE

5TH AVE

6TH AVE

7TH AVE

8TH PL

FLORAL

SKINNER BUTTE

VALLEY RIVER DR

VALLEY RIVER WAY

DELTA HWY

ELWOOD

ELWOOD DR

ELWOOD CT

TRAP LN

POOL ST

SAND

SAND AVE

ABBIE

CLINTON

LORELLI

VALLEY BUTTE

CRENSHAW

COUNTRY

Willamette River

SOUTHERN PACIFIC CO. RAILROAD

HWY 99

Legend

- Drainpipe - Modeled
- Drainpipe - Not Modeled
- Waterway - modeled
- Waterway - not modeled

Major Subbasins on this map

- A2 = A2 Channel
- RC = Roosevelt Channel
- A3 = A3 Channel

AB-123 Subbasin ID's within Major Subbasins

- Modeled Point
- 12345 Modeled Reference Numbers

Capital Projects

- BDxx Water Quality
- BDxx Natural Resources
- BDxx Flood Control

- Other Water Features
- Acquisition Corridor
- Urban Growth Boundary
- Eugene City Limits

Due to the scale of these maps, the display of some modeled pipe segments may either hide other nearby pipes, or appear connected when they are not.
To verify actual connections please refer to Table 3-3.

N W E S

1 inch equals 1,000 feet

500 0 500 1,000 Feet

Produced by LCOG - August 2002
g:\projects\basins\drainage_maps\BethelDanebo\BD_subarea06.mxd

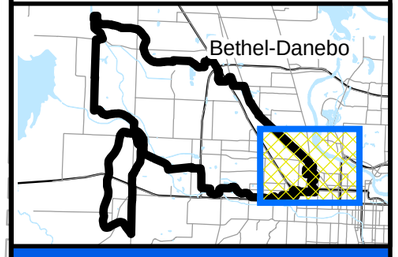


Figure 3-7

Figure 3-5

BONNIE HEIGHTS
RUTH
LN
OAK HILL
CROW RD
GH-000
ED CONE
OWEN
TERRY
ARROWSMITH
Amazon Creek
CROW RD
W 11TH AVE
LA PORT DR
WESTEC DRIVE
BARBARA
RENNE
CREEK
RD
PITCHFORD AVE
GREEN HILL RD
WILLOW CREEK RD
WILLOWDALE
GYPSY
KELLMOR
LOUVERING
No Map
No Map
Willow Creek Basin

Bethel-Danebo Basin Drainage System

Legend

- Drainpipe - Modeled
- Drainpipe - Not Modeled
- Waterway - modeled
- Waterway - not modeled

Major Subbasins on this map

- GH - Greenhill

AB-123 Subbasin ID's within Major Subbasins

- Modeled Point
- *12345* Modeled Reference Numbers

Capital Projects

- BDxx Water Quality
- BDxx Natural Resources
- BDxx Flood Control

- Other Water Features
- Acquisition Corridor
- Urban Growth Boundary
- Eugene City Limits

Due to the scale of these maps, the display of some modeled pipe segments may either hide other nearby pipes, or appear connected when they are not.
To verify actual connections please refer to Table 3-3.

N
W E
S

EUGENE

1 inch equals 1,000 feet

500 0 500 1,000 Feet

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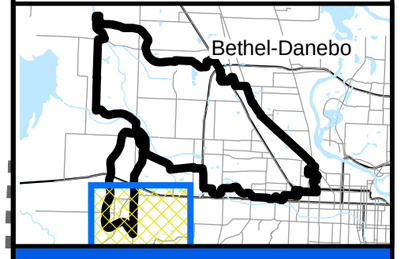


Figure 3-8

A general characterization of water quality in the Bethel-Danebo basin is described in Section 2.6. This section describes the processes that were used to further evaluate the existing water quality data (Section 4.1). Then, it describes the capital project alternatives and development standard alternatives (Section 4.2) that were proposed to address the water quality problems. Section 4.3 describes the selected water quality alternatives.

4.1 Evaluation of Water Quality Under Existing and Expected Future Conditions

To supplement the water quality information provided in Section 2.6, pollutant loads for Total Suspended Solids were calculated for the basin. Although TSS has not been shown to be directly related to all other pollutants, it was used as a general indicator of other pollutants for the purposes of making relative comparisons. The relative values and not the absolute values of the pollutant loads were used to assign priorities and to target those drainage subbasins or land uses that appear to contribute the largest pollutant loads to receiving waters. The values were also used to evaluate the relative contribution of pollutant loads expected as a result of future development. The methods used to estimate pollutant loads are described in Volume I, Section 3.2. The results for the Bethel-Danebo basin are provided in Figures 4-1 through 4-3 below. As mentioned in Section 2.6, these results are based on stormwater quality monitoring conducted in the City of Eugene. Although three of the stormwater monitoring stations were located in the Bethel-Danebo basin, all of the City-wide data were also used to provide general information regarding stormwater quality in Eugene and to identify a stormwater management strategy for this basin. In general, the Bethel-Danebo basin pollutant load is 1,806,000 pounds per year under existing condition and pollutant load is expected to increase by 43% as a result of future development (based on results from the TSS pollutant loads estimations).

Figure 4-1
Estimated Total Suspended Solids Loads Per Year in the Bethel-Danebo Basin (UGB)

Estimated TSS Pounds Per Year in the Bethel-Danebo basin	1,000 Pounds	Bethel-Danebo basin Relative to the Range of TSS Pounds Per Year in Other Eugene Basins
From Existing Development	1,806	
From Development of Vacant Land	784	
Total Buildout	2,590	

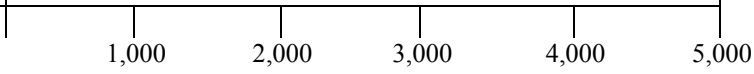


Figure 4-2
Estimated Increases in Total Suspended Sediment Loads Associated with Future Buildout in the Bethel-Danebo Basin (within the UGB)

Estimated Increase in TSS Loads	Percent	Bethel-Danebo Basin Relative to the Range of Increase in TSS Loading in Other Eugene Basins
From Future Development	43	

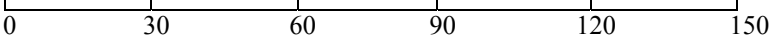
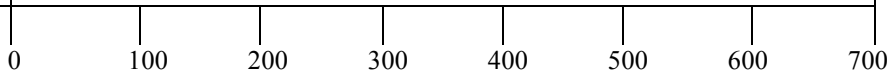


Figure 4-3
Estimated Total Suspended Solids Loads Per Acre - Per Year
in the Bethel-Danebo Basin (UGB)

Estimated TSS Pounds Per Acre Per Year in the Bethel-Danebo basin	Pounds per Acre per Year	Bethel-Danebo basin Relative to the Range of TSS Pounds Per Acre Per Year in Other Eugene Basins
Existing Development	292	
Development of Vacant Land	127	
Total Buildout	419	



The above information, along with the information provided in Section 2.6, was used to develop capital project and development standard alternatives for addressing water quality. The capital project alternatives and the development standard alternatives are described in Section 4.2, and the selected alternatives for the water quality portion of the basin strategy are described in Section 4.3.

4.2 Development of Water Quality Strategy

As shown in the stormwater basin master planning process flow chart in Figure 1-1, Step 1 included a compilation of basin characteristics. These basin characteristics are summarized in Section 2.0 of this document. Step 2 in the process included problem identification under both existing and future land use conditions. The results of this step for water quality are provided in Section 4.1 above. The next step included the development of potential stormwater management tools (i.e., capital projects or development standards) to address the identified problems. These stormwater management tools were developed as a result of an all-day basin assessment meeting. The meeting was attended by a large multi-disciplinary group of people including staff with experience in water quality, engineering, maintenance, natural resources, planning, and groundwater resources. Preliminary ideas were developed based on the goals and objectives of the project. This section describes the capital projects and water quality development standards that were proposed to address the identified water quality problems.

4.2.1 Capital Project Alternatives

Identifying potential capital projects to address water quality concerns is very different from identifying capital projects to address flooding issues. With respect to flooding, specific capacity deficiencies are identified through modeling and capital projects are proposed to address those deficiencies. With respect to water quality, pollutant discharges associated with urban runoff are ubiquitous. Therefore, with the exception of the specifically observed water quality problems, the focus of developing capital project alternatives for water quality was on identifying opportunity areas for the siting of surface water capital projects. This included looking for areas with the following characteristics: 1) sufficient space was available for a surface water quality facility, 2) space was available that was publicly owned or vacant and potentially available for purchase, 3) the location drained a large and densely developed high source area, and 4) the

location could be used to construct a capital project that addresses multiple objectives in addition to water quality control (i.e., flood control, natural resources enhancement, recreation, education).

For the Bethel-Danebo basin, only two opportunities were identified for larger-scale surface water quality projects. The first opportunity is located at the confluence of two open waterways in the Greenhill Tributary drainage system. The second opportunity consists of retrofitting Empire Park Pond located adjacent to Highway 99. These proposed capital projects are described in more detail below. As the A-3 Channel has been designated by DEQ as "water quality limited", and it receives drainage from high source industrial and commercial land uses, this system was considered to be high priority for locating water quality capital projects. Since open space was not available for surface water quality facilities, capital projects involving retrofits to the piped stormwater drainage system were evaluated and considered. These proposed projects are also described below.

Citywide Annual Budget Line Item – High Source Areas – This capital project would include retrofitting the piped stormwater drainage systems in high source areas with structural water quality facilities such as sedimentation manholes and select proprietary stormwater treatment devices to reduce the pollutant load. Single or multiple facilities may be appropriate for these high source areas and the facilities will be selected and designed to treat the particular pollutant of concern based on specific site conditions. The following seven drainage areas (identified by most downstream nodes) draining urban runoff into the A-3 Channel were identified for potential retrofits:

1) Node 67158, *page 31 of 97
   Approximately 70 acre drainage (Wallis Street drainage area).
2) Node 63276, *page 31 of 97
   Approximately 135 acre drainage (open waterway east of Wallis Street).
3) Node 63303, *page 31 of 97
   Approximately 73 acre drainage (Bailey Hill Road drainage area).
4) Node 63302, *page 31 of 97
   Approximately 7.3 acre drainage (intersection of 5th Ave and Market Street).
5) Node 63351, *page 42 of 97
   Approximately 154 acre drainage (south Seneca Road drainage area).
6) Node 63364, *page 42 of 97
   Approximately 307 acre drainage (Seneca Road and the A-3 Channel).
7) Node 63335, *page 42 of 97
   Approximately 172 acre drainage (north Seneca Road drainage area).

* Note: The page number listed above refers to the page number in the City of Eugene Wastewater and Stormwater Index Map books.

Citywide Annual Budget Line Item - Tip-ups – Tip ups were considered to be opportunity areas for addressing multiple objectives. In addition to localized flooding problems caused by sediment and debris buildup in tip-ups, the accumulated sediment and debris may be flushed into the downstream open waterway when large storms occur. Typically, the existing tip-ups do not have adequate access for maintenance. Tip-up retrofits were proposed to address potential maintenance-related flooding issues as described in Section 3.2.1. To address multiple objectives, the tip-up retrofits that were proposed included manhole or vault-like structures for

water quality benefits. These structures would allow for the capture and removal of sediments/debris and would also allow for maintenance access. There are seventeen tip-up locations that have been identified in this basin. They are listed in Section 3.2.1.

BD08- Retrofit Empire Pond – Empire Park Pond is located at the intersection of Highway 99, Empire Park Drive and Barger Drive. It receives stormwater runoff from Highway 99 and associated land uses in the highway corridor. It appears that stormwater runoff is causing sedimentation and water quality degradation of the pond. The pond provides an opportunity to enhance water quality and natural resource benefits. This capital project involves constructing a sediment forebay for stormwater discharges into the pond and enhancing the natural resources of the existing pond area through sediment removal and revegetation. The sediment forebay would prevent debris and coarse sediments from discharging into the pond and would facilitate maintenance access for removal of this material.

BD11C- Greenhill Tributary Water Quality Facility – The existing open space adjacent to the confluence of two open waterways on the Greenhill Tributary east fork provides an opportunity for a surface water quality project. This capital project includes constructing a water quality facility at this location.

In addition to the above proposed capital projects, the following related capital project is currently underway. This projects is described here as it will also provide some water quality benefits to the Bethel-Danebo basin.

BD100 - Royal Ave. Nodal Development Project – The Royal Ave. Nodal Development project is a 2000-acre pilot project being developed by the City for the purposes of demonstrating nodal development design concepts. More detail on this project can be found in Section 3.2.1 of this document.

4.2.2 Development Standard Alternatives

Potential development standards were considered for addressing the identified water quality problems in the Bethel-Danebo basin. The standards that were considered include:

- *Require Best Management Practices (BMPs) to reduce pollutants associated with stormwater runoff from new development for a design storm representing a specified amount of rainfall* – This standard would require developers to construct stormwater quality BMPs to reduce pollutants in stormwater runoff associated with a specific design event. Based on an analysis of rainfall data from Eugene, the design event was selected to represent 80% of the average total annual rainfall. An evaluation of the design storms representing 70%, 80%, and 90% of the average total annual rainfall was conducted. The design storm representing 80% was found to be the most cost effective. Significant cost increases were estimated using the 90% event with not much additional treatment. And, the cost difference between the 70% and 80% events was insignificant. Therefore, the 80% event was selected. As a result, the water quality design storm volume for detention type facilities is 1.4 inches over a 24 hour period; and the water quality design storm intensity for flow through type facilities is 0.22 inches/hour for on-line facilities and 0.13 inches/hour for off-line facilities. For more details

on the analysis conducted to develop the water quality design storm parameters, see Appendix K of Volume I.

- *Require additional BMPs for specific land uses* – This standard would be implemented in addition to the standard listed above. The standard listed above would result in a base set of water quality BMPs required for all land uses. This development standard would require additional water quality BMPs for specific land uses. Specifically, it would require oil control for high traffic areas, and structural source controls for industrial/commercial activities that are exposed to stormwater.

- *Require developers to construct stormwater quality BMPs that remove a specified percentage of pollutants (e.g., 80% removal of TSS)* - This development standard was not considered viable, however, due to its many disadvantages including: 1) this approach is very difficult for the development community to address because there are many unknowns about how to meet such a performance standard; 2) it is difficult to enforce compliance with this approach without conducting very expensive chemical monitoring of the influent and effluent; and 3) this approach does not address the fact that some constituents may be of concern in one receiving water but not another.

- *Prohibit filling and/or piping of key waterways* – This standard would prohibit filling and piping of "key" waterways that provide important stormwater functions including water quality protection and treatment. Criteria would be established for identifying "key" waterways for protection. This standard is covered in Section 5.2.2 of this plan.

4.3 Selected Alternatives

The water quality management alternatives selected address pollutant discharges from both existing and new development. For existing development, the focus was on opportunity areas for siting surface water quality capital projects. Where space is limited, underground water quality structures are recommended for high source areas. A significant portion of the Bethel-Danebo basin remains to be developed (i.e., 26% within the UGB). This will result in incremental increases in the discharge of pollutant loads to the open waterways. Therefore, for future development, a development standard is recommended for all land uses and additional BMPs are recommended for high source areas as they would effectively reduce these incremental increases in pollutant discharges. The development standard also applies to significant re-development as it will reduce additional pollutant discharges resulting from the re-development and will aid in addressing the existing water quality condition. The resulting water quality management strategy for the Bethel-Danebo basin consists of the following elements. For more detail regarding each of the capital projects, capital project fact sheets are provided in the Appendix.

- **Water Quality Development Standards:**

  - Require treatment BMPs that are designed according to the BMP Manual and the City's water quality design storms.

- Require additional BMPs for specific land use activities of concern (i.e., oil control for high traffic areas, and structural source controls for commercial/industrial activities that are exposed to stormwater).

- Prohibit filling and/or piping of key waterways for water quality protection and treatment (covered in Section 5.2.2).

- **Incentives for Existing Development:** Financial incentives will be incorporated into the stormwater user fee structure to encourage existing development not subject to the new water quality development standards to construct (retrofit) new stormwater quality BMPs.

- **Capital project Citywide Annual Budget Line Item – Water Quality Facilities in High Source Areas:** Retrofit the piped stormwater drainage systems in high source areas (e.g., commercial and industrial areas) with structural water quality facilities such as sedimentation manholes and other proprietary stormwater treatment devices to reduce the pollutant load. Single or multiple facilities may be appropriate for these high source areas and the facilities will be selected and designed to treat the particular pollutant of concern based on specific site conditions.

- ***Capital Project Citywide Annual Budget Line Item – Retrofit of Tip-ups:** Retrofit the existing tip-ups located throughout the basin with a sedimentation manhole that provides water quality benefits and maintenance access.

- **Capital Project BD08- Retrofit Empire Park Pond:** Retrofit the existing pond to provide water quality and natural resource benefits.

- **Capital Project BD11C- Greenhill Tributary Water Quality Facility:** Design and construct a neighborhood water quality facility at the confluence of two open waterways on east fork of the Greenhill Tributary.

- ***Capital Project BD100 – Royal Ave. Nodal Development Project:** Incorporate stormwater quality capital improvements into the Royal Avenue Nodal Development: integrate and enhance existing open waterway features to incorporate conveyance, water quality, recreation and open space; and use alternative street drainage and water quality systems including vegetated swales, structural and non-structural controls.

- **Multiple Objective Stormwater Capital Improvement Program:** In general, all stormwater capital projects, including flood control and natural resources projects, will consider water quality objectives when feasible and appropriate.

*Also listed under the flood control strategy in Section 3.0.

Note: It should be noted that this basin stormwater management strategy was intended to focus on water quality management tools in the form of development standards and capital projects. To comply with the National Pollutant Discharge Elimination System (NPDES) permit for stormwater discharges, the City is or has been also implementing a significant number of other

stormwater quality management practices that will supplement this strategy and help to reduce the discharge of pollutants in stormwater. These include the following:

Inspection, Enforcement, and Monitoring

- Strengthen Enforcement to Prevent and Eliminate Illicit Connections
- Field Screening to Detect and Eliminate Illicit Connections
- Monitor Stormwater Discharges from Industrial Facilities

Operations and Maintenance

- Revise Comprehensive Operation and Maintenance Plans
- On-going Evaluation of City Vegetation Management Practices to Protect Stormwater Quality
- On-going Evaluation of Ice and Snow Road Traction Practices to Protect Stormwater Quality
- Evaluate and Improve DOT Practices to Improve Stormwater Quality
- Improve Clean-up After Accidents and Fires
- Evaluate and Improve Existing Street Sweeping Program
- Evaluate and Improve Effectiveness of Storm System Cleaning
- Storm System Mapping and Data Management
- Improve Litter Pickup Programs in Public Areas and Major Events
- Prevent Leaks and Spills from Municipal Trucks
- Maintain and Equip a Trained Environmental Spill Response Team

Planning and Administration

- Review Street Design Standards with Respect to Water Quality (this has been completed)
- Erosion Prevention and Construction Site Management Program (a new ordinance was developed in 1999)
- Illegal Dumping Program
- Improve Solid Waste Management Program to Address Stormwater Quality
- Inventory and Maintain Wetland Mitigation Sites to Ensure Benefits are Maintained in Perpetuity

Public Education

- Stormwater Information and Education Activities
- Storm Drain Stenciling
- Support government and community Tree Planting Programs
- Eugene Stream Team Volunteer Activities
- Educate Commercial/Industrial Business About Good Housekeeping Practices
- Improve Reporting of Illegal Dumping
- Education for Stormwater-Friendly Design Practices
- Expand Household Hazardous Waste Disposal Program

SECTION 5 Stormwater Related Natural Resources

For purposes of the basin master planning process, the term "natural resources" pertains specifically to the City's open waterways drainage system and the characteristics of it that provide or assist in providing beneficial stormwater functions such as: storm conveyance, flood storage, water quality preservation or treatment, aquatic riparian habitat, and water temperature controls. These natural resources include the primary waterway corridors of Eugene and adjoining riparian and wetland areas, and headwater streams and wetlands. These characteristics are described in Section 2.0 of this report.

Section 5.1 describes the evaluation process used and the basin-specific problems and opportunities identified under existing and expected future conditions. A description of existing waterway protection measures, other related efforts underway, and gaps in stormwater related natural resources data is also included. Sections 5.2 describes the alternatives considered for addressing these problems and opportunities, and Section 5.3 describes the selected alternatives.

5.1 Evaluation of Natural Resources Under Existing and Expected Future Conditions

The following provides the objectives, methods, and results of the stormwater related natural resources evaluation for the Bethel-Danebo basin.

Objectives of the evaluation

- Determine the extent of the open waterway drainage system that should be protected for beneficial stormwater functions.
- Determine where existing protection policies apply and where gaps exist.
- Determine where restoration efforts should be targeted to improve stormwater functions.
- Determine where intervention efforts are needed to correct streambank stability problems.
- Determine what other efforts are underway which may ultimately provide protection consistent with stormwater program objectives.

Methods used to conduct the evaluation

Several methods were used to conduct the natural resources evaluation including the following:

- The following information was compiled and reviewed to assess the location, condition, and function of the Bethel-Danebo basin waterway systems. Most of the data were contained in the City's geographic information system (GIS):
  - Open waterway drainage system.
  - Draft inventory of the Eugene-Springfield Metropolitan Plan Natural Resources Study.
  - FEMA floodway and floodplain areas.
  - National wetland inventory.
  - Soil Survey of Lane County Area, Oregon (1987), Natural Resources Conservation Service.
  - Historic photos, hydric soils – to help reconstruct the historic drainage system (i.e. pre-settlement).
  - Areas with stormwater pipe system.
  - 1999 aerial photography of the Bethel-Danebo basin.

- Site visits to collect and verify GIS information about select portions of the waterway system including location, size, condition, and function. For the site visits that were conducted, functions were evaluated using a modified version of the Oregon Freshwater Assessment Methodology (OFWAM). This method was modified to focus on the stormwater related benefits of natural resources.
- Eugene Public Works Department engineering and maintenance staff were interviewed as to their knowledge of the system.
- Property owners provided site specific information at public workshops and through other contacts.
- Policy plans were reviewed to determine where and how waterways were protected in the Bethel-Danebo basin.
- Other City of Eugene and Metro area staff were consulted to identify other on-going efforts which may ultimately provide protection for waterways consistent with stormwater program objectives.

Results of the evaluation

The results are provided below in terms of both existing conditions and expected future conditions.

Existing Waterway System Conditions:

- The highly urbanizing condition of the Bethel-Danebo basin is causing significant changes to the open waterway systems.
- There are about 48 miles of remaining open waterways in the basin.
- Most of the remaining waterways are large conveyance channels constructed by the Soil Conservation Service in the 1950s and 1960s and are characterized by a trapezoidal shape with moderate riparian functions.
- Significant channels include Amazon Creek ("A" Channel), A3 Channel, A2 Channel, West Beltline Floodway, Marshall Channel, Roosevelt Channel, and the Greenhill Tributaries.
- Efforts to rehabilitate and/or restore Amazon Creek waterway and its floodplain functions have occurred in the southern portion of the basin.
- About 2 miles of waterways in this basin are protected through either FEMA Floodway restrictions or the City's Waterside Protection Overlay Zone.

Expected Future Waterway System Conditions:

- Future conditions for "private" waterways are expected to deteriorate due to lack of specific waterway protection policies and measures in this basin.
- Future conditions of "publicly owned and/or maintained" waterways are expected to remain the same or improve over existing conditions due to the City's commitment to environmentally friendly maintenance practices and increasing level of responsibility for managing the open waterway systems.

The remainder of this section provides additional context for the stormwater related natural resources evaluation:

Existing Protection Measures

- The Waterside Protection Overlay Zone (EC 9.4700) applies within West Eugene Wetlands Plan boundary and provides protection for channels, setbacks and contiguous riparian areas.
- The Natural Resource Zone (EC 9.2500) is intended to protect outstanding natural resource areas in adopted plans (EC 9.2500). It currently does not apply to any specific property but could be used in the future as a waterway protection tool.
- The Planned Unit Development (EC 9.8300) provisions contain specific approval criteria for protecting significant natural resources. These criteria are to be balanced with other policy needs and standards and, therefore, offer some but no consistent protection standards for waterways.
- Site Review (EC 9.8425) provisions contain approval criteria that could used for waterways protection if specifically identified for protection.

Other Related On-going Efforts

- Endangered Species/Salmon program is expected to develop strategies for responding to the *January 2001* listing of spring Chinook salmon. Strategies are likely to include incentives and regulatory measures for protection and restoration of salmon habitat in Eugene. The timeline for developing strategy options for Council consideration is fall 2002.
- The Metro Natural Resources Study (NR Study) is expected to provide increased protection of waterways with riparian habitat functions. The timeline for implementation of protection measures is 2005.

Data Gaps

- There are little or no available data as to existing aquatic habitat and species condition in the Bethel-Danebo basin waterways. These data would not only help further inform the condition of the waterways, but would also allow for better evaluation of the effects of proposed capital improvements to these waterways.

5.2 Development of the Natural Resources Strategy

As shown in the stormwater basin master planning process flow chart in Figure 1-1, Step 1 included a compilation of basin characteristics. These basin characteristics are summarized in Section 2.0 of this document. Step 2 in the process included problem identification under both existing and future land use conditions. The results of this step for natural resources are provided in Section 5.1 above. The next step included the development of potential stormwater management tools (i.e., capital projects or development standards) to address the identified problems and opportunities. These stormwater management tools were developed as a result of an all-day basin assessment meeting. The meeting was attended by a large multi-disciplinary group of people including staff with experience in water quality, engineering, maintenance, natural resources, planning, and groundwater resources. Preliminary ideas were developed based on the goals and objectives of the project. This section describes the capital projects and development standards that were proposed to address the identified stormwater-related natural resource problems and opportunities.

5.2.1 Capital Project Alternatives

The following capital projects were considered that would address stormwater related natural resources problems and opportunities:

Stream Corridor Acquisition - Stream corridors and specific sites with relatively high stormwater values which are also at risk of future development would be identified for acquisition. The following corridor (shown on Figures 3-2 through 3-8) was identified for acquisition in the Bethel-Danebo basin:

- "A" Channel north of Royal Avenue.

Citywide Annual Budget Line Item – Streambank Stabilization – This would be an annual budget line item for identifying and implementing streambank stabilization projects to help streams adjust to increased runoff volumes while limiting negative impacts associated with downcutting, sedimentation, and erosion. Where appropriate, bioengineering techniques would be used.

Citywide Annual Budget Line Item - Outfall Stabilization – This would be an annual budget line item for identifying and retrofitting storm drainage system outfalls which are creating localized erosion and bank stability problems.

Capital Project BD100 – Royal Avenue Nodal Development Project - The Royal Avenue Nodal Development project is a 2000-acre pilot project being developed by the City for the purposes of demonstrating nodal development design concepts. While the primary purpose of the project is to link land use and transportation systems more effectively in order to reduce vehicle miles traveled, a secondary purpose is to demonstrate an alternative stormwater design system. Key stormwater concepts being considered include: integration and enhancement of existing open waterway features as multiple-use corridors for conveyance, recreation and open space; alternative street drainage systems including vegetated swales; requirements for on-site treatment of runoff by commercial and high density residential land uses; and construction of neighborhood treatment facilities.

5.2.2 Development Standard Alternatives

Potential development standards were considered for addressing identified stormwater related natural resources problems and opportunities in the Bethel-Danebo basin.

- *Prohibit filling and/or piping of key waterways* – Using this approach, criteria would be established for identifying "key" waterways to be protected. A map of the key waterways and requirements would be adopted that would prohibit filling and/or piping of the waterways unless exemptions could be obtained. The key waterways approach would recognize that certain waterways possess characteristics that provide important stormwater functions and should be protected, while other smaller, isolated, segmented waterways provide little or no stormwater function and protection would not be warranted. This code would only apply within the Eugene city limits.

- *Pursue setback protection requirements for key waterways through other appropriate processes* – There is a significant overlap between the stormwater program, NR Study, and ESA/Salmon program. This approach would rely on these other processes for providing some or all natural resources protection policies.

- *Require BMPs to reduce pollutants associated with stormwater runoff from new development* – This standard would require new development to control the quality of stormwater runoff by selecting, designing, constructing, and maintaining a water quality facility. This standard is covered in Section 4.2.2 of this plan.

5.3 Selected Alternatives

The selected natural resources management strategy includes a combination of capital projects, development standards, and other items to address existing and future stormwater related natural resources problems and opportunities, as follows:

- **Support Existing Waterway Protection Standards:** (i.e., Waterside Protection Overlay Zone, "Needed Housing", Natural Resource Zone, Planned Unit Development provisions, Site Review provisions as applicable).

- **Prohibit Filling and/or Piping of Key Waterways:**

  Note: This standard was selected and an ordinance was processed through the Eugene Planning Commission and City Council. Ultimately, this standard was replaced by an approach that would apply no-fill/no-pipe prohibitions to all waterways until the NR Study was completed. When processed for adoption, this standard was referred to as the Open Waterways ordinance. The Open Waterways ordinance was challenged and subsequently remanded back to the City by the Land Use Board of Appeals for further processing. This ordinance is no longer in effect. The strategy for protecting stormwater significant waterways from being piped and filled is currently under development.

- **Water Quality Development Standard:** These standards are selected to prevent pollutants from entering the waterways. They include: treatment BMPs for stormwater runoff from new development, additional BMPs for specific land use activities of concern, and flow controls for headwater areas to protect water quality, and are covered in Section 4.2.2 of this plan.

- **Pursue Waterway Setback Protection Measures in Coordination with Natural Resources Study and ESA/Salmon Program (described in Section 5.1):** Coordination will continue to ensure consistency with stormwater program objectives for long term stream corridor protection and to identify and fill gaps in protection measures for waterways.

- **Stream Corridor Acquisitions:** Acquire the "A" Channel north of Royal Avenue.

- **Citywide Annual Budget Line Item - Streambank Stabilization:** Projects to be determined on an annual basis.

- **Citywide Annual Budget Line Item - Outfall Stabilization:** Projects to be determined on an annual basis.

- ***Capital Project BD100 – Royal Ave. Nodal Development Project:** Incorporate stormwater related natural resource benefits into the Royal Ave. Nodal Development project.

- **Multiple Objective Stormwater Capital Improvement Program:** In general, all stormwater capital projects, including flood control and water quality projects, will consider stormwater related natural resources protection and enhancement as project objectives when feasible.

- **Aquatic Habitat and Species Data Collection:** Opportunities to fill-in data gaps will be explored via local studies and/or as part of partnership arrangements with federal and state agencies.

*Also listed under the flood control strategy and/or the water quality strategy in Sections 3.0 and 4.0.

6.1 Integrated Stormwater Management Strategy

The stormwater management strategy for the Bethel-Danebo basin represents the City's recommended combined approach of capital projects and development standards to address the flood control, water quality, and stormwater related natural resources and maintenance problems and opportunities associated with stormwater discharges. The purpose of this section is to summarize the flood control, water quality, and stormwater related natural resource elements of the strategy as they were presented in Sections 3.0, 4.0, and 5.0 respectively. In addition, this section discusses the costs and priorities associated with implementing the strategy. The elements of the stormwater management strategy are presented below:

Flood Control Strategy

The following capital projects are proposed:

- **Citywide Annual Budget Line Item – Tip-Ups:** Retrofit the existing tip-ups located throughout the basin with a sedimentation manhole that provides maintenance access.
- **Capital Project BD06 - Increase Pipe Sizes Along Bell Ave.:** Increase pipe sizes along Bell Ave. to eliminate the expected flooding problems (Note: The fact sheet that is provided in the appendix for this project is not up-to-date as of the date of this document and does not reflect the new survey information that was obtained for this system. It has been provided for general information purposes. See details regarding information updates in Section 1.0).
- **Capital Project BD11A – Greenhill Tributary Drainage Improvements:** Replace undersized culverts/pipe and modify the open waterway to eliminate the expected flooding problems.
- **Capital Project BD15 – Culvert Replacement in the Roosevelt Channel:** Replace the existing 48" diameter culvert with a bridge to eliminate the expected flooding problems.
- **Capital Project BD100 – Royal Ave. Nodal Development:** Incorporate stormwater flood control benefits into the Royal Ave. Nodal Development project.

Water Quality Strategy

In order to reduce the pollutant load, the City proposes to implement an on-site water quality development standard for all new development and significant redevelopment throughout the basin. This development standard requires treatment BMPs that are designed according to the BMP Manual and the City's water quality design storms. The standard also requires additional BMPs for specific land use activities of concern (i.e., oil control for high traffic areas, and structural source controls for commercial/industrial activities that are exposed to stormwater).

Financial incentives will be incorporated into the stormwater user fee structure to encourage existing development not subject to the new water quality development standards to construct (retrofit) new stormwater quality BMPs.

In addition, the following capital projects are proposed:

- **Capital Project Citywide Annual Budget Line Item – Water Quality Facilities in High Source Areas:** Retrofit the piped stormwater drainage systems in high source areas (e.g., commercial and industrial areas) with structural water quality facilities to reduce the pollutant load.
- ***Capital Project Citywide Annual Budget Line Item – Retrofit of Tip-ups:** Retrofit the existing tip-ups located throughout the basin with a sedimentation manhole that provides maintenance access**.**
- **BD08- Retrofit Empire Park Pond:** Retrofit the existing pond to provide water quality and natural resource benefits.
- **BD11C- Greenhill Tributary Water Quality Facility:** Design and construct a neighborhood water quality facility at the confluence of two open waterways on the east fork of the Greenhill Tributary.
- ***BD100 - Royal Ave. Nodal Development:** Incorporate water quality benefits into the Royal Ave. Nodal Development project.

* Provide flood control benefits as well and are included in the list of flood control capital projects provided above.

Natural Resources Management Strategy

The natural resources strategy is focused on the protection and enhancement of open waterways for their stormwater functions and benefits. Part of the strategy will include support for existing waterway protection standards (i.e., Waterside Protection Overlay Zone, Natural Resource Zone, Planned Unit Developments provisions, Site Review provisions as applicable). Another part of the strategy involves coordinating with other related on-going efforts (NR Study, ESA) to ensure that, ultimately, the stormwater functions and benefits of stream corridors are protected and enhanced.

In addition, the following capital projects are proposed to improve open waterways in the basin:

- **Stream Corridor Acquisitions:** Acquire portions of specific parcels along the Amazon Diversion Channel, Amazon Creek, and the Greenhill Roadside channel.
- **Citywide Annual Budget Line Item – Streambank Stabilization:** Projects to be determined on an annual basis.
- **Citywide Annual Budget Line Item – Outfall Stabilization:** Projects to be determined on an annual basis.
- ***Capital Project BD100- Royal Ave. Nodal Development:** Incorporate stormwater related natural resource benefits into the Royal Ave. Nodal Development project.

* Also listed under either the flood control strategy and/or the water quality strategy.

Multiple Objective Stormwater Capital Improvement Program

It should be noted that, in general, all stormwater capital projects, will consider flood control, water quality and natural resources protection and enhancement as project objectives when feasible and appropriate. All stormwater capital projects will conform to adopted code requirements for private development, including stormwater quality standards. Opportunities to fill-in aquatic habitat and species data gaps will be explored via local studies and/or as part of partnership arrangements with federal and state agencies.

6.2 Summary of Strategy Benefits

When implemented, the integrated strategy is expected to provide the following benefits:

1. Provide the required level of flood protection basin-wide through capital projects.
2. Reduce existing pollutant loads through capital projects and financial incentives to retrofit existing developments.
3. Reduce pollutant loads associated with new developments through development standards.
4. Identify, protect and manage significant open waterways for their beneficial stormwater functions.

6.3 Summary of Strategy Implementation and Costs

For a description of implementation of water quality and stormwater related natural resources standards, refer to Volume I – Citywide Basin Master Plan Report.

This section describes the approach for capital project implementation in the Bethel-Danebo basin. It also provides estimated costs and expected funding sources for each of the capital projects.

Six specific projects were selected and prioritized for implementation over a 35-year time period (2001-2035). Eight generic capital project categories were also identified for construction city-wide on an on-going yearly basis over the same 35-year period. These generic capital project categories include retrofit of tip-ups and water quality facilities in high source areas as identified for the flood control and pollution prevention strategies above. In addition, 1.1 miles of stream corridors representing 7.6 acres are targeted for immediate acquisition. Together these three categories of capital projects constitute the City's capital programming for the Bethel-Danebo basin. Refer to Figures 3-1 through 3-6 for a generalized location of these projects.

For a general description of the capital prioritization methodology and financing approach, refer to Volume I – Citywide Basin Master Plan Report. Table 6-1 of this document shows the priority schedule, cost, and funding allocations for the six specific capital projects and the yearly line item projects.

A separate scheme was developed for prioritizing stream corridor sites for acquisition. There is one high priority stream corridor acquisition identified in the Bethel-Danebo basin: portions of

the Lee-Marvin parcels along the Amazon Diversion Channel, Amazon Creek and Greenhill Road roadside channel. Table 6-2 indicates the acquisition parcels and estimated cost. For more detailed background information see *City of Eugene Stream Corridor Acquisition Study (May 2001).*

Table 6-1*
Implementation Schedule Years 2001 – 2035

Capital Project Identification	Priority	Total Estimated Cost	Estimated Funding Source and Allocation		
			SDCs	User Fees	Federal Priority Funds
BD 11A – Green Hill Tributary Improvements	2001 - 2005	$940,600	$319,804 [34%]	$620,796 [66%]	$0
BD 15 – Roosevelt Channel Culvert	2001 - 2005	$135,900	$43,488 [32%]	$92,412 [68%]	$0
BD 100 – Royal Node Infrastructure	2001 - 2005	$1,400,000	$1,400,000 [100%]	$0	$0
BD 08 – Retrofit Empire Park Pond	2006 - 2010	$385,000	$77,000 [20%]	$308,000 [80%]	$0
BD 06 – Increase Pipe Sizes Along Bell Avenue	2011 - 2035	$794,600	$365,516 [46%]	$429,084 [54%]	$0
BD 11C – Greenhill Tributary Water Quality Facility	2011 - 2035	$748,800	$224,640 [30%]	$524,160 [70%]	$0
Subtotal:		**$4,404,900**	**$2,430,448**	**$1,974,452**	**$0**
Yearly Capital Program Line Items Citywide: • Water Quality Facilities in High Source Areas • Stormwater Outfall Stabilization • Streambank Stabilization • Retrofit Tip-ups • General Rehabilitation • Stream Corridor Acquisition • Services for New Development • Wetland Mitigation Bank		These costs have not been calculated on a basin specific basis. See Volume I Citywide for overall cost estimates.			

* See Introduction section for information updates related to capital projects BD06, BD11A, BD11C and BD100.

Table 6-2
Stream Corridor Acquisition Schedule Years 2001 – 2007

Priority Stream Corridor	Area Miles/Acres	Estimated Cost
Portions of Lee-Marvin parcels	1.1 miles / 7.6 acres	$260,000

APPENDIX

CAPITAL PROJECT FACT SHEETS

Project Identifier	**BD01 - Citywide Annual Budget Line Item**
Project Title	**Bethel-Danebo Streambank Stabilization**

Project Location

Open Waterways throughout the Bethel Danebo Basin.

Subbasin	**NA**
GIS U/S Node Location	**NA**
GIS D/S Node Location	**NA**
Drainage Area Served by Capital Project	**NA** Acres
% Impervious (1994 Existing Land Use)	**NA**
% Impervious (Future)	**NA**
Design Flow (Future Conditions	**NA** cfs

Project Description

Implement streambank stabilization projects to help streams adjust to increased runoff volumes while limiting negative impacts associated with downcutting , sedimentation, and erosion. Where appropriate use bioengineering techniques to stabilize streambanks.

Project Elements

0 SY – Streambank Stabilization

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Downcutting, sedimentation, and erosion problems have been observed in open waterways that are receiving increased runoff volumes associated with urbanization.

Opportunities

Streambank stabilization provides the opportunity to improve or restore riparian vegetation and aquatic habitat conditions.

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
Streambank Stabilization	Inspect vegetation and banks for erosion.

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

N/A

Water Quality

This CP eliminates localized erosion of streambeds and streambanks.

Natural Resources

This CP can help restore native riparian vegetation and improve aquatic habitat conditions.

Other City Objectives Addressed by the Capital Project

To be completed by the City

Costs

Construction Costs:	
Site Acquisition:	$0
Engineering / Administration:	
Capital Project Implementation Costs	

There will be a $150,000 annual line item in the capital project budget to address streambank stabilization projects on a city-wide basis.

Annual Maintenance Costs	**$0**

Project Identifier	**BD02 - Citywide Annual Budget Line Item**
Project Title	**Water quality facilities for high source areas**

Project Location

Piped storm drainage systems located throughout the City of Eugene that convey stormwater runoff from mostly developed (i.e. no space for above ground water quality facilities) high pollutant source areas (i.e. commercial and industrial areas).

Subbasin	**N/A**	
GIS U/S Node Location	**N/A**	
GIS D/S Node Location	**N/A**	
Drainage Area Served by Capital Project	**N/A**	Acres
% Impervious (1994 Existing Land Use)	**N/A**	
% Impervious (Future)	**N/A**	
Design Flow (Future Conditions	**N/A**	cfs

Project Description

Construct offline, underground structural water quality facilities in developed, high pollutant source areas. Types of facilities include sedimentation manholes, and proprietary stormwater treatment devices. Depending on flow rate, costs vary from $2000 for a small sedimentation manhole to $60,000 for a large Storm Filter.

Project Elements

1 EA – Underground structural water quality facility

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Based on monitoring data collected within the City of Eugene, stormwater from high pollutant source areas is a significant source of pollutant loads to receiving waters.

Opportunities

Opportunity to reduce pollutant discharges in stormwater runoff from high pollutant sources in developed areas.

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
Underground structural water quality facility	Depending on the facility type, maintenance may be required once every month to once every two years.

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

N/A

Water Quality

This CP provides treatment of stormwater runoff from various sized high pollutant source drainage areas. Pollutant load reductions will depend on the type of facilities used and the locations of the facilities.

Natural Resources

N/A

Other City Objectives Addressed by the Capital Project

To be Completed by the City

Costs

Construction Costs:

Site Acquisition: $0

Engineering / Administration:

Capital Project Implementation Costs

There will be a $150,000 annual line item in the capital project budget to address water quality facilities for high source areas on a city-wide basis.

Annual Maintenance Costs

Design Assumptions

Possible high source retrofit locations:

1) Node 63312 - Approximate drainage area = 20 acres
Intersection of Bailey Hill Rd., and 7th Ave.
2) Node 63302 - Approximate drainage area = 7.2 acres
Intersection of 5th Ave and Market St.
3) Node 69906 - Approximate drainage area = 10 acres
Intersection of Side St., and Hwy 99
4) Node 62073 - Approximate drainage area = 22 acres
Right-of-Way Seneca Rd. 250' South of Roosevelt Blvd
5) Node 62067 - Approximate drainage area = 15 acres
Right-of-way Meadow Ln. 350' West of Maple St.
6) Node 61790 - Approximate drainage area = 32 acres
Right-of-Way Bertelson Rd. 150' South of Cross St.
7) Node 62316 - Approximate drainage area = 27 acres
150' east and 100' South of the end of Crane Ln.
8) Node 63376 - Approximate drainage area = 37.5 acres
Right-of-Way Wallis St., and Intersection with 4th Ave.
9) Node 66632 - Approximate drainage area = 20 acres
Right-of-Way Seneca Rd. 850' North of 5th Ave
10) Node 71558 - Approximate drainage area = 14 acres
Wilson St., and 7th Ave.

Project Identifier	**BD03 - Citywide Annual Budget Line Item**
Project Title	**Outfall stabilization**

Project Location

All storm drainage system outfalls in the Bethel Danebo basin that are causing erosion and bank stabilization problems.

Subbasin	**N/A**	
GIS U/S Node Location	**N/A**	
GIS D/S Node Location	**N/A**	
Drainage Area Served by Capital Project	**N/A**	Acres
% Impervious (1994 Existing Land Use)	**N/A**	
% Impervious (Future)	**N/A**	
Design Flow (Future Conditions	**N/A**	cfs

Project Description

Identify and retrofit storm drainage system outfalls creating bank stability problems along open waterways in the Bethel Danebo basin.

Project Elements

1 Ea – Outfall Protection

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Erosion and bank stabilization problems, and in some cases maintenance access problems, exist at storm drainage system outfalls draining into open waterways in the Bethel Danebo basin.

Opportunities

Opportunity to retrofit storm drainage system outfalls to provide maintenance access, energy dissipation, and bank stabilization.

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
Outfall Protection	Inspect and clean outlet, inspect vegetation and slope protection.

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

N/A

Water Quality

This CP provides bank stabilization that will reduce sedimentation from erosion caused by storm drainage system outfalls draining into open waterways in the Bethel Danebo basin.

Natural Resources

This CP will reduce impacts on streambank vegetation and aquatic habitat.

Other City Objectives Addressed by the Capital Project

To be completed by the City

Costs

Construction Costs:	
Site Acquisition:	$0
Engineering / Administration:	
Capital Project Implementation Costs	

There will be a $125,000 annual line item in the capital project budget to address outfall stabilization projects on a city-wide basis.

Annual Maintenance Costs	**$0**

Project Identifier	**BD04 - Citywide Annual Budget Line Item**
Project Title	**Retrofit of Tip-ups**

Project Location

Tip-ups located throughout the Bethel Danebo Basin.

Subbasin	**N/A**
GIS U/S Node Location	**N/A**
GIS D/S Node Location	**N/A**
Drainage Area Served by Capital Project	**N/A** Acres
% Impervious (1994 Existing Land Use)	**N/A**
% Impervious (Future)	**N/A**
Design Flow (Future Conditions	**N/A** cfs

Project Description

Retrofit the tip-ups with manholes that provide sedimentation storage and maintenance access. Re-install outlet pipe at a positive grade.

Project Elements

1 EA – Retrofit of Tip-up

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Surcharging, build up of sediment and debris, and limited access for maintenance are all problems associated with the existing tip-ups.

Opportunities

This CP provides an opportunity to reduce sedimentation problems and to facilitate maintenance.

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
Retrofit of Tip-up	Inspect sediment loading and debris accumulation, remove debris and sediment.

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

This CP is expected to reduce capacity problems due to sediment buildup.

Water Quality

The new manhole will provide storage of sediment and debris which can be periodically removed.

Natural Resources

N/A

Other City Objectives Addressed by the Capital Project

To be Completed by the City

Costs

Construction Costs:

Site Acquisition: $0

Engineering / Administration:

Capital Project Implementation Costs

There will be a $125,000 annual line item in the capital project budget to address tip-up retrofits projects on a city-basis.

Annual Maintenance Costs

Design Assumptions

The following tip-ups within the Bethel-Danebo Basin were identified for retrofit:

1)BDA2140B located at the north end of Golden Garden Road. Node 58233 to 58235, Page 16 of 97. Tip-up offset = 3.8 ft
2) BDA2290C - located adjacent to Willamette H.S. Node 69021 to 60488, Page 29 of 97. Tip-up offset = 2.79 ft
3) BDA3110D - located along 1st just east of Wallis. Node 63307 to 63359, Page 31 of 97. Tip-up offset = 0.99 ft
4) BDRC050B - located at the U.S. end of the Roosevelt Channel. Node 61837 to 61977, page 29 of 97. Tip-up offset = 0.19 ft
5) BDGH120E - located at Terry Street. Node 61601 to 61605, Page 19 of 97. Tip-up offset = 1.59 ft
6) BDA3130A, BDA3150A, and BDA3180A - all located at the U.S. end of the A3 Channel. Nodes 63364, 63335, and 63351 to node 63305, Page 42 of 97. Tip-up offset =1.34, 0.77, 1.16 ft respectively
7) located just east of Baxter St., south of Marshall, and north of Hawthorne. Node 60536 to 60456, Page 29 of 97. Tip-up offset = 0.52 ft
8) drains into an open waterway running north along Beltline. Node 66893 to 61737, Page 19 of 97. Tip-up offset = 1.5 ft
9) drains into a ditch which drains to the Roosevelt Channel south of Marcum and east of Fergus. Node 61759 to 61738, Page 19 of 97. Tip-up offset = 2.4 ft
10) drains from Jessen Drive into the open waterway along Highway 99. Node 58242 to 58243, Page 27 of 97. Tip-up offset = 2.3 ft
11) - originating from Hilton Dr. and draining into the open waterway which parallels Beltline. Node 66280 to 61733, Page 19 of 97. Tip-up offset = 1.6 f
12) drains to the west under SPRR and into an open waterway located just north of 5th Ave. Node 63635 to 63623, Page 42 of 97. Tip-up offset = 1.9 ft
13) - located on Cody St. between Dewey St., Node 66171 to 58856, Page 17 of 97. Tip-up offset = 2.8 ft
14) - located at the west end of Side St. draining west to the open waterway that runs along the Burlington Northern Railroad ROW. Node 62228 to 62234, Page 41 of 97. Tip-up offset = 3.5 ft
15) - located at the south end of Mangan Street draining east to an open waterway, Node 58861 to 58848, Page 19 of 97. Tip-up offset = 2.4 ft

Project Identifier	**BD06**
Project Title	**Bell Ave. Pipe Improvements**

Project Location

Pipe segments along Bell Ave. upstream of the Marshall Ditch between Harold St. and Hwy. 99, pages 30 and 41 of the sewer map index.

Subbasin	**BDA2**	
GIS U/S Node Location	**62092**	
GIS D/S Node Location	**62095**	
Drainage Area Served by Capital Project	**64**	Acres
% Impervious (1994 Existing Land Use)	**52**	
% Impervious (Future)	**59**	
Design Flow (Future Conditions	**32**	cfs

Project Description

This capital project includes pipe replacements for the following segments: BDA2400B (replace a 36" CSP with a 48" CSP), BDA2400C through BDA2400E (replace a 30" CSP with a 42" CSP), and BDA2400F and BDA2400G (replace the 21" and 30" CSPs with 36" CSPs).

Project Elements

556 Ft – 36" CSP (2-5 ft. cover)

1151 Ft – 42" CSP (2-5 ft. cover)

1167 Ft – 48" CSP (2-5 ft. cover)

Problems and/or Opportunities Addressed by the Capital Projects

Problems

The entire piped system is surcharged under existing conditions. The capacities of segments BDA2400D, BDA2400E, BDA2400F, and BDA2400G are expected to be deficient under existing land use conditions for a 10-year event. The capacity of segment BDA2400B is expected to be deficient under future land use conditions for a 10-year event.

Opportunities

N/A

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
36" CSP (2-5 ft. cover)	N/A
42" CSP (2-5 ft. cover)	N/A
48" CSP (2-5 ft. cover)	N/A

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

This capital project eliminates the expected surface flooding problems for the 10-year design storm under existing and future land use conditions along Bell Ave.

Water Quality

N/A

Natural Resources

N/A

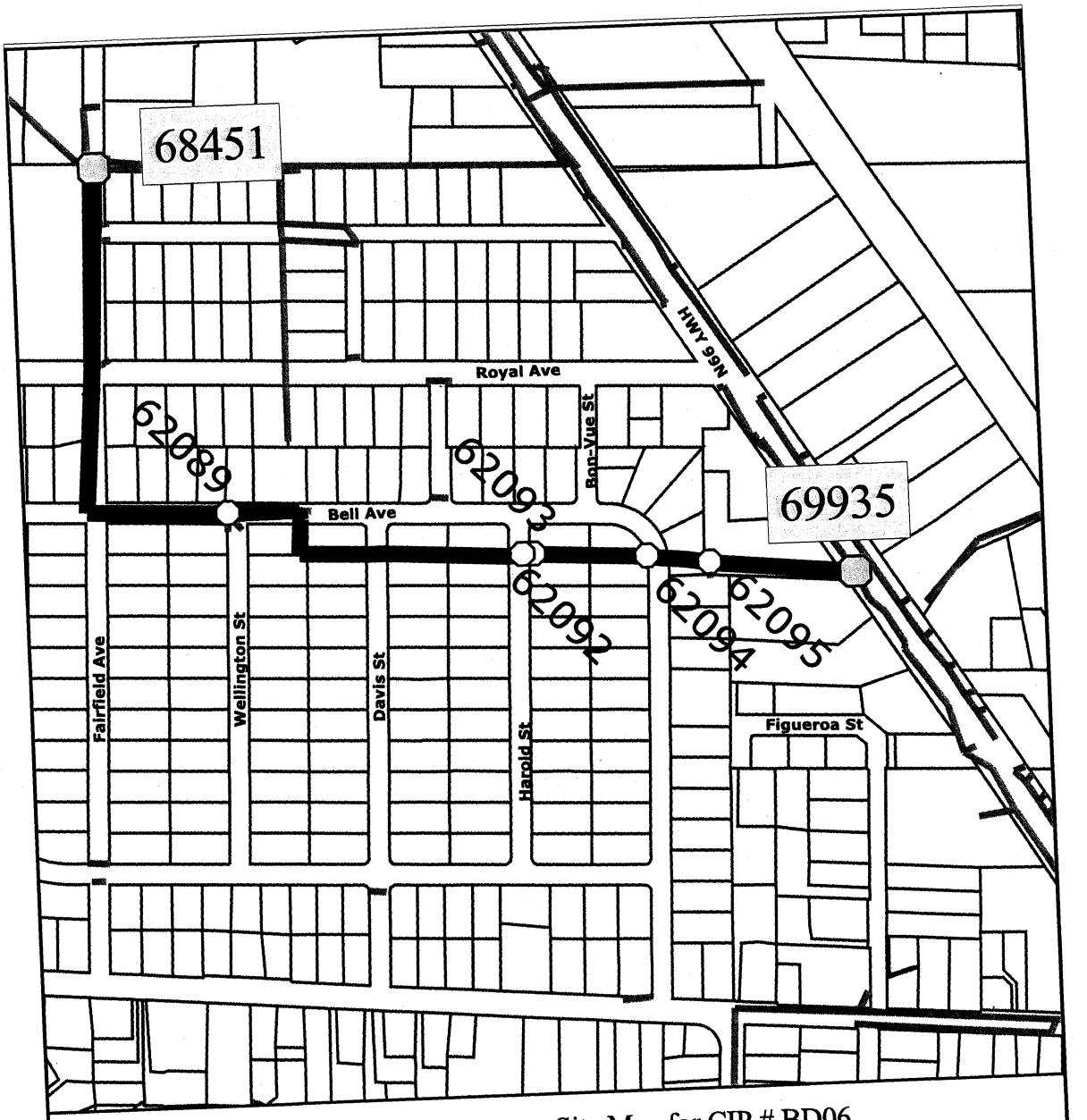
Other City Objectives Addressed by the Capital Project

To be completed by the City

Costs

Construction Costs:	$662,200
Site Acquisition:	$0
Engineering / Administration:	$132,400

Capital Project Implementation Costs	**$794,600**
Annual Maintenance Costs	**$0**



Property Parcel Boundary

Capital Project Location

Storm Drainage System (Pipe or Open Channel)

Capital Improvement Project Element

Upstream/Downstream Node

Upstream/Downstream Subnode

Manholes or Catch Basins

200 0 200 400 Feet

N

Site Map for CIP # BD06

Increase Pipe Sizes Along Bell Ave
Bethel - Danebo Basin
City of Eugene
Capital Project

April 2001
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BD06

URS

Design Assumptions

The ground surface elevations appear to be incorrect in the GIS system, so a ground surface elevation was estimated for the pipe segments between nodes 69935 to 62092. The slope of the pipes was altered from the existing system in order to increase their capacity. It was assumed that lowering the inverts will not create problems for laterals which connect to the main pipe system. The 36" and 42" diameter CSP to be installed has approximately 3' of cover, and the 48" diameter CSP to be installed has approximately 4' of cover.

This CP includes the following pipe replacements: for segment BDA2400B, a 36" diameter CSP which runs along Fairfield Ave. and Bell Ave. will be removed and replaced with 1167 LF of 48" diameter CSP pipe; for segments BDA2400C through BDA2400E, a 30" diameter CSP from Bell Ave. east of Wellington St. to Gilbert St. will be removed and replaced with 1151LF of 42" diameter CSP; and finally for segment BDA2400F and BDA2400G, the 21" and 30" diameter CSPs from Gilbert St. to Hwy 99N will be removed and replaced with 556LF of 36" diameter CSP.

Project Identifier	**BD08**
Project Title	**Empire Park Pond Enhancements**

Project Location

Empire Park Pond is located at the intersection of Hwy 99N, Empire Park Drive and Barger Drive, on page 28 of the sewer index map.

Subbasin	**BDA2**
GIS U/S Node Location	**69700**
GIS D/S Node Location	**58997**
Drainage Area Served by Capital Project	**345** Acres
% Impervious (1994 Existing Land Use)	**36**
% Impervious (Future)	**59**
Design Flow (Future Conditions	**N/A** cfs

Project Description

Construct a 2 ac-ft sediment forebay for stormwater discharges into the pond and enhance the natural resources of the existing pond area (approximately 2.1 acres) through sediment removal and revegetation. The sediment forebay would prevent debris and coarse sediments from discharging into the pond and would facilitate maintenance access for removal of this material.

Project Elements

2 Ac-Ft – Water Quality Pond
2.1 Ac – Stormwater Marsh/Wetland
4300 SY – Natural Resource Enhancement

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Empire Park Pond receives stormwater discharges from Highway 99 and associated land uses in the highway corridor. It appears that stormwater runoff is causing sedimentation and water quality degradation of the pond.

Opportunities

There is an opportunity to enhance the water quality and natural resource benefits of the pond. The pond could also be developed into a public amenity that offers educational opportunities.

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
Water Quality Pond	Inspect and clean inlet and outlet, maintain vegetation, inspect sediment loading, remove sediment, remove debris, inspect and repair separation berm.
Stormwater Marsh/Wetland	Inspect and clean inlet and outlet, inspect & maintain vegetation, remove debris.
Natural Resource Enhancement	Inspect vegetation, remove debris.

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

This capital project protects and enhances the existing flood control benefits of the Empire Park Pond.

Water Quality

This enhanced pond and sediment forebay will provide treatment of stormwater runoff from a 345-acre drainage area with an estimated annual discharge of 95,000 lbs of TSS under future land use conditions (15% low-density residential, 15% commercial, 70% industrial). This CP is expected to remove 46,000 of the 95,000 lbs/yr of TSS.

Natural Resources

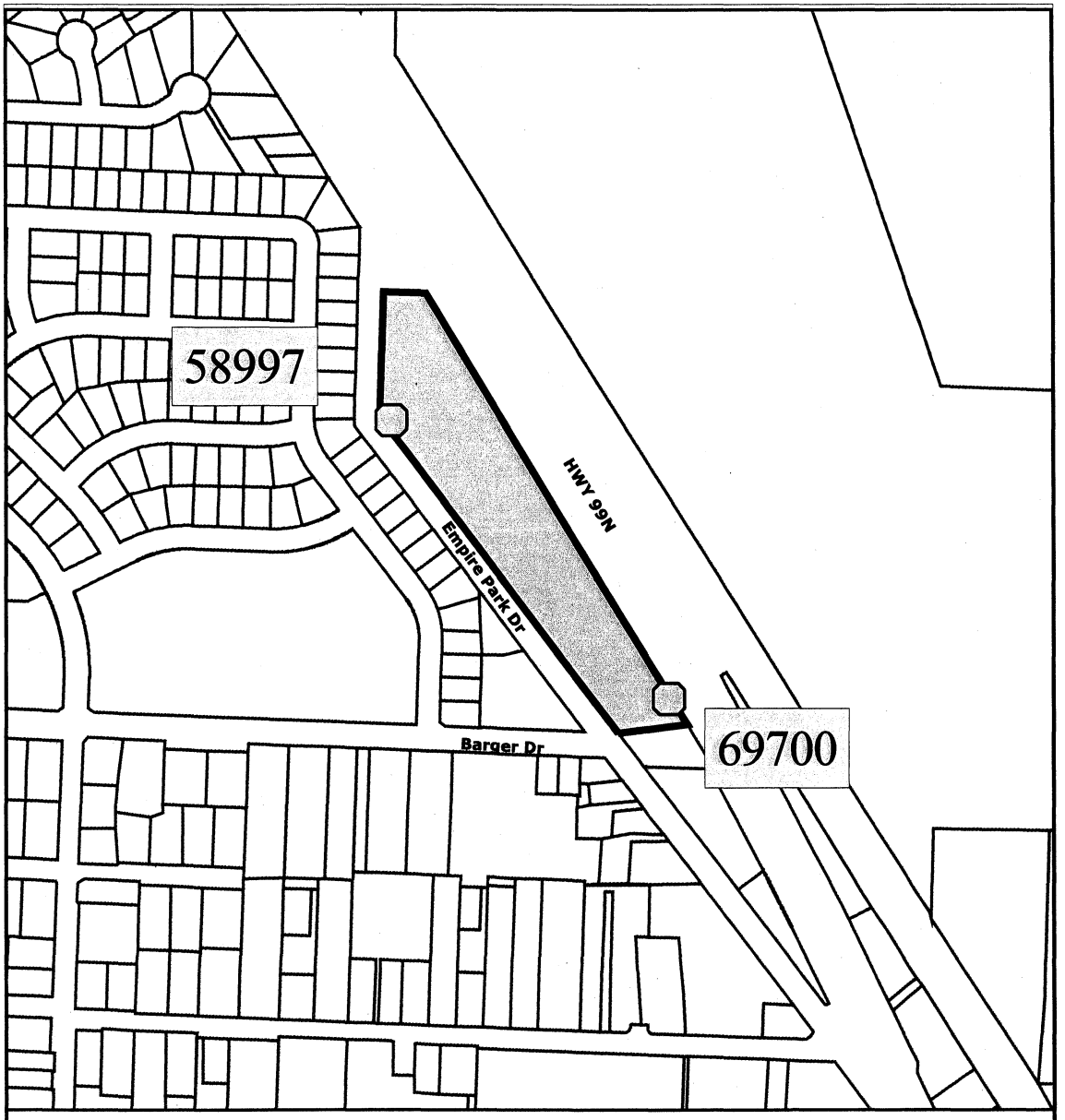
This capital project will enhance an existing 2.6-acre natural resource area by removing invasive species, replanting native vegetation and improving habitat for aquatic wildlife.

Other City Objectives Addressed by the Capital Project

To be completed by the City

Costs

Construction Costs:	$320,900
Site Acquisition:	$0
Engineering / Administration:	$64,100
Capital Project Implementation Costs	**$385,000**
Annual Maintenance Costs	**$8,600**



Property Parcel Boundary

Capital Project Location

Storm Drainage System (Pipe or Open Channel)

Capital Improvement Project Element

Upstream/Downstream Node

Upstream/Downstream Subnode

Manholes or Catch Basins

N

200 0 200 400 Feet

Site Map for CIP # BD08

Retrofit Empire Park Pond
Bethel - Danebo Basin
City of Eugene
Capital Project

April 2001
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BD08

URS

Design Assumptions

The pre-settling basin volume is equal to approximately 10% of the water quality volume.
The surface area of the existing pond was scaled off from the stormwater system index map.
This CP would treat subbasins BDA2220-250 for water quality.
The TSS removal was estimated by multiplying the total TSS load by 0.8 (since the facility will treat 80% of the runoff) and then again by 0.6 (since the BMP used to provide treatment is expected to be approximately 60% effective.)

Project Identifier	**BD11A**
Project Title	**Greenhill Tributary Culvert Replacement**

Project Location

Culvert BDGH070A (48" CSP) in the Greenhill Tributary system located north of Royal Ave. and west of Candlelight Dr., page 18 of the stormwater system index map.

Subbasin	**BDGH**
GIS U/S Node Location	**59945**
GIS D/S Node Location	**80039**
Drainage Area Served by Capital Project	**229** Acres
% Impervious (1994 Existing Land Use)	**29**
% Impervious (Future)	**44**
Design Flow (Future Conditions	**91** cfs

Project Description

Replace the existing 48" culvert with a 8' x 5' concrete box culvert (1,005 LF).

Project Elements

1005 LF – 5' x 8' Concrete Box Culvert (0-5 ft. of cover)

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Due to the limited capacity of culvert BDGH070A (29 cfs) and the resulting surcharging of the culvert, overbank flooding is expected under existing land use conditions in upstream open waterway segments BDGH090D and BDGH090A.

Opportunities

N/A

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
5' x 8' Concrete Box Culvert (0-5 ft. of cover)	N/A

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

This capital project eliminates the expected overbank flooding in the upstream open waterways for the 10-year design storm under existing and future land use conditions.

Water Quality

N/A

Natural Resources

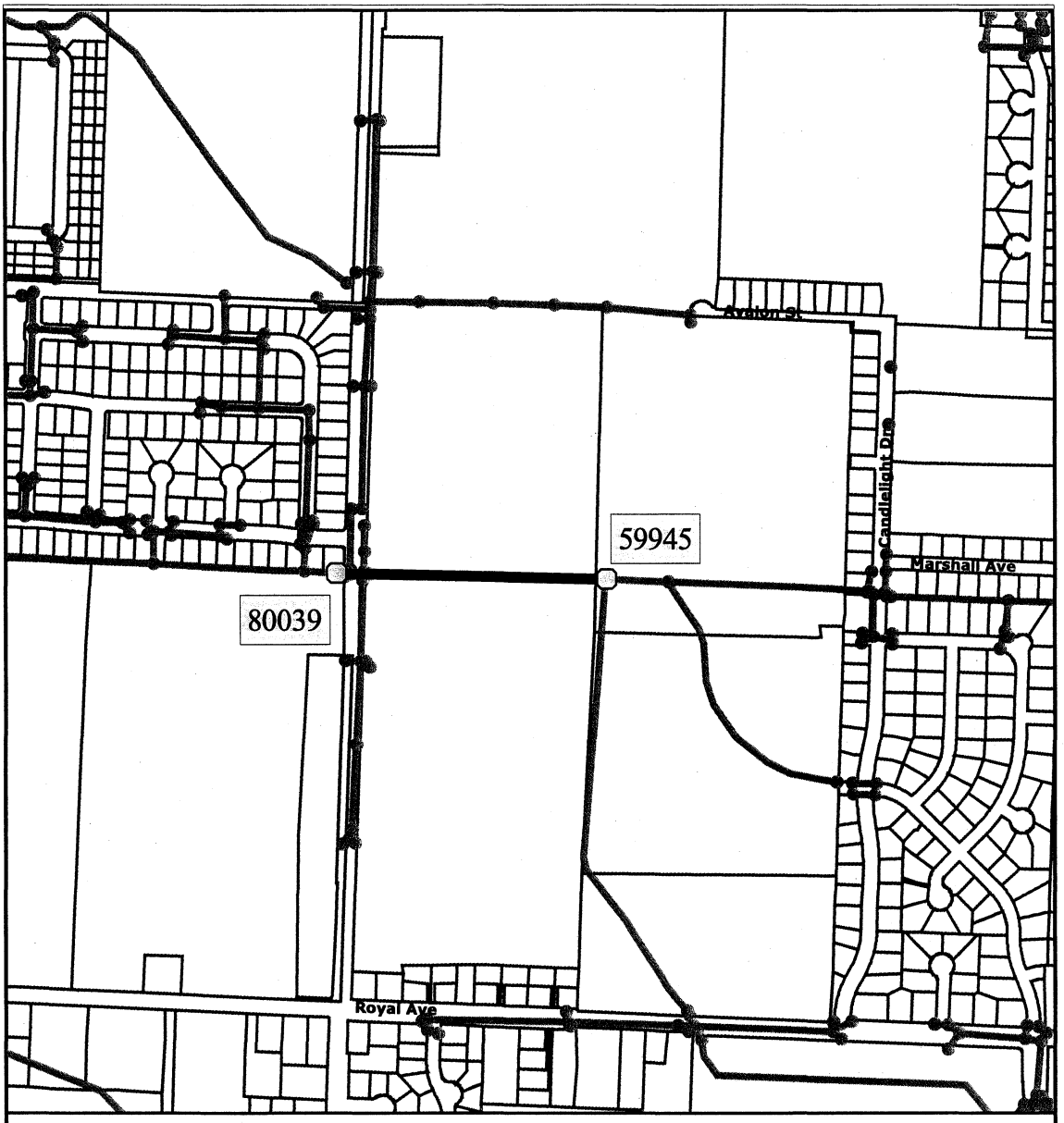
N/A

Other City Objectives Addressed by the Capital Project

To be completed by the City

Costs

Construction Costs:	$783,900
Site Acquisition:	$0
Engineering / Administration:	$156,700
Capital Project Implementation Costs	**$940,600**
Annual Maintenance Costs	**$0**



Property Parcel Boundary
Capital Project Location
Storm Drainage System (Pipe or Open Channel)
Capital Improvement Project Element
Upstream/Downstream Node
Upstream/Downstream Subnode
Manholes or Catch Basins

200 0 200 400 Feet

N

Site Map for CIP # BD11A

Greenhill Tributary improvements
Bethel - Danebo Basin
City of Eugene
Capital Project

April 2001
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BD11A

URS

Design Assumptions

There is approximately 1.5' of cover over the entire length of the culvert. The depth of flow is approximately 92% of the diameter of the culvert. The maximum velocity within the culvert is approximately 2 fps.

Project Identifier	**BD11C**
Project Title	**Greenhill Tributary Water Quality Facility**

Project Location

Culvert BDGH070A (48" CSP) in the Greenhill Tributary system located north of Royal Ave. and west of Candlelight Dr., page 18 of the stormwater system index map.

Subbasin	**BDGH**
GIS U/S Node Location	**59945**
GIS D/S Node Location	**80039**
Drainage Area Served by Capital Project	**229** Acres
% Impervious (1994 Existing Land Use)	**29**
% Impervious (Future)	**44**
Design Flow (Future Conditions	**N/A** cfs

Project Description

Construct a 10 ac-ft neighborhood water quality facility where two open waterway segments enter the upstream end of culvert BDGH070A (48" CSP).

Project Elements

10 Ac-Ft – Water Quality Pond

3 Ac – Residential Property Acquisition

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Stormwater runoff carries problem pollutants such as sediments, metals, nutrients, bacteria, and oils and greases to open waterways in Eugene.

Opportunities

Vacant land provides an opportunity for the construction of a water quality facility. The water quality facility would operate as a neighborhood open water amenity that would also provide recreational and educational opportunities for Danebo School and nearby residents.

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
Water Quality Pond	Inspect and clean inlet and outlet, maintain vegetation, inspect sediment loading, remove sediment, remove debris, inspect separation berm.
Residential Property Acquisition	N/A

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

N/A

Water Quality

This neighborhood water quality facility will provide treatment of stormwater runoff from a 229-acre drainage area with an estimated annual discharge of 66,000 lbs of TSS under future land use conditions (80% low-density residential, 15% medium/high-density residential, 5% parks and open space). This CP is expected to remove 32,000 of the 66,000 lbs/yr of TSS.

Natural Resources

The water quality facility provides natural resource enhancement of approximately 3 acres.

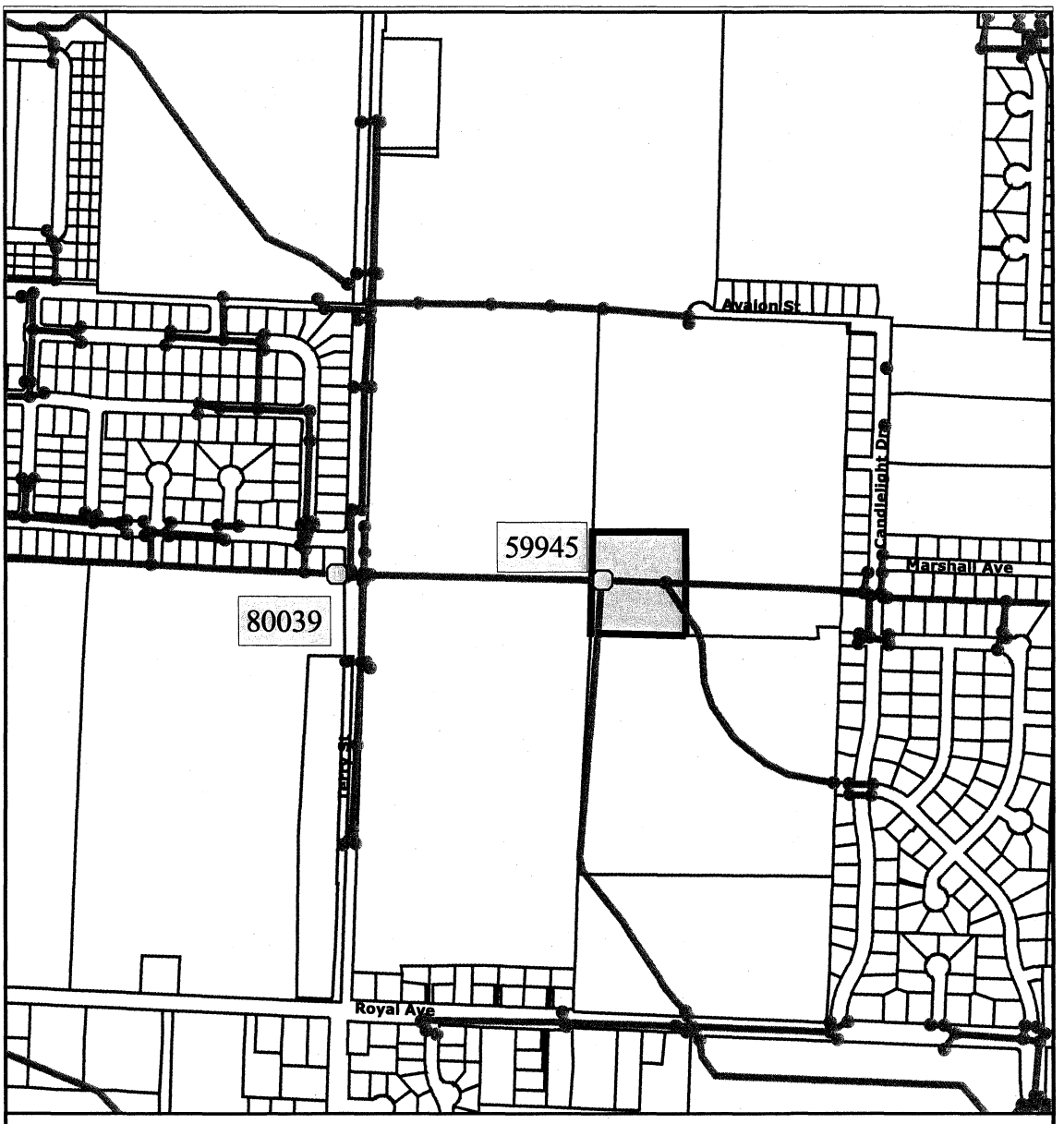
Other City Objectives Addressed by the Capital Project

To be completed by the City

Costs

Construction Costs:	$519,000
Site Acquisition:	$105,000
Engineering / Administration:	$124,800

Capital Project Implementation Costs	**$748,800**
Annual Maintenance Costs	**$11,200**



Property Parcel Boundary
Capital Project Location
Storm Drainage System (Pipe or Open Channel)
Capital Improvement Project Element
Upstream/Downstream Node
Upstream/Downstream Subnode
Manholes or Catch Basins

200 0 200 400 Feet

N

Site Map for CIP # BD11C

Greenhill Tributary Water Quality Facility
Bethel - Danebo Basin
City of Eugene
Capital Project

April 2001
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BD11C

URS

Design Assumptions

This CP would treat subbasins BDGH090-110 for water quality.
The TSS removal was estimated by multiplying the total TSS load by 0.8 (since the facility will treat 80% of the runoff) and then again by 0.6 (since the BMP used to provide treatment is expected to be approximately 60% effective.)

Project Identifier	**BD15**
Project Title	**Roosevelt Channel Culvert Replacement**

Project Location

A 48" CSP culvert that runs under a private driveway east of Bertlesen Rd. in the Roosevelt Channel (page 30 of the sewer index map).

Subbasin	**BDRC**
GIS U/S Node Location	**61935**
GIS D/S Node Location	**61934**
Drainage Area Served by Capital Project	**616** Acres
% Impervious (1994 Existing Land Use)	**39**
% Impervious (Future)	**57**
Design Flow (Future Conditions	**260** cfs

Project Description

Replace the 48" CSP with a bridge (20' wide x 55' long) and reconstruct the channel to match the size and shape of the downstream open waterway.

Project Elements

1100 SF – Bridge

1 EA – BD15 Open Waterway Improvement

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Culvert BDRC030C (48" CSP) is expected to be deficient for a 10-year storm under future land use conditions.

Opportunities

N/A

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
Bridge	N/A
BD15 Open Waterway Improvement	Inspect vegetation and banks for erosion.

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

This capital project will eliminate overbank flooding of the Roosevelt Channel upstream of this culvert (BDRC030C) for the 10-year storm under future land use conditions.

Water Quality

N/A

Natural Resources

N/A

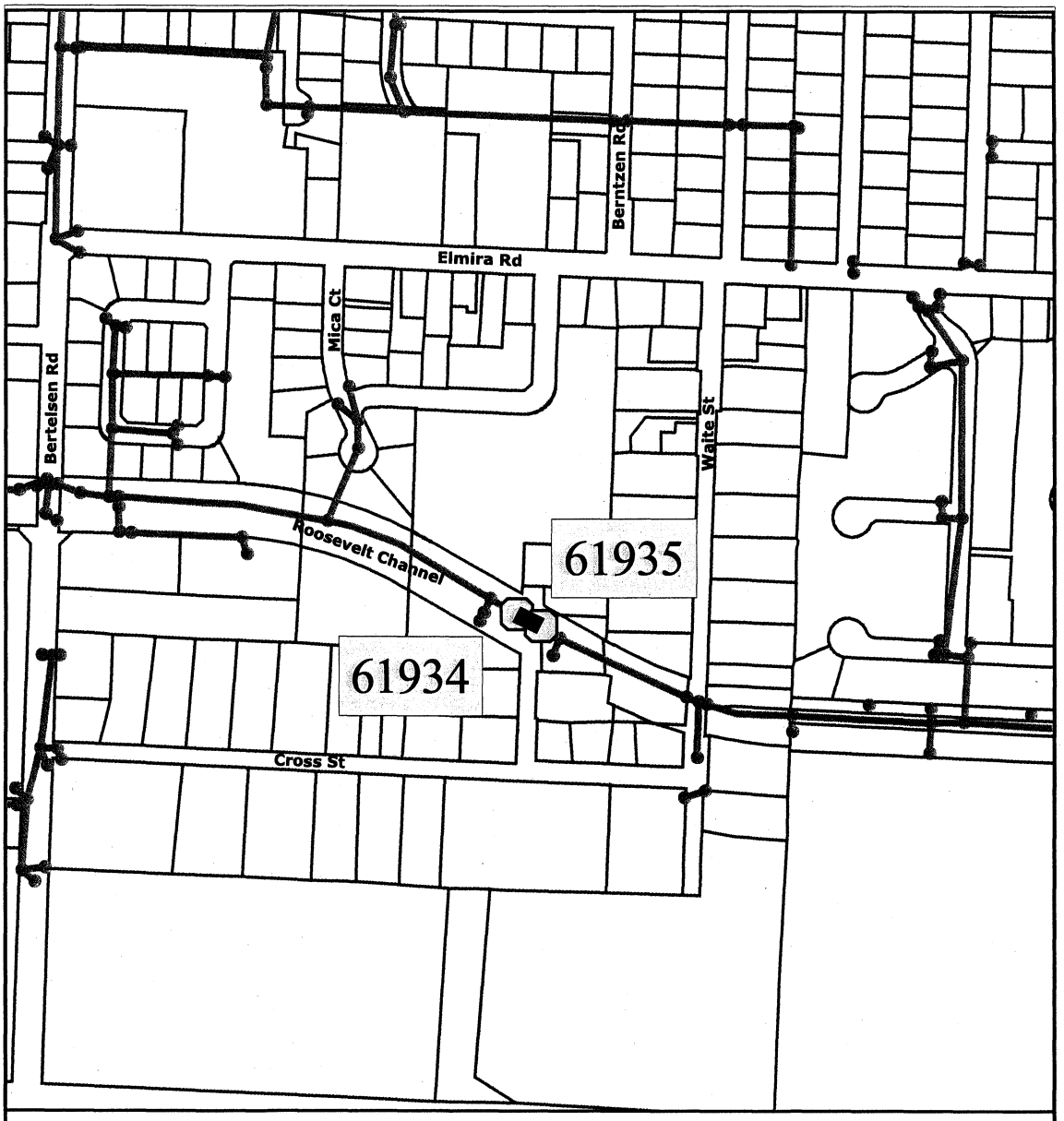
Other City Objectives Addressed by the Capital Project

To be completed by the City

Costs

Construction Costs:	$113,300
Site Acquisition:	$0
Engineering / Administration:	$22,600

Capital Project Implementation Costs	**$135,900**
Annual Maintenance Costs	**$0**



Property Parcel Boundary

Capital Project Location

Storm Drainage System (Pipe or Open Channel)

Capital Improvement Project Element

Upstream/Downstream Node

Upstream/Downstream Subnode

Manholes or Catch Basins

200 0 200 400 Feet

N

Site Map for CIP # BD15

Roosevelt Channel Culvert Replacement
Bethel - Danebo Basin
City of Eugene
Capital Project

April 2001
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BD15

URS

Design Assumptions

The predicted future flow is 87% above the capacity of the existing culvert.

Capital Project Fact Sheet

Basin Name: Citywide Projects

Project Identifier	BD100
Project Title	Royal Node Stormwater Infrastructure
Project Location	
Royal Ave. Nodal Development	
Subbasin	NA
GIS U/S Node Location	NA
GIS D/S Node Location	NA
Drainage Area Served by Capital Project	NA Acres
% Impervious (1994 Existing Land Use)	NA
% Impervious (Future)	NA
Design Flow (Future Conditions	NA cfs

Project Description

The Royal Node Site Plan utilizes a combination of open drainage channels, standard pipe systems, grassy swales and stormwater BMPs to drain the site.

Project Elements

1 EA – Bethel-Danebo Royal Node Stormwater infrastructure

Problems and/or Opportunities Addressed by the Capital Projects

Problems

Typical drainage and water quality problems associated with urbanization.

Opportunities

Opportunity to develop an overall stormwater management plan prior to development that will incorporate flood control, water quality and natural resources.

Maintenance Requirements

Facility Type	*Annual Maintenance Activities*
Bethel-Danebo Royal Node Stormwater infrastructure	

CSWMP Objectives and Policies Addressed by the Capital Project

Flood Control

Channels will be designed for a minimum 10-year event.

Water Quality

The planned system integrates surface drainage in conjunction with traditional pipe and gutter systems to reduce the amount of pollutants washing off streets, rooftops and lawns to allow water to percolate back into the soil.

Natural Resources

This CP can help restore native riparian vegetation and improve aquatic habitat conditions.

Other City Objectives Addressed by the Capital Project

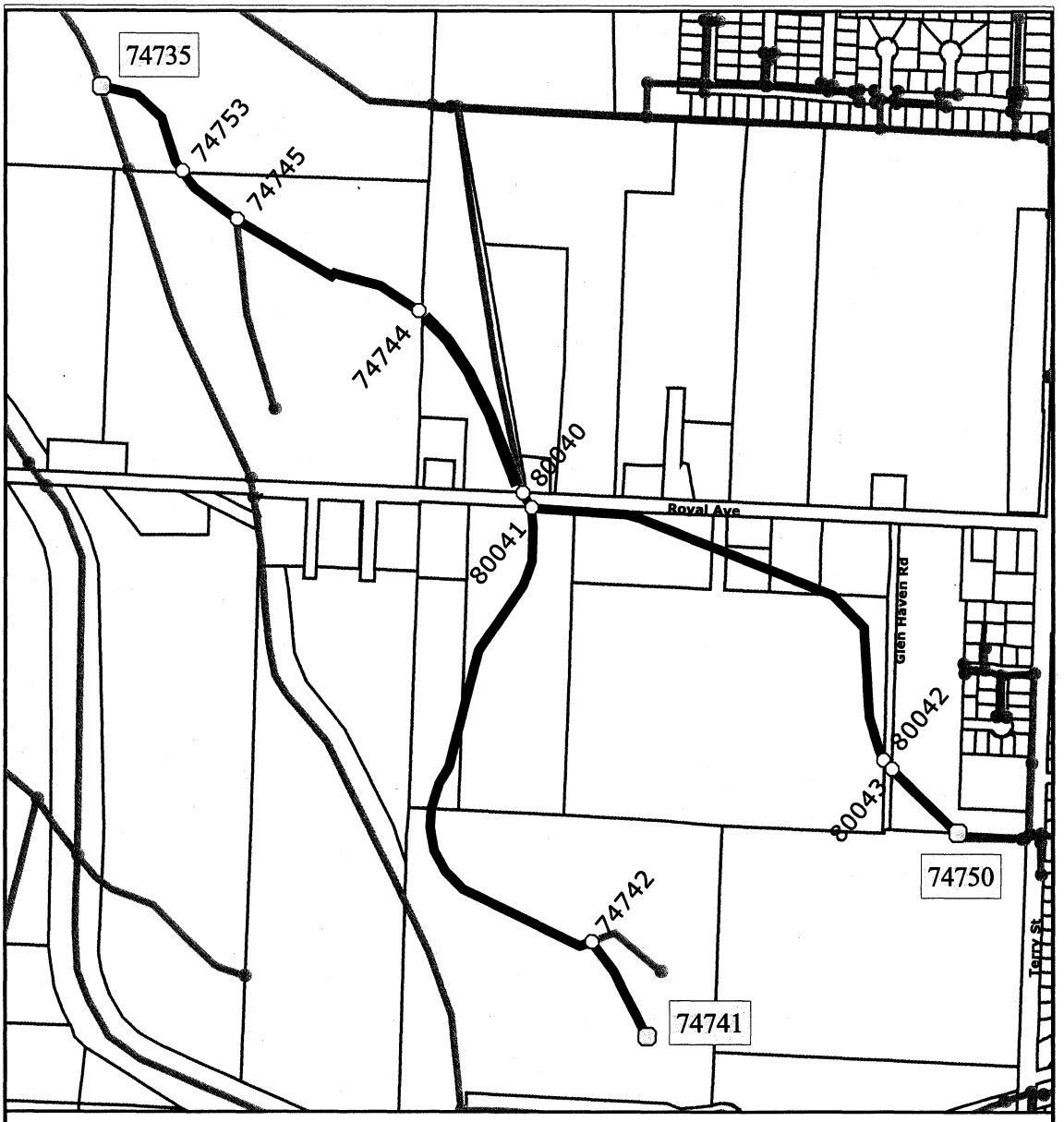
Costs

Construction Costs:

Site Acquisition:

Engineering / Administration:

Capital Project Implementation Costs	$1,444,100
Annual Maintenance Costs	



Property Parcel Boundary
Capital Project Location
Storm Drainage System (Pipe or Open Channel)
Capital Improvement Project Element
Upstream/Downstream Node
Upstream/Downstream Subnode
Manholes or Catch Basins

200 0 200 400 Feet

N

Site Map for CIP # BD100

Royal Node Stormwater Infrastructure
Bethel - Danebo Basin
City of Eugene
Capital Project

April 2001
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BD100

URS