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Project #:06.16

STORM AND SURFACE WATER FACILITIES PLAN for BROOKINGS-HARBOR AREA

for:

City of Brookings, Oregon

and

Curry County, Oregon

Final (Brookings) - October 2007
Draft - December 2006

This project has been funded in part with financial assistance provided by The Coastal Zone Management Act of 1972, as administered by The Ocean and Coastal Management Program, Department of Land Conservation and Development.

BEFORE THE BOARD OF COUNTY COMMISSIONERS

IN AND FOR THE COUNTY OF CURRY, OREGON

In the Matter of the Adoption of Revisions to the Curry County Comprehensive Plan by Amending Specific Provisions of the Public Facilities Plan for Urban Growth Expansion for the Brookings and Harbor Study Areas and by Adopting a New Storm and Surface Water Facilities Plan for Brookings-Harbor Area.	)	ORDINANCE NO. 08-09

The Curry County Board of Commissioners ordains as follows:

Section 1: Findings

1. On August 30, 2002, the Board of Curry County Commissioners amended the Curry County Comprehensive Plan for the purpose of adopting the *Public Facilities Plan for Urban Growth Expansion: Brookings and Harbor Study Areas* (Curry County Ordinance No. 02-03).

2. Portions of the *Public Facilities Plan for Urban Growth Expansion: Brookings and Harbor Study Areas* are in need of amendment. Those portions of the Plan in need of amendment are attached hereto and incorporated by reference.

3. The *Storm and Surface Water Facilities Plan for Brookings-Harbor Area* (October of 2007), a copy of which is attached hereto and incorporated by reference, was prepared by HGE Inc., a private consulting firm. The development of this plan was a joint effort between the City of Brookings and Curry County using a technical assistance grant from the Oregon Department of Land Conservation and Development (DLCD). The *Storm and Surface Water Facilities*

CURRY COUNTY, OREGON
Commissioners' Journal
CJ: 2008-443
12/09/2008 02:24:26 PM

Plan for the Brookings-Harbor area is a supplemental section to the *Public Facilities Plan for Urban Growth Expansion: Brookings and Harbor Study Areas* of the Curry County Comprehensive Plan.

4. The initial draft of the Plan was completed in December of 2006. The draft text was subsequently modified following input from the public, the Brookings City Council, the Board of Curry County Commissioners, and the City of Brookings and Curry County Planning Commissions.

5. With the concurrence of both the City Council and the Board of Curry County Commissioners, staff sent to DLCD the 45 day notice required under ORS 197.610 for post acknowledgment plan amendments for the proposed changes to the comprehensive plans.

6. Following public notice as required by law, the Brookings City Council and the Board of Curry County Commissioners held a joint hearing on the proposed amendments on Monday, December 8, 2008, at 5:30 P.M. at the Brookings City Hall.

7. On Tuesday, December 9, 2008, the Board of Curry County Commissioners approved the comprehensive plan amendment changes that are attached hereto and incorporated by reference.

Section 2: Amendments

The Curry County Comprehensive Plan (Ordinance No. 83-7, and its subsequent amendments) is amended as shown by the attached changes in the *Public Facilities Plan for Urban Growth Expansion for the Brookings and Harbor Study Areas* (Exhibit "A") and by adopting the attached *Storm and Surface Water Facilities Plan for Brookings-Harbor Area* with Addendums 1, 2 and 3.

The *Public Facilities Plan for Urban Growth Expansion: Brookings and Harbor Study Areas,* Appendix A: Facilities Maps/Projects Descriptions is further amended by removing the four (4) *"Storm Facilities"* maps.

Section 3: Severance Clause

If any section, subsection, sentence, clauses or phrases of this ordinance is, for any reason, held to be unconstitutional or otherwise invalid, such decision shall not affect the validity of the remaining portions of this ordinance.

Section 4: Effective Date:

Consistent with ORS Chapters 197 and 215, this ordinance shall take effect upon its passage.

DATED this 9th day of December, 2008.

CURRY COUNTY BOARD OF COMMISSIONERS

Georgia Yee Nowlin, Chair

Lucie La Bonté, Vice Chair

Marlyn Schafer, Commissioner

Approved as to Form:

M. Gerard Herbage
Curry County Legal Counsel

Patricia R. Cook
Recording Secretary

Effective Date: 12/9/08

EXHIBIT A

CITY OF BROOKINGS – PUBLIC FACILITIES PLAN

DRAFT REVISIONS
SEPTEMBER, 2008

Draft text is *bold and italicized.*
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Stormwater Needs

On _____, the City adopted the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area." ~~*A public education program is recommended to disseminate information on the importance of preventing negative impacts from stormwater.*~~ *In the Plan are design and development standards and proposed improvements to the storm drainage facility. There are also maps depicting the various basin areas, hydrologic/ hydraulic analysis, and the discussion of the effects on specific areas in the Plan.*

~~Using the Santa Barbara Urban Hydrograph computer model, pre and post development storm flows were calculated for each basin. A 25 year return period was assumed. The flows for North and South of the Chetco are as follows. (See figures in Appendix A for reference)~~

~~**North of the Chetco River (Brookings)**~~

~~Area Number~~	~~Acreage~~	~~Pre Development Peak Flow (cfs)~~	~~Post Development Peak Flow (cfs)~~
~~1~~	~~109~~	~~69~~	~~101~~
~~2~~	~~222~~	~~110~~	~~260~~
~~3~~	~~107~~	~~35~~	~~92~~
~~3a~~	~~152~~	~~43~~	~~115~~
~~3b~~	~~67~~	~~20~~	~~53~~
~~3c~~	~~15~~	~~7~~	~~17~~
~~4~~	~~343~~	~~90~~	~~235~~
~~4a~~	~~10~~	~~8~~	~~16~~
~~5~~	~~154~~	~~53~~	~~136~~
~~5a~~	~~164~~	~~60~~	~~151~~
~~5b~~	~~258~~	~~60~~	~~147~~
~~6~~	~~286~~	~~93~~	~~240~~
~~7~~	~~52~~	~~30~~	~~68~~
~~8~~	~~125~~	~~64~~	~~150~~
~~9~~	~~125~~	~~19~~	~~42~~

~~South of the Chetco River (Harbor)~~

~~Area Number~~	~~Acreage~~	~~Pre Development Peak Flow (cfs)~~	~~Post Development Peak Flow (cfs)~~
~~10~~	~~204~~	~~61~~	~~161~~
~~10a~~	~~115~~	~~63~~	~~146~~
~~11~~	~~53~~	~~32~~	~~73~~
~~12&13~~	~~23~~	~~18~~	~~36~~
~~14~~	~~14~~	~~12~~	~~23~~
~~15~~	~~134~~	~~98~~	~~206~~
~~16~~	~~113~~	~~61~~	~~142~~
~~17~~	~~435~~	~~183~~	~~447~~
~~17a~~	~~342~~	~~151~~	~~368~~
~~17b~~	~~82~~	~~17~~	~~42~~
~~17c~~	~~54~~	~~17~~	~~44~~
~~18~~	~~257~~	~~116~~	~~280~~
~~19~~	~~19~~	~~14~~	~~30~~
~~20~~	~~226~~	~~35~~	~~74~~
~~21~~	~~42~~	~~40~~	~~72~~
~~22~~	~~446~~	~~59~~	~~122~~
~~23~~	~~90~~	~~60~~	~~132~~

Draft text is ***bold and italicized.***
Text to be deleted has ~~strikethroughs~~.

Storm Drainage Needs

Historically, runoff from the Harbor Hills drained down onto the Harbor Bench, over which flow a number of drainage swales. When the flow capacity of the swales was exceeded, the runoff flooded the flatland; the soils eroded from the hills onto the delta created farmland. Construction of Highway 101 altered this natural pattern by concentrating the more diffuse swale flows into culverts under the highway. The areas downstream of these culverts now convey additional, more concentrated flows with resultant flooding and erosion.

The storm drainage from newly developed areas creates additional impervious surfaces such as roads, roofs, sidewalks, and other open areas. Creating impervious surface increases the amount of runoff by allowing the water to concentrate faster. This increased runoff can exceed the capacity of the existing pipes, culverts, ditches, and natural drainage channels. The drainage from the newly developed areas must be collected and transported to the ocean without creating flooding, erosion, or negative environmental impacts.

Curry County currently provides storm drainage services for the study area. Curry County provides a low level of service, primarily ditch cleaning and culvert maintenance. Development in the urban growth areas will require much higher operational activities as maintain water quality features, detention facilities and substantial new amounts of pipes and/or ditches. A method of funding a utility to provide such services is critical in any selected alternative.

Improvements to the Harbor Bench drainage channels should be considered as a possible additional benefit to existing residents and new development, given the history of flooding in this area. As part of the development the culverts can be moved or altered to bring the drainage back to the natural configuration. Any detailed master plan should examine the feasibility of culvert changes in the areas south of the Chetco River. The Harbor Bench area is prime agricultural land. It is extremely sensitive to erosion and flood impacts. Special attention and planning must be given to this area.

On _____, the City adopted the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area." Details concerning storm drainage needs can be found in that document.

Alternatives

To avoid adverse impacts created by development, ~~three~~ *five* strategies are generally utilized:

1. *There should be no post-development net increase in storm drainage discharge downstream.*
2. *Low impact development practices as described in the 2008 "Storm and Surface Water Facilities Plan" shall be implemented.*
3. The capacity of the downstream drainage infrastructure is improved to convey the increased flow. Usually this means constructing larger culverts and storm drains. Generally, the natural drainage channels are improved, but because of the study area's proximity to the ocean and the steep rocky terrain, these channel improvements may not be necessary.
4. A regional detention facility is constructed to capture the additional runoff and release the flow at a slower natural rate. A regional facility is normally associated with a single drainage way or creek.
5. An onsite detention facility is constructed for each individual development. The goal for a regional or onsite detention facility is that the runoff from the post-development condition be reduced to flow equaling the pre-development condition.

Recommendation

The numerous drainage basins in the study area were evaluated for use of the above methodologies. Pre- and post-development flows were estimated using the Santa Barbara Urban Hydrograph computer model. An appropriate strategy for each drainage basin was selected using flow generation, amount of existing development, the terrain, and other features. The areas north and south of the Chetco River were considered separately because conditions vary greatly between these study areas.

Detailed master plans for each basin must be prepared to refine facility sizing, horizontal and vertical alignments, and to refine alternatives. Each basin should have a master plan prepared prior to large-scale development in the drainage basin to coordinate improvement efforts.

The Storm and Surface Water facilities Plan for Brooking Harbor Area" contains the following policies:

- *Low impact development is preferred.*
- *Negative impacts to natural watercourses are to be avoided.*
- *Piping of a natural watercourses is to be avoided, where practicable.*
- *Protection of ground water sources is critical.*
- *Proposed facilities should address water quality impacts and mitigation measures.*
- *Erosion and sediment must be controlled using the City, County, and Department of Environmental Quality requirements.*
- *Stormwater discharges shall be maintained at current levels.*

- ~~*The City will consider a stormwater utility fee to fund needed maintenance on the existing facility*~~.
- *A public education program is recommended to disseminate information on the importance of preventing negative impacts from stormwater.*

The "Storm and Surface Water Facilities Plan for Brookings-Harbor Area" contains specific design and development standards and proposed improvements to the storm drainage facility.

North of the Chetco River (Brookings)

The storm drainage improvements north of the Chetco River will be located on steep, rocky terrain. The proposed Urban Growth Areas are generally located east of Highway 101. ~~The areas west of Highway 101, except for basins 5A and 5B, consist of steep cliffs that drop directly into the ocean. Basins 6 and 7 discharge directly to the Chetco River.~~

Since the increased runoff insignificantly impacts the natural channels west of Highway 101, the recommended improvements involve the following:

- constructing a local conveyance system;
- constructing a new collector or improving the existing channel;
- constructing a new culvert under Highway 101 (ODOT culverts are only designed for existing conditions, not anticipated development conditions), and
- erosion control improvements in the existing creek channels

~~Basins 5A and 5-B discharge into developed areas that appear prone to downstream damage.~~ With the high levels of development, regional detention facilities will be expensive. To mitigate the increased flows, onsite detention facilities for each development will be the best alternative to development impacts. Development would pay for these on-site detention facilities.

Discussion concerning specific basins is found in the "Storm and Surface Water Faciltities Plan for Brookings-Harbor Area."

~~1. Basin 1~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Lone Ranch Creek drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

~~2. Basin 2~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Ram Creek drainage way~~
~~Improve culvert under Highway 101~~

~~Provide channel erosion improvements between Highway 101 and ocean~~

3. ~~Basin 3, 3A, 3C, and 3B~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

4. ~~Basin 4 and 4A~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Shy Creek drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

5. ~~Basin 5~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain or channel improvements in Harris Creek drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

6. ~~Basin 5A and 5B~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain in drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

7. ~~Basin 6~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Ferry Creek drainage way~~
~~Improve culvert under North Chetco Road~~
~~Provide channel erosion improvements between North Chetco Road and River~~

8. ~~Basin 7~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Hall Creek drainage way~~
~~Improve culvert under North Chetco Road~~
~~Provide channel erosion improvements between Chetco Road and River~~
~~Improve culvert under Highway 101~~

~~Provide channel erosion improvements between Highway 101 and ocean~~

South of the Chetco River (Harbor)

The study area south of the Chetco River provides a more complicated drainage situation. Basins ~~13 through 19~~ are located northeast of Highway 101 on the Harbor Hills. The terrain in the Harbor Hills basins are generally quite steep, then flatten out onto the Harbor Bench. Highway 101 provides a barrier between the Harbor Hills and the Harbor Bench.

The Harbor Bench is relatively flat and has a history of flooding. Many residences are located in this prime farmland, even though it is located outside the Urban Growth Boundary (UGB). Increasing runoff without proper controls would exacerbate an already serious flooding and erosion situation.

Unlike the areas north of the Chetco River, regional or onsite detention to service new development is the most suitable storm water control methodology for the areas discharging to the Harbor Bench. The Harbor Bench area is sensitive to erosion and flooding. The regional or on-site detention should be funded by the developer or through SDC accrual.

Basins ~~20 through 23~~ are also located on the Harbor Hills, but drain north to the Chetco River. Drainage of these basins requires use of the natural streams, so regional or onsite detention is the most likely scenario. Since the drainage crosses areas outside the UGB, constructing channel improvements or storm pipes would seem unlikely due to land use and environmental concerns. (Note: Drainage areas inside the UGB can be impacted with proper reconstruction and/or mitigation)

Discussion concerning specific basins is found in the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area."

~~The following improvements are recommended for Basins 13 through 23.~~

~~1. Basin 13~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drains or improve drainage way~~
~~Improve culvert under Highway 101~~

~~2. Basin 14~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~3. Basin 15~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

4. ~~Basin 16~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

5. ~~Basin 17 and 17A~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

6. ~~Basin 17B~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain or improve drainage way~~
~~Provide erosion controls in natural channels~~

7. ~~Basin 18~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

8. ~~Basin 19~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

9. ~~Basin 20~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Improve Jordan Creek drainage way~~

~~10. Basin 21~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Improve Carey Creek drainage way~~

~~11. Basin 22~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~12. Basin 23~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

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Funding Sources

Implementing the infrastructure for the new urban growth areas requires capital funding. The following mechanisms are feasible for providing capital resources:

System Development Charges

Oregon law allows cities and service districts to charge system development charges for future growth. System development charges are fees that the developer pays to connect to the infrastructure system. The receipts from these fees can be saved, applied to bond payments, or applied to actual project expenses. Oregon law provides a specific methodology to justify charging these fees since the fees can only be applied towards growth related projects. System development charges are a common method of financing system growth.

Developer Financing

In cities and service districts that are unable to capitalize infrastructure improvements, developers have the ability to provide the improvements. Generally a developer provides the infrastructure improvements, transfers the facilities to the jurisdiction, then is reimbursed for the capacity outside the developers needs. Usually the developer is compensated on a per connection basis when the actual connection takes place. Generally the developer is not guaranteed full repayment.

Revenue Bonds

A common method of financing improvements to the infrastructure system is revenue bonding. Revenue bonds are repaid through rate charges for the service provided. The city or service district pledges to charge rates sufficient to repay the debt. In Oregon, a governing body such as a city council can implement revenue bonds, but revenue bonds can be referred to the voters through the petition process.

General Obligation Bonds

General obligation bonds assess a tax against property values in the taxation district as a capital source. This funding source was recently used by the City of Brookings to expand the wastewater treatment plant. General obligation bonds require a majority vote of the registered voters in the taxation district. The revenue stream can come from property tax receipts. However, the City is collecting user fees to pay for plant expansion. Use of general obligation bonds for development related projects presents obstacles. The requirement for a majority vote puts the project in the voters' hands. If there are no clear benefits to the public, then the bond issue can be defeated.

Grants

Federal or state grants do not appear to be feasible for providing the infrastructure. Many state and federal agencies provide grant assistance, but these funds are many aimed at assisting existing communities with long-standing problems. Unfortunately grant requests far outstrip available funds. With the current political climate, grant funds to provide infrastructure for new development appear unlikely.

Utility Fee

The City has adopted a stormwater utility fee to be added to monthly bills of properties within City limits to fund needed maintanance of stormwater facilities.

Recommendations

It is recommended that the City of Brookings and the Harbor Water PUD study and develop mechanisms for funding growth-related projects. These funding mechanisms will revolve around System Development Charges, Developer Contributions and Revenue Bonding. Other funding mechanisms should be explored where feasible or appropriate. The city will require all new development to pay for the expansion of services to the area being developed. While the use of bonds is a common revenue source for such projects, their inclusion in this document does not bind the city to their use. When bonds are determined to be the necessary mechanism to fund a project, the city shall bring the issue to the vote of the citizens.

CITY OF BROOKINGS – PUBLIC FACILITIES PLAN
DRAFT REVISIONS – JULY 8, 2008

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INTRODUCTION (PAGE 11)

Pump Stations

Flows from the entire Harbor collection system enter HSD pump station No. 4. Discharge from this station is to the Brookings WWTP by means of an 8-inch force main over the Chetco River. Space for additional force mains is available. Pump station No. 4 is rated at 1,000 gpm and 125 feet. The number one pump station has a capacity of 650 gpm at 95 feet. The other three pump stations are small and serve limited areas.

City of Brookings Storm Drainage System

The City of Brookings operates a storm drainage system within the city boundaries. ~~Eight~~ Drainage basins flow to the ocean or the Chetco River. Generally local area flows are conveyed via pipes to discharge points at surface drainage ways. The majority of the existing piping system is located in the western old portions of the city draining to the Chetco. Highway 101 presents a major flow obstruction to natural drainage pattern, requiring culvert crossings. Some limited historical flooding has occurred, but the problems are related to site-specific causes.

Curry County Storm Drainage System

Curry County services all storm drainage in the study areas north and south of the Chetco. The service level is mainly rural road maintenance that mainly consists of ditch culvert cleaning associated with road maintenance. All other drainage features are privately owned. The Harbor Bench area, which is outside the urban growth area, has experienced flooding and erosion due upstream growth and diversion of flows due to culvert placement.

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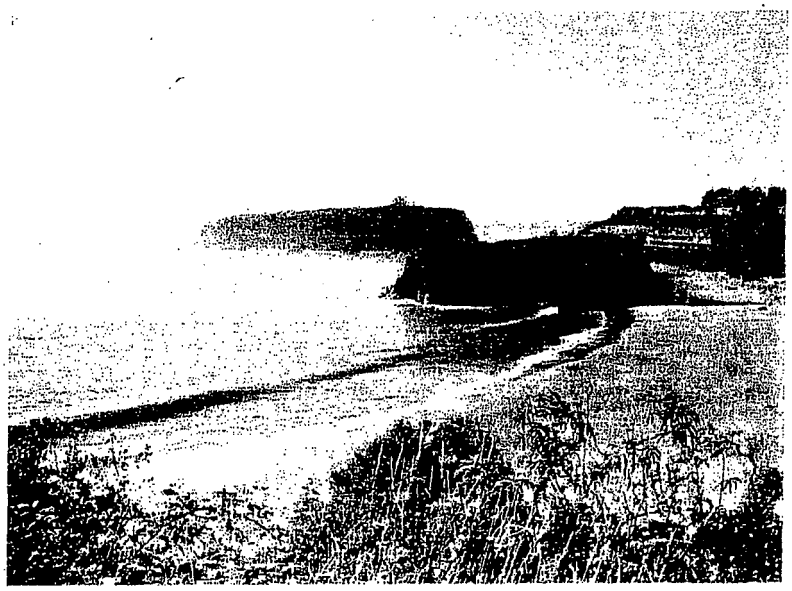
Project #:06.16

This binder is in the
"Attachments File"
in the County Clerk's vault

STORM AND SURFACE WATER FACILITIES PLAN for BROOKINGS-HARBOR AREA



for:

City of Brookings, Oregon

and

Curry County, Oregon

Final (Brookings) - October 2007
Draft - December 2006

This project has been funded in part with financial assistance provided by The Coastal Zone Management Act of 1972, as administered by The Ocean and Coastal Management Program, Department of Land Conservation and Development.

IN AND FOR THE CITY OF BROOKINGS
STATE OF OREGON

In the Matter of the Adoption of Revisions to the City of Brookings Comprehensive Plan and the Public Facilities Plan for Urban Growth Expansion for the Brookings and Harbor Study Areas and by Adopting a New Storm and Surface Water Facilities Plan for Brookings-Harbor Area, and Declaring an Emergency.	**ORDINANCE NO. 09-O-626**

Sections:

Section 1. Findings
Section 2. Amendments
Section 3. Severance Clause
Section 4. Effective Date
Section 5. Emergency

The City Council for the City of Brookings ordains as follows:

Section 1: Findings

1. On August 30, 2002, the Brookings City Council amended the City of Brookings Comprehensive Plan for the purpose of adopting the *Public Facilities Plan for Urban Growth Expansion: Brookings and Harbor Study Areas* (City of Brookings Ordinance No. 02-O-548).

2. Portions of the *Public Facilities Plan for Urban Growth Expansion: Brookings and Harbor Study Areas* are in need of amendment. Those portions of the Plan in need of amendment are attached hereto and incorporated by reference.

3. The *Storm and Surface Water Facilities Plan for Brookings-Harbor Area* (October of 2007), a copy of which is attached hereto and incorporated by reference, was prepared by HGE Inc., a private consulting firm. The development of this plan was a joint effort between the City of Brookings and Curry County using a technical assistance grant from the Oregon Department of Land Conservation and Development (DLCD). The *Storm and Surface Water Facilities Plan for the Brookings-Harbor area* is a supplemental section to the *Public Facilities Plan for Urban Growth Expansion: Brookings and Harbor Study Areas* of the City of Brookings Comprehensive Plan.

4. The initial draft of the Plan was adopted in December of 2006. The draft text was subsequently modified following input from the public, the Brookings City Council, the Board of Curry County Commissioners, and the City of Brookings and Curry County Planning Commissions.

5. With the concurrence of both the City Council and the Board of Curry County Commissioners, staff sent to DLCD the 45 day notice required under ORS 197.610 for post acknowledgment plan amendments for the proposed changes to the Comprehensive Plans.

6. Following public notice as required by law, the Brookings City Council and the Board of Curry County Commissioners held a joint hearing on the proposed amendments on Monday, December 8, 2008, at 5:30 P.M. at the Brookings City Hall.

7. On Monday, January 12, 2009, the Brookings City Council approved the Comprehensive Plan amendment changes that are attached hereto and incorporated by reference.

Section 2 Amendments

The City of Brookings Comprehensive Plan (Ordinance No. 02-O-548, and it subsequent amendments) is amended as shown by the attached changes in the *Comprehensive Plan, Public Facilities Plan for Urban Growth Expansion for the Brookings and Harbor Study Areas* and by adopting the attached *Storm and Surface Water Facilities Plan for Brookings-Harbor Area* with Addendums 1, 2 and 3.

The Public Facilities Plan for Urban Growth Expansion: Brookings and Harbor Study Areas, Appendix A: Facilities Maps/ Projects Descriptions is further amended by removing the four (4) "Storm Facilities" maps.

Section 3: Severance Clause

If any section, subsection, sentence, clauses or phrases of this ordinance is, for any reason, held to be unconstitutional or otherwise invalid, such decision shall not affect the validity of the remaining portions of this ordinance.

Section 4: Effective Date:

Consistent with ORS Chapters 197 and 227, this ordinance shall take effect upon its passage, due to an emergency as stated in Section 5.

Section 5: Emergency

It is hereby determined that it is in the best interest of the public that immediate action be taken. The revisions being adopted by this Ordinance were previously adopted by the Curry County Board of Commissioners on December 9, 2008. By law these revisions must be co-adopted by both the County and the City. In an effort to keep the adoption and effective dates within responsible proximity, this emergency clause is being used. Therefore, an emergency is declared to exist and the Ordinance shall be in full force and effect immediately on its passage by the City Council and signing of the Mayor.

First Reading: January 12, 2009
Second Reading: January 12, 2009
Passage: January 12, 2009
Effective Date: January 12, 2009

Signed by me in authentication of its passage this 13th, day of January, 2009.

Mayor Larry Anderson

ATTEST:

City Recorder Joyce Heffington

CITY OF BROOKINGS – COMPREHENSIVE PLAN

DRAFT REVISIONS
SEPTEMBER, 2008

CITY OF BROOKINGS – COMPREHENSIVE PLAN
DRAFT REVISIONS – Sept., 2008

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GOAL 11 PUBLIC FACILITIES AND SERVICES

GOAL:

To plan and develop a timely, orderly and efficient arrangement of public facilities and services to provide a framework for urban and rural development.

FINDINGS:

1. The City has adopted a Public Facilities and Services Plan that establishes the framework for the distribution of water and sanitary sewer services and storm drainage systems throughout the expanded Urban Growth Boundary.

3. The City has adopted a Water Master Plan/Conservation Management Plan.

4. The City has adopted a Water Curtailment ordinance that provides the city with the mechanisms to curtail water use in emergencies, including low surface water flows in the Chetco River.

5. *On _____, the City adopted the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area." New policies from this Plan are found in the "Public Facilities Plan for Urban Growth Expansion."*

~~5~~*6.* The city currently provides the following facilities and services within the City Limits:

CITY OF BROOKINGS – COMPREHENSIVE PLAN
DRAFT REVISIONS – Sept., 2008

Draft text is ***bold and italicized.***
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POLICIES:

To insure timely, orderly and efficient arrangement of public facilities and services the following policies will be implemented by the City of Brookings.

1. Public Works

A. Water treatment facilities. Facilities will be maintained with the proper observation and planning to expand facilities on a timely basis to provide continued service to existing customers and projected growth. Expansion programs will be funded through the most cost-effective methods utilizing all available federal, state and local funds.

B. Water distribution, pumping and storage. New development requiring extension of water mains, pumping and storage facilities will be paid for and constructed by the developer pursuant to the provisions of the City of Brookings Standard Specifications document dated August 1988.

C. Water Master Plan/Conservation Management Plan. The city will maintain a Water Master Plan/Water Conservation Management Plan, which will be updated as required.

D. Wastewater treatment facility. Expansion programs will be funded through the most cost-effective methods utilizing all available federal, state and local funds.

E. Wastewater collection facilities. New development requiring extension of sewer mains and new pumping stations will be paid for and constructed by the developer City of Brookings Standard Specifications document dated August 1988.

F. Streets and other infrastructure facilities. The City's Public Works Department will inspect and maintain all public street and subsurface infrastructure facilities. The extension of existing streets for new development shall be paid for and constructed by the developer pursuant to the provisions of the City of Brookings Standard Specifications document dated August 1988.

G. Strom drain facilities. New development requiring new storm drain systems

or the extension of existing systems including provision of retention basins, will be paid for and constructed by the developer pursuant to the provision of the City of Brookings Standard Specifications document dated August 1988.

On _____, the City adopted the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area." New policies from this Plan are found in the "Public Facilities Plan for Urban Growth Expansion."

2. Fire Prevention and Protection

The fire chief will continue to serve as the head of prevention and protection services. He will continue to maintain the high level of training and service that the community has come to expect through the conduct of local and regional training sessions and a continued education for himself.

3. Police Protection

The chief of police shall be responsible for continually monitoring the department's facility requirements and operations. In conjunction with the annual preparation of his budget request, a written evaluation shall be prepared for the city manager, who in turn, may call attention to specific items for consideration by planning commission, council or staff.

CITY OF BROOKINGS – PUBLIC FACILITIES PLAN

DRAFT REVISIONS
SEPTEMBER, 2008

Draft text is *bold and italicized.*
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Stormwater Needs

On _____, the City adopted the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area." ~~A public education program is recommended to disseminate information on the importance of preventing negative impacts from stormwater.~~ In the Plan are design and development standards and proposed improvements to the storm drainage facility. There are also maps depicting the various basin areas, hydrologic/ hydraulic analysis, and the discussion of the effects on specific areas in the Plan.

~~Using the Santa Barbara Urban Hydrograph computer model, pre and post development storm flows were calculated for each basin. A 25 year return period was assumed. The flows for North and South of the Chetco are as follows. (See figures in Appendix A for reference)~~

~~North of the Chetco River (Brookings)~~

~~Area Number~~	~~Acreage~~	~~Pre Development Peak Flow (cfs)~~	~~Post Development Peak Flow (cfs)~~
~~1~~	~~109~~	~~69~~	~~101~~
~~2~~	~~222~~	~~110~~	~~260~~
~~3~~	~~107~~	~~35~~	~~92~~
~~3a~~	~~152~~	~~43~~	~~115~~
~~3b~~	~~67~~	~~20~~	~~53~~
~~3c~~	~~15~~	~~7~~	~~17~~
~~4~~	~~343~~	~~90~~	~~235~~
~~4a~~	~~10~~	~~8~~	~~16~~
~~5~~	~~154~~	~~53~~	~~136~~
~~5a~~	~~164~~	~~60~~	~~151~~
~~5b~~	~~258~~	~~60~~	~~147~~
~~6~~	~~286~~	~~93~~	~~240~~
~~7~~	~~52~~	~~30~~	~~68~~
~~8~~	~~125~~	~~64~~	~~150~~
~~9~~	~~125~~	~~19~~	~~42~~

~~South of the Chetco River (Harbor)~~

~~Area Number~~	~~Acreage~~	~~Pre Development Peak Flow (cfs)~~	~~Post Development Peak Flow (cfs)~~
~~10~~	~~204~~	~~61~~	~~161~~
~~10a~~	~~115~~	~~63~~	~~146~~
~~11~~	~~53~~	~~32~~	~~73~~
~~12&13~~	~~23~~	~~18~~	~~36~~
~~14~~	~~14~~	~~12~~	~~23~~
~~15~~	~~134~~	~~98~~	~~206~~
~~16~~	~~113~~	~~61~~	~~142~~
~~17~~	~~435~~	~~183~~	~~447~~
~~17a~~	~~342~~	~~151~~	~~368~~
~~17b~~	~~82~~	~~17~~	~~42~~
~~17c~~	~~54~~	~~17~~	~~44~~
~~18~~	~~257~~	~~116~~	~~280~~
~~19~~	~~19~~	~~14~~	~~30~~
~~20~~	~~226~~	~~35~~	~~74~~
~~21~~	~~42~~	~~40~~	~~73~~
~~22~~	~~446~~	~~59~~	~~122~~
~~23~~	~~90~~	~~60~~	~~132~~

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Text to be deleted has ~~strikethroughs~~.

Storm Drainage Needs

Historically, runoff from the Harbor Hills drained down onto the Harbor Bench, over which flow a number of drainage swales. When the flow capacity of the swales was exceeded, the runoff flooded the flatland; the soils eroded from the hills onto the delta created farmland. Construction of Highway 101 altered this natural pattern by concentrating the more diffuse swale flows into culverts under the highway. The areas downstream of these culverts now convey additional, more concentrated flows with resultant flooding and erosion.

The storm drainage from newly developed areas creates additional impervious surfaces such as roads, roofs, sidewalks, and other open areas. Creating impervious surface increases the amount of runoff by allowing the water to concentrate faster. This increased runoff can exceed the capacity of the existing pipes, culverts, ditches, and natural drainage channels. The drainage from the newly developed areas must be collected and transported to the ocean without creating flooding, erosion, or negative environmental impacts.

Curry County currently provides storm drainage services for the study area. Curry County provides a low level of service, primarily ditch cleaning and culvert maintenance. Development in the urban growth areas will require much higher operational activities as maintain water quality features, detention facilities and substantial new amounts of pipes and/or ditches. A method of funding a utility to provide such services is critical in any selected alternative.

Improvements to the Harbor Bench drainage channels should be considered as a possible additional benefit to existing residents and new development, given the history of flooding in this area. As part of the development the culverts can be moved or altered to bring the drainage back to the natural configuration. Any detailed master plan should examine the feasibility of culvert changes in the areas south of the Chetco River. The Harbor Bench area is prime agricultural land. It is extremely sensitive to erosion and flood impacts. Special attention and planning must be given to this area.

On _____, the City adopted the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area." Details concerning storm drainage needs can be found in that document.

Alternatives

To avoid adverse impacts created by development, ~~three~~ *five* strategies are generally utilized:

1. *There should be no post-development net increase in storm drainage discharge downstream.*
2. *Low impact development practices as described in the 2008 "Storm and Surface Water Facilities Plan" shall be implemented.*
3. The capacity of the downstream drainage infrastructure is improved to convey the increased flow. Usually this means constructing larger culverts and storm drains. Generally, the natural drainage channels are improved, but because of the study area's proximity to the ocean and the steep rocky terrain, these channel improvements may not be necessary.
4. A regional detention facility is constructed to capture the additional runoff and release the flow at a slower natural rate. A regional facility is normally associated with a single drainage way or creek.
5. An onsite detention facility is constructed for each individual development. The goal for a regional or onsite detention facility is that the runoff from the post-development condition be reduced to flow equaling the pre-development condition.

Recommendation

The numerous drainage basins in the study area were evaluated for use of the above methodologies. Pre- and post-development flows were estimated using the Santa Barbara Urban Hydrograph computer model. An appropriate strategy for each drainage basin was selected using flow generation, amount of existing development, the terrain, and other features. The areas north and south of the Chetco River were considered separately because conditions vary greatly between these study areas.

Detailed master plans for each basin must be prepared to refine facility sizing, horizontal and vertical alignments, and to refine alternatives. Each basin should have a master plan prepared prior to large-scale development in the drainage basin to coordinate improvement efforts.

The Storm and Surface Water facilities Plan for Brooking Harbor Area" contains the following policies:

- *Low impact development is preferred.*
- *Negative impacts to natural watercourses are to be avoided.*
- *Piping of a natural watercourses is to be avoided, where practicable.*
- *Protection of ground water sources is critical.*
- *Proposed facilities should address water quality impacts and mitigation measures.*
- *Erosion and sediment must be controlled using the City, County, and Department of Environmental Quality requirements.*
- *Stormwater discharges shall be maintained at current levels.*

- ~~*The City will consider a stormwater utility fee to fund needed maintenance on the existing facility.*~~
- *A public education program is recommended to disseminate information on the importance of preventing negative impacts from stormwater.*

The "Storm and Surface Water Facilities Plan for Brookings-Harbor Area" contains specific design and development standards and proposed improvements to the storm drainage facility.

North of the Chetco River (Brookings)

The storm drainage improvements north of the Chetco River will be located on steep, rocky terrain. The proposed Urban Growth Areas are generally located east of Highway 101. ~~The areas west of Highway 101, except for basins 5A and 5B, consist of steep cliffs that drop directly into the ocean. Basins 6 and 7 discharge directly to the Chetco River.~~

Since the increased runoff insignificantly impacts the natural channels west of Highway 101, the recommended improvements involve the following:

- constructing a local conveyance system;
- constructing a new collector or improving the existing channel;
- constructing a new culvert under Highway 101 (ODOT culverts are only designed for existing conditions, not anticipated development conditions), and
- erosion control improvements in the existing creek channels

~~Basins 5A and 5 B discharge into developed areas that appear prone to downstream damage.~~ With the high levels of development, regional detention facilities will be expensive. To mitigate the increased flows, onsite detention facilities for each development will be the best alternative to development impacts. Development would pay for these on-site detention facilities.

Discussion concerning specific basins is found in the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area."

~~1. Basin 1~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Lone Ranch Creek drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~.

~~2. Basin 2~~.

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Ram Creek drainage way~~
~~Improve culvert under Highway 101~~

~~Provide channel erosion improvements between Highway 101 and ocean~~

3. ~~Basin 3, 3A, 3C, and 3B~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

4. ~~Basin 4 and 4A~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Sky Creek drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

5. ~~Basin 5~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain or channel improvements in Harris Creek drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

6. ~~Basin 5A and 5B~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain in drainage way~~
~~Improve culvert under Highway 101~~
~~Provide channel erosion improvements between Highway 101 and ocean~~

7. ~~Basin 6~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Ferry Creek drainage way~~
~~Improve culvert under North Chetco Road~~
~~Provide channel erosion improvements between North Chetco Road and River~~

8. ~~Basin 7~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain in Hall Creek drainage way~~
~~Improve culvert under North Chetco Road~~
~~Provide channel erosion improvements between Chetco Road and River~~
~~Improve culvert under Highway 101~~

~~Provide channel erosion improvements between Highway 101 and ocean~~

South of the Chetco River (Harbor)

The study area south of the Chetco River provides a more complicated drainage situation. Basins ~~13 through 19~~ are located northeast of Highway 101 on the Harbor Hills. The terrain in the Harbor Hills basins are generally quite steep, then flatten out onto the Harbor Bench. Highway 101 provides a barrier between the Harbor Hills and the Harbor Bench.

The Harbor Bench is relatively flat and has a history of flooding. Many residences are located in this prime farmland, even though it is located outside the Urban Growth Boundary (UGB). Increasing runoff without proper controls would exacerbate an already serious flooding and erosion situation.

Unlike the areas north of the Chetco River, regional or onsite detention to service new development is the most suitable storm water control methodology for the areas discharging to the Harbor Bench. The Harbor Bench area is sensitive to erosion and flooding. The regional or on-site detention should be funded by the developer or through SDC accrual.

Basins ~~20 through 23~~ are also located on the Harbor Hills, but drain north to the Chetco River. Drainage of these basins requires use of the natural streams, so regional or onsite detention is the most likely scenario. Since the drainage crosses areas outside the UGB, constructing channel improvements or storm pipes would seem unlikely due to land use and environmental concerns. (Note: Drainage areas inside the UGB can be impacted with proper reconstruction and/or mitigation)

Discussion concerning specific basins is found in the "Storm and Surface Water Facilities Plan for Brookings-Harbor Area."

~~The following improvements are recommended for Basins 13 through 23.~~

~~1. Basin 13~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drains or improve drainage way~~
~~Improve culvert under Highway 101~~

~~2. Basin 14~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~3. Basin 15~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~4. Basin 16~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~5. Basin 17 and 17A~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~6. Basin 17B~~

~~Provide local collection system to service new development~~
~~Construct main collector storm drain or improve drainage way~~
~~Provide erosion controls in natural channels~~

~~7. Basin 18~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~8. Basin 19~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~9. Basin 20~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Improve Jordan Creek drainage way~~

~~10. Basin 21~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Improve Carey Creek drainage way~~

~~11. Basin 22~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

~~12. Basin 23~~

~~Provide local collection system to service new development~~
~~Provide onsite detention for every development~~
~~Construct main collector storm drain or improve drainage way~~
~~Improve culvert under Highway 101~~

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Funding Sources

Implementing the infrastructure for the new urban growth areas requires capital funding. The following mechanisms are feasible for providing capital resources:

System Development Charges

Oregon law allows cities and service districts to charge system development charges for future growth. System development charges are fees that the developer pays to connect to the infrastructure system. The receipts from these fees can be saved, applied to bond payments, or applied to actual project expenses. Oregon law provides a specific methodology to justify charging these fees since the fees can only be applied towards growth related projects. System development charges are a common method of financing system growth.

Developer Financing

In cities and service districts that are unable to capitalize infrastructure improvements, developers have the ability to provide the improvements. Generally a developer provides the infrastructure improvements, transfers the facilities to the jurisdiction, then is reimbursed for the capacity outside the developers needs. Usually the developer is compensated on a per connection basis when the actual connection takes place. Generally the developer is not guaranteed full repayment.

Revenue Bonds

A common method of financing improvements to the infrastructure system is revenue bonding. Revenue bonds are repaid through rate charges for the service provided. The city or service district pledges to charge rates sufficient to repay the debt. In Oregon, a governing body such as a city council can implement revenue bonds, but revenue bonds can be referred to the voters through the petition process.

General Obligation Bonds

General obligation bonds assess a tax against property values in the taxation district as a capital source. This funding source was recently used by the City of Brookings to expand the wastewater treatment plant. General obligation bonds require a majority vote of the registered voters in the taxation district. The revenue stream can come from property tax receipts. However, the City is collecting user fees to pay for plant expansion. Use of general obligation bonds for development related projects presents obstacles. The requirement for a majority vote puts the project in the voters' hands. If there are no clear benefits to the public, then the bond issue can be defeated.

Grants

Federal or state grants do not appear to be feasible for providing the infrastructure. Many state and federal agencies provide grant assistance, but these funds are many aimed at assisting existing communities with long-standing problems. Unfortunately grant requests far outstrip available funds. With the current political climate, grant funds to provide infrastructure for new development appear unlikely.

Utility Fee

The City has adopted a stormwater utility fee to be added to monthly bills of properties within City limits to fund needed maintanance of stormwater facilities.

Recommendations

It is recommended that the City of Brookings and the Harbor Water PUD study and develop mechanisms for funding growth-related projects. These funding mechanisms will revolve around System Development Charges, Developer Contributions and Revenue Bonding. Other funding mechanisms should be explored where feasible or appropriate. The city will require all new development to pay for the expansion of services to the area being developed. While the use of bonds is a common revenue source for such projects, their inclusion in this document does not bind the city to their use. When bonds are determined to be the necessary mechanism to fund a project, the city shall bring the issue to the vote of the citizens.

TEXT TO BE DELETED HAS ~~STRIKETRHOUGHS~~.

INTRODUCTION (PAGE 11)

Pump Stations

Flows from the entire Harbor collection system enter HSD pump station No. 4. Discharge from this station is to the Brookings WWTP by means of an 8-inch force main over the Chetco River. Space for additional force mains is available. Pump station No. 4 is rated at 1,000 gpm and 125 feet. The number one pump station has a capacity of 650 gpm at 95 feet. The other three pump stations are small and serve limited areas.

City of Brookings Storm Drainage System

The City of Brookings operates a storm drainage system within the city boundaries. ~~Eight~~ Drainage basins flow to the ocean or the Chetco River. Generally local area flows are conveyed via pipes to discharge points at surface drainage ways. The majority of the existing piping system is located in the western old portions of the city draining to the Chetco. Highway 101 presents a major flow obstruction to natural drainage pattern, requiring culvert crossings. Some limited historical flooding has occurred, but the problems are related to site-specific causes.

Curry County Storm Drainage System

Curry County services all storm drainage in the study areas north and south of the Chetco. The service level is mainly rural road maintenance that mainly consists of ditch culvert cleaning associated with road maintenance. All other drainage features are privately owned. The Harbor Bench area, which is outside the urban growth area, has experienced flooding and erosion due upstream growth and diversion of flows due to culvert placement.

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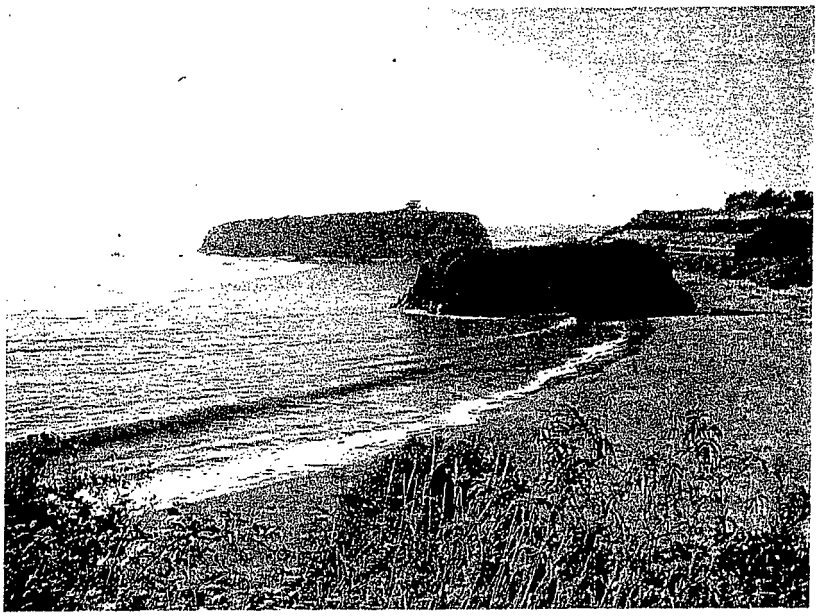
STORM AND SURFACE WATER FACILITIES PLAN for BROOKINGS-HARBOR AREA



for:

City of Brookings, Oregon

and

Curry County, Oregon

Final (Brookings) - October 2007
Draft - December 2006

This project has been funded in part with financial assistance provided by The Coastal Zone Management Act of 1972, as administered by The Ocean and Coastal Management Program, Department of Land Conservation and Development.

Project No. 06.16

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This project has been funded in part with financial assistance provided by The Coastal Zone Management Act of 1972, as administered by The Ocean and Coastal Management Program, Department of Land Conservation and Development.

Addendum No. 3
to

Storm and Surface Water Facilities Plan for Brookings-Harbor Area

December 8, 2008

On December 8, 2008, the Curry County Board of Commissioners and the Brookings City Council held a public hearing the on the adoption of revisions to the Curry County Comprehensive Plan and City of Brookings Comprehensive Plan by amending specific provisions of the Public Facilities Plan for Urban Growth Expansion for the Brookings and Harbor Study Areas and by adopting a new *Storm and Surface Water Facilities Plan for Brookings-Harbor Area.* After deliberating on the matter, the City of Brookings City Council and the Curry County Board of Commissioners made the following text changes to the proposed *Storm and Surface Water Facilities Plan for Brookings-Harbor Area* (October 2007):

1. Add the following definitions for TMDL (Total Maximum Daily Load) and O & M.:

    a. **Total Maximum Daily Load (TMDL)** means a written quantitative plan and analysis for attaining and maintaining water quality standards and includes the elements described in OAR 340-042-0040. These elements include a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet state water quality standards, allocations of portions of that amount to the pollutant sources or sectors, and a Water Quality Management Plan to achieve water quality standards.

    b. **O & M.** means Operations and Maintenance

2. Add the word "naturally" to the first sentence, last paragraph, between "run" and "high" on page 2 of the "Addendum to Storm and Surface Water Facilities Plan for Brookings-Harbor Area June 26, 2007." The sentence shall read as follows:

    "Temperatures in the Chetco tend to ***naturally*** run high in the summer and can exceed the 64 F rearing temperature criteria."

3. Label creeks and streams on the map.

4. Create a list of County storm and surface water projects with the following:

    a. Replace culvert at Johnson Creek and Oceanview Drive at an estimate cost of $150,000.

b. Replace culvert at Fish House Creek and Lower Harbor Road at an estimate cost of $400,000.

c. Phased reconstruction of approximately 14,000 lineal feet of water courses on the Harbor Bench at an estimated cost of $2,800,000 to be funded by multiple sources.

5. Modify the first sentence, first paragraph on page 7-2 which reads:

a. "Both the City and County have expressed a desire to not conduct ongoing monitoring with City and County resources."

b. *To read:* "Both the City and County have expressed a desire to ~~not~~ conduct ongoing monitoring ~~with City and County resources~~ ***only if funding is available***."

6. Under "***Chemical application to reduce aquatic and roadside vegetation***" in Addendum (No.1), Attachment No. 4 (page 7-23), dated June 26, 2007, titled "Harbor Hills Special Plan Area, CSWMP Work Plan, the following text shall be made:

"~~Discourage this practice~~ **Follow the best management practice for chemical application** to the greatest extent possible."

7. The following typographical errors shall be corrected:

a. Page 5-4, second paragraph, line 5 states "...many basins consist of only two or three basins." Shall be changed to "sub-basins."

b. Page 5-15, last paragraph, line 4 states "...requires oxygen to complete and ..." shall be changed to "deplete."

c. Page 6-17, last paragraph, last sentence states "The Couty" shall be changed to read "The County."

8. The text under **Harbor Hills Special Plan Area** in page 4 of "ADDENDUM TO STORM AND SURFACE WATER FACILITIES PLAN FOR BROOKINGS-HARBOR AREA" dated June 26, 2007 shall be replaced with the following text:

"The Harbor Hills Special Plan Area was established as an area of environmental concern under the Joint Management Agreement (JMA) between the City of Brookings and Curry County dated January 22, 2001. This area was to be designated as a special plan area on the comprehensive plan. Under the JMA, any special plan must be adopted as post acknowledgement plan amendment pursuant to ORS 197.610 by both the

City and County before any development permits are issued by the County for construction within Special Planned Areas.

"Under the terms of the JMA, the County must commission or require a comprehensive surface water management plan for the Harbor Hills Special Plan Area prior to land use approvals for new development (other than that allowed by the present zoning designation) to address surface water run-off, stream channel erosion, and potential impacts on the groundwater balance of the Harbor Bench aquifer. All future nonresource development, including roads and infrastructure, must comply with this plan. The plan is to include appropriate measures to assure that impacts from future development on water resources will be prevented or remedied."

9. The following paragraph on page 6-22 shall be removed:

"~~The undeveloped hillsides in this area are the site of the proposed Harbor Hills (or HW3) development. The proposed development involves approximately 632 acres and has an estimated (projected) population of 5,000 persons~~."

9. Attachment #4 of Addendum No. 1, which is a reprint from the Harbor Hills Special Plan Area *Comprehensive Surface Water Management Plan* (CSWMP), shall be removed.

10. Correct the culvert size on maps 5.4, 5.16, 5.18 as suggested by Dan Crumley, County Roadmaster. The most northerly culvert in basin number 55.1 is labeled 48" and needs to be changed to 36" in size.

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ADDENDUM No. 2 TO STORM AND SURFACE WATER FACILITIES PLAN For BROOKINGS - HARBOR AREA October 22, 2007

Background

The above referenced plan (henceforth referenced as "the Plan") was completed and submitted as a draft to the City of Brookings and Curry County in December 2006. Review comments from DLCD were received by the author on May 10, 2007. Follow up conversations and correspondence established some issues for further development or elaboration and it is to this effect that the first addendum was prepared. The first addendum, issued June 26, 2007, was focused on three general issues:

1) Water quality enhancement - especially with regard to future TMDL requirements or goals, and

2) Structural best management practices (BMP's) with an emphasis on steep hillside applications, and

3) Potential impacts and concerns associated with development on the Harbor Hills.

Copies of the first Addendum are being provided for inclusion in the Plan binders.

Addendum No. 2 has been prepared to address corrections, revisions, comments and concerns that have arisen prior to, and in, the Brookings City Council Workshop of August 30, 2007. The objective of Addendum No. 2 is to sufficiently revise the Plan to provide the City with an adoptable final document. Since the revisions reflect City concerns only at this time, the Brookings "Final" Plan is being issued as an addendum rather than a full modification and reissue of the Plan document. The "final" status of this document does not necessarily extend to Curry County, since they did not participate in the development of Addendum No. 2.

Corrections

The Draft included several minor typos which have been corrected in the digital master file. Mapping and text in many places indicate "Pfield" or "Lpine" where the correct street names are "Fifield" and "Alpine." Also, "Macklyn Creek" incorrectly appears as "Maclyn Creek" in several places. These are also being corrected in the digital (study) master file.

Section 5.4.2 PA1 includes erroneous information related to problems at the mislabeled "Harris Heights Subdivision." The plat for the area (Harris Beach P.U.D.) includes a dedication statement: "...and do hereby dedicate to the Public the streets and utility easements as shown thereon."

Responsibility for maintenance is therefore the City's – it is not ambiguous as was suggested in the draft.

Revisions

Section 7, as it pertains to the City of Brookings projects, has been revised and provided for replacement of the (draft) Section 7. The revisions include cost revisions for the recommended projects, some project scope revisions (projects #6,7, and 9), and the deletion of Project #8 and Table 7.5.

Both the cover and face page have been revised and provided for insertion in the Plan binders.

Clarification

Problem Area 6 (PA6) noted on page 5-6 has two components: the inadequate capacity of the 18" line conveying flows across Highway 101 (from Subbasin 19.6 to Subbasin 19.2) and the lack of capacity at Lucky Lane (and downstream) to accommodate flows diverted from the 18" line during periods when flow exceeds the 18" line's capacity. Ultimately, the problems at Lucky Lane are derivative and dependent on conditions, and constructed modifications, located at the intake to the 18" line.

Modelling for this study was based on the Santa Barbara Urban Hydrograph (SBUH) method for determining runoff.

Additions

Curry County GIS provided most of the basemap information utilized in developing the Plan maps.. As reported by Curry County, the GIS incorporates the following technical standards:

Horizontal Datum:	NAD83 (CORS 96) 2002.0
Vertical Datum:	NAVD 88
Coordinate System:	State Plane
Units:	International Feet

A Summary Section has been prepared and provided with this Addendum for inclusion in the document.

ADDENDUM TO STORM AND SURFACE WATER FACILITIES PLAN For BROOKINGS - HARBOR AREA June 26, 2007

Background

The above referenced plan (henceforth referenced as "the Plan") was completed and submitted as a draft to the City of Brookings and Curry County in December 2006. Review comments from DLCD were received by the author on May 10, 2007. Follow up conversations and correspondence established some issues for further development or elaboration and it is to this effect that this addendum has been prepared.

The addendum focuses on three general issues:

1) Water quality enhancement - especially with regard to future TMDL requirements or goals, and

2) Structural best management practices (BMP's) with an emphasis on steep hillside applications, and

3) Potential impacts and concerns associated with development on the Harbor Hills.

Water Quality

Section 4.2 of the Plan provides a brief description of the EPA's Phase II regulations. As noted in this section, Brookings (and Curry County) are not currently subject to Phase II permit requirements. Nevertheless, the stormwater Phase II regulatory requirements provide an excellent general outline of measures that can be implemented by the City and County to enhance water quality in the area and to facilitate compliance with TMDL requirements currently in development.

Phase II permits focus primarily on six component measures. These are listed in Section 4.2 of the Plan. An EPA document describing and providing guidance on each measure is provided in Attachment 1. Additional information on Phase II requirements can be found on the EPA website.

Minimum Measures #1 and #2 "public education and outreach" and "public involvement/participation" respectively have been implemented by the City and County. In general, these efforts should be considered as ongoing and evolving. The implicit goal is to maintain an awareness of stormwater issues as well as expand the level of understanding and participation.

Minimum Measure #3, "illicit discharge detection and elimination" focuses on specific sources of water quality contamination. A key element is the development of a storm sewer and drainage map. This was completed as part of the Plan. The map assists with outfall location (for visual inspection

and periodic sampling for selected water quality parameters) and assists with tracing possible sources of contamination. Inspections should be conducted with City and County staff involvement - especially in areas requiring access across private property. Both the City and County should develop an illicit discharge detection and elimination program. Priority should be given to those subbasins most likely to have significant sources. In general, those will be the more developed areas and areas that include industrial or commercial development that generate waste materials or discharges.

Minimum Measure #4, "construction site stormwater runoff control," has been addressed by both City and County Ordinances.

Minimum Measure #5, "post-construction stormwater management in new development and redevelopment," has also been addressed by both City and County ordinances. Nevertheless, the ordinances should be viewed as works in progress and should be revised periodically to take into account local experience, conditions, and improvements in technology. Of particular concern are structural BMP's applicable to steep hillsides characteristic of the area. Structural BMP's are discussed in the next section of this addendum.

Minimum Measure #6, "pollution prevention/good housekeeping for municipal operations" involves the development and implementation of an O& M program to prevent or reduce pollutant runoff from municipal operations. The intent is to develop a more rigorous program that includes employee training and more comprehensive treatment of operations including park and green space maintenance, fleet and building maintenance, new construction, and stormwater system maintenance.

TMDL's for the Chetco River are discussed in Section 4.2 of the plan. Parameters of concern for the Chetco include: dissolved oxygen (DO), bacteria, pH, and temperature. Chetco River water quality is discussed in Section 5.5.1 of the Plan.

Temperatures in the Chetco tend to naturally run high in the summer and can exceed the 64°F rearing temperature criteria. Occurrence of the higher temperatures, in the case of the Chetco, does not appear to be related to human activity. Exceedences have been measured just outside of the Kalmiopsis Wildnerness boundary and groundwater temperatures (near the confluence with the North Fork of the Chetco River at a depth of -5 feet MSL) run in the upper 60's to 70°'s F in August (as evidenced by City records for their Ranney well intake). High temperatures were also noted in State Game Commission studies[1],[2] that were used as the basis for local instream water rights. Summer flows are considerably lower than winter flows resulting in no shading of the lower river by riparian vegetation (trees) during the low-flow summer period. The lower estuary is dominated by colder ocean water with the notable exception of the boat basins where, due to lack of flow circulation, and flow exchange with the lower estuary, and increased solar incidence, temperatures

1 *Source: The Fish and Wildlife Resources of the South Coast Basin, Oregon, and Their Water Requirements, A Report to the State Water Resources Board* Oregon State Game Commission, Dec. 1962.

2 *Source: Fish and Wildlife Resources of the South Coast Basin, Oregon, and Their Water Requirements (Revised) A Report with Recommendations to the Oregon State Water Resource Board* State Game Commission, April 1972.

can also be excessively high. Most of the tributary streams have shaded riparian areas or involve subsurface pipes; consequently, there are a few opportunities for significant improvements associated with streamside tree plantings. For the Chetco, efforts should focus on maintenance of existing riparian areas in order to minimize future temperature impacts. An emphasis on infiltration based BMP's for subbasins tributary to the boat basins would likely reduce discharge temperatures during the summer period. In general, throughout the study area, riparian protection or enhancement will minimize temperature impacts on streams and receiving waters.

The pH and DO concerns are typically associated with algae proliferation and decay associated with higher temperatures and excess nutrients. These issues are discussed in Section 5.5.1. Nutrients and other pollutant ions can be attracted to sediment particles; effective sediment (and erosion) control can reduce nutrient and pollutant transfer; consequently, vigilance in the application and monitoring of the City's and County's erosion control ordinances will reduce pollutant impacts in general.

Elevated coliform bacteria concentrations are often associated with urban development (dogs and other pets are common sources) and rural development (septic tanks and domestic animals.) Reduction of bacteria concentrations can probably be best addressed through community education and, in the case of septic tanks, through inspection and correction of failing systems.

The Curry County Water Quality Implementation Plan (DEQ Project Number W04555-00) dated June 30, 2006, focuses on water quality issues throughout Curry County. The Implementation Plan includes discussion of educational opportunities, including a voucher program to assist landowners' replacement of failing or ineffective septic systems, and a description of performance measures for water quality improvement. The performance measures address: temperature; excess sediment; nutrients and agricultural chemicals, and coliform bacteria. Recommendations include: a $40,000 per year, 10-year plan for tree planting in riparian areas on 10 major rivers; a $75,000 per year, 5-year plan to assist watershed council's sediment abatement programs; and a $20,00 - $30,000 per year water quality testing program. It also notes the DEQ/OSU/Watershed Council's Beach Bacteria Study in the Brookings area. A copy of the Implementation Plan is included as Attachment #2.

Structural Best Management Practices (BMP's)

BMP's are discussed briefly in Section 7.1 of the Plan. A more detailed description of the general goals of the storm water BMP's and structural BMP's is provided in Attachment #3. Additional descriptions and guidance can be found in *"Rainstorming! Water Quality and Stormwater Information Guide,* Rogue Valley Council of Governments, 2005. Both the City and County have copies of this document. Guidance can also be found on the DEQ website and specifically in the following documents available online:

- Biofilters (Vegetated Filter Strips, Bioswales, and Constructed Wetlands) for Storm Water Discharge Pollution Removal
- Best Management Practices for Storm Water Discharges Associated with Industrial Activities.

- Best Management Practices for Storm Water Discharges Associated with Construction Activities.

The Brookings - Harbor area includes a wide range of soils and topography so all of the structural BMP's have potential applications. However, steep hillsides represent an exception. Maintenance of current off-site maximum flow rates and water quality is best effected through facilities or infrastructure that promotes infiltration and/or on-site detention. Steep hillsides either complicate the provision of the facilities or, in many cases, the provision of the facilities may not be practicable on the site to be developed. Concerns revolve around two issues:

- Provision of infiltration facilities will tend to concentrate water in the area of the facility and areas down gradient. Depending on the geological stability for the area, this could enhance instability and slide potential.
- The facilities need a suitable, stable site for support. The weight of the facility and detained water may also contribute to instability and slide potential.

Clarify

Engineering can often overcome site specific concerns; however, costs may be prohibitive. Such sites may be effectively unbuildable. Larger lots and developments are likely to have suitable sites for the needed facilities; however, the goal of providing facilities as close to the source as possible may be compromised. Proposals for such developments will require additional study and review to determine how the goals will be met in the larger context of the development and affected areas and drainways. Both the City and County currently require site specific studies. City land Doctrine

Harbor Hills Special Plan Area

See pg 4-1

A copy of the *Comprehensive Surface Water Management Plan (CSWMP)* for the Harbor Hills Special Plan Area, prepared by EGR & Associates, Inc. (2006 Drft) was obtained in early December 2006. There was insufficient time to review the document and incorporate or comment on information in the Study. The CSWMP focuses, in considerable detail, on surface and groundwater characteristics of the Harbor Hills and Harbor Bench within the Harbor Hills Special Plan Area. Currently, the CSWMP is undergoing a rigorous peer review. This section of the Addendum is limited to comments on Section 7 of the CSWMP (Attachment #4) entitled "Mitigation Analysis and Standards Development." In general, the following comments are limited to exceptions taken to the material presented. Comments, referenced by page number, are listed below:

p. 7-1	Pre-existing impacts should be addressed to the extent needed to comply with the stated goals.
pp. 7-2, 7-3 (Sec. 7.1.1.1)	Currently, municipal water in the Brookings-Harbor Area is obtained from the Chetco River. There are no economical alternatives and attempts to increase supply have met with strong resistance from Waterwatch and others. Chetco source water is high-valued and should not be considered as a substitute for local groundwater sources except in localized areas with limited supplies unavoidably affected by local development. Also, the Harbor Bench is a significant agricultural area; any conversion of irrigation rights would

diminish its agricultural capabilities. Also, "paper" water rights are often not utilized to the extent certificated - in other words, there is not necessarily a one-to-one correspondence between the water rights and actual water use.

pp. 7-6, 7-7 The stream restoration approach is essentially the same as that proposed in Section 7.4.2 of the Plan. The HW3 study notes that a similar approach was used by a farmer on Pedrioli Creek on the Harbor Bench to restore the stream with notable success.

p. 7-17 Policy No. 3 should be clarified. Off-site flows should not be increased; however, assessment of off-site drainage to carry design-year flows may require upgrades or restoration.

p. 7-20 (Table 7-9) Provides for stream turbidity monitoring in HHSPA.

It should be noted that *Section 8: Ongoing Monitoring of Stream Flow, Groundwater Levels, and Water Quality* CSWMP (not attached) provides considerable detail on ongoing and proposed monitoring parameters and locations on both the Harbor Hills and Harbor Bench.

In general, approaches and recommendations included in Section 7 and 8 of the CSWMP appear reasonable and consistent with the stated goals (p. 7-1) except as noted above. This assessment is limited and provisional and not intended to substitute for results of the peer review, or to signal acceptance of other sections of the CSWMP.

SUMMARY

BACKGROUND

Both Curry County and the City of Brookings lack current, comprehensive stormwater plans for the Brookings-Harbor area. Mapping of the existing storm water infrastructure was highly limited and outdated. Documentation for many areas, especially in the County, was non-existent.

Area drainage is currently accommodated by a combination of creeks, ditches, and culverts. Several creeks have been re-routed, or routed to subsurface piping, to facilitate development. Detention/sedimentation facilities are limited. Much of the hydraulic conveyance system is old and undersized (according to current design standards).

Development throughout the UGB is ongoing and extensive. Potential impacts on downstream infrastructure, properties, water quality, and (within the Harbor Bench) ground water levels have raised concerns among many residents and highlight the need for a comprehensive stormwater plan as well as coordination between the City and County on these matters.

STUDY AREA

The study area focuses on the entire current UGB. Areas uphill and tributary to the UGB are also included because of current and potential future impacts from these areas on the UGB. Approximately 33 square miles are included in the study area.

CLIMATE

The study area has a marine-influenced climate with summer temperatures moderated by cooler air blowing in over the Pacific Ocean. Rainfall accumulations are heaviest during the period of November through March. Transition in the fall from relatively dry "summer" conditions to wet "winter" conditions is often abrupt and associated with the advent of large storms originating over the Pacific. Average annual rainfall is 73.48 inches.

Precipitation events for the study area have been mapped by the National Oceanic and Atmospheric Administration (NOAA) and are summarized below:

Frequency Events	Rainfall Accumulated Depth
5-yr, 24-hour	6.0 inches
25-yr, 24-hour	8.0 inches
50-yr, 24-hour	9.0 inches

GROWTH and DEVELOPMENT

Brookings and Harbor have both experienced considerable growth over the past 25 years. Significant growth is anticipated to continue into the foreseeable future and several large scale developments have been proposed. Future growth, based on current plans or proposals, is likely to be focused to the north (Lone Ranch and surrounding areas) and in the Harbor Hills. Development in the Harbor Hills is of particular concern because of potential impacts to the unique agricultural area known as the Harbor Bench.

LEGAL and REGULATORY CONSIDERATIONS

Oregon adheres to the civil law doctrine of drainage which stems from common law or court-made law. This doctrine provides for the maintenance of natural drainage across adjoining properties. There are three basic provisions:

1. A landowner may not divert water onto adjoining land that would not otherwise have flowed there. "Diverted water" is a broad term that may include water diverted from one drainage area to another or water that may normally pond, infiltrate, or evaporate.

2. A landowner may not change the place where water flows onto a lower, adjoining property.

3. A landowner may not accumulate large quantities of water, then release it with the result of greatly accelerating on the flow on the lower, adjoining property. The intent of this provision is to prevent substantial increases in flow that could cause problems downstream.

The EPA and DEQ have developed and implemented permitting requirements referred to as "Phase II regulations." Brookings is not required (by DEQ) to have a Phase II permit. Several other agencies require permitting or coordination for development of drainage projects. Both the City and County have ordinances and policies regarding drainage or development that impacts drainways.

DRAINAGE SYSTEM MAPPING

Mapping of the existing drainage system was developed using curry County GIS as a primary source for basemap material. Existing stormwater infrastructure and drainways were added to the maps. Sources of this information were highly diverse and varied in detail and reliability. Considerable fieldwork was required to find and identify features to map. The overall mapping effort was highly iterative with numerous draft versions prepared, reviewed, field checked and modified. Nevertheless, the maps should still be viewed as provisional. Both the City and the County are encouraged to add detail and corrections as more and better information is provided and discovered.

BASIN DELINEATION

Overall, the study area is characterized by having a very large number of independent basins, which are tributary to the Chetco River or the Pacific Ocean. The most complex area delineated is Macklyn Creek which involves 11 subbasins. Overall, 101 subbasins were delineated. While this is a substantial and workable number for purposes of this study; future studies or predesign efforts may find it necessary or desirable to further subdivide the selected subbasin(s) as much as ten or twenty fold in order to more accurately model flows in an area of interest.

PROBLEM AREAS

In general, stormwater issues arise with the advent and progress of the wet-weather season typically starting in November. This is also when leaf drop occurs. The combination of leaf drop and winter storms can result in local culvert or catch basin obstruction and consequent back-ups or flooding. Accumulations of sediment or debris within pipes can also compromise hydraulic capacity until flushed. While larger pipes or alternate designs may reduce the propensity for problems at any given location, the provision of such does not always ensure that problems will not occur. Stormwater infrastructure maintenance is conducted by both City and County staffs; however, since obstructions can occur rapidly during storm events, some problems may arise even though recent maintenance was conducted. Because of this, City staff typically check certain problem areas on a daily basis during the work week.

The plan discusses 25 specific problem areas in detail. The most notable problem areas occur in the Macklyn Creek drainage area and the Harbor Bench.

HYDROLOGIC ANALYSIS

Modelling of the stormwater system was conducted using the Santa Barbara Urban Hydrograph (SBUH) method. The model consists of linked files in an effort to comply with the expressed desire for a single model covering the study area. As the project moved forward, the single model approach did not match well with available data and resources. Most of the 101 modeled subbasins discharge directly to either the tidally influenced Chetco River or to the Pacific Ocean. Combining these discharges is hydraulically meaningless because of nature and dilution of the receiving bodies; however, the modeling could be used with appropriate rainfall statistics and water quality estimates (based on sampling and testing) to estimate pollutant loads on the receiving bodies.

The overall modelling effort appears to be conservatively high in its flow estimates. This is evidenced by the relative lack of reported problems associated with existing infrastructure. More basin detention could be occurring than is incorporated in the SBUH model; however, addressing this supposition would require considerable data acquisition and analysis. Much of the existing infrastructure was designed to accommodate recurrence intervals of less than 25 years. The 1985 Brookings Storm Drainage

Development Plan used a 5-year recurrence interval for the design basis. It also used the Rational Method (which typically results in higher design flows than the SBUH model) and designs flows of 2.5-5.0 fps. With allowances for surcharging, such infrastructure is likely to be adequate for events well beyond the 5-year, 24-hour event. Given the investment and extent of the existing infrastructure, the relative lack of manifest problems, the possibility of model over-prediction, the following approach is incorporated herein:

1) Assume future development will be required to maintain pre-development flows off-site.

2) Assume existing infrastructure is hydraulically adequate except where specific problems have been noted.

3) In general, new or replacement infrastructure should be sized for the 25-year, 24-hour peak event. An exception is ODOT crossings which will have to follow current ODOT Standards where design is based on the 50-year event. Another exception is in areas where the City or County Engineer believe the increased sizing is either inconsistent with connecting infrastructure or would otherwise adversely impact downstream areas.

RECOMMENDATIONS

Section 7 of the Plan includes extensive recommendations for: policy development (water quality, erosion and sediment control, and hydraulics); maintenance; design and development standards (design criteria, future development); constructed improvements (Brookings, Curry County); and studies.

Recommended capital improvements for Brookings include:

Reference Numbers	Priority	Subbasin Location	Description	Opinion of Probable Cost
1	I	19.6	250 LF Line upgrade (Addresses in part, problems near Lucky Lane)	$84,000
2	I	19.9	Upgrade of drainage along north edge of City Hall parking lot.	$30,000
3	I	19.9	Replace 36" Macklyn Creek line with 48" line. Not recommended prior to construction of (ref. no 2) project above and further study.	$500,000 (order-of-magnitude estimate)
4	II	19.6	Continuation of (ref. no 1) project across Hwy 101. Not constructable until 2016 due to ODOT restrictions.	$100,000 (budget allowance)
5	II	19.2	Continuation of (ref. no.1 and 4) projects above. Includes 30" and 42" line upgrades.	$403,000
6	II	19.1	Replace 12" culvert across Alpine St.	$1,000 (Assumes work completed by City Staff.)
7	II	19.1	Replace defective 48" line across Mill Beach Rd.	$57,000
8	II	27	Extend storm drain along Old County Rd.	$62,000
9	II	23.1	Replace culvert at Willow St. and Railroad St.	$6,000
10	II	23.1	Replace culvert at Railroad St. and Oak St.	$46,000
11	I	Macklyn Creek	Detailed stormwater study of the Macklyn Creek drainage.	$30,000 - $50,000 (depending on final scope)
Total				**$1,339,000**

FINANCING

Grant funding is generally not available for funding stormwater related improvements; consequently, the "need" for any particular capital improvement is shaped in large part by the cost of the project and willingness of the governmental entity involved to devote the funds, or to incur the debt, necessary to complete the project. Priority is generally given to those projects that address existing or incipient problems that can be honestly characterized as urgent. Remaining projects are typically undertaken in accordance with prevailing perceptions of need and affordability.

System Development Changes (SDC's) can also be a source of funding for projects involving a capacity enhancement.

Another potential source of funding is the creation of a stormwater utility. A stormwater utility, like a water or wastewater utility, provides a service through the operation and maintenance of a public facility. Few communities currently have stormwater utilities; however, they have increased in recent years as communities try to address stormwater management needs on something other than a crisis basis. Revenue derived from user fees can be used for maintenance or capital improvements and associated debt service.

A stormwater utility can be established by ordinance. A second ordinance is also needed to establish the rate structure. A flat rate would allow the City to simply add a line item and cost to the water or sewer utility billing. This eliminates the need for computations, special billing software, or modifications, periodic updates, separate billings, and related administrative costs.

The political realities of establishing a stormwater utility are such that revenues generated are not likely to truly meet all the stormwater related needs. For Brookings, a $3.00 per month stormwater charge attached to the sewer billings (3,290 active connections) would yield $118,440 per year. Monies could be used to supplement and expand current public works efforts devoted to stormwater management. Monies could also be used for debt service repayment.

IMPLEMENTATION

An implementation plan was not developed and presented in the Plan because remaining issues of coordination between the City and County and resolution of how to proceed. Nevertheless, capital projects identified for Brookings could be incorporated into capital improvement plans and capital budgets independent of further coordination with the County on stormwater planning and policy development.

PUBLIC INFORMATION

Dissemination of information to the public regarding storm water issues in general (as well as for specific projects, policies, ordinances, etc.) is essential for community support of needed actions by the City and County. With regard to improved water quality, it is

probably the most important action the City or County can take. Understanding the impact and transport of household chemicals and pet wastes can make a real and favorable impact on how people manage their houses and yards. Public discussion can help stimulate interest in stormwater related issues and water quality; this, in turn can generate support for needed projects or programs. Both Planning meetings and City Council or County meetings can provide some information for projects and stormwater related issues that have become sufficiently important for those bodies to discuss or consider.

SECTION 1: INTRODUCTION

1.1 BACKGROUND

Both Curry County and the City of Brookings lack current, comprehensive stormwater plans for the Brookings-Harbor area. Brooking's last comprehensive storm drainage plan was completed in 1985 and focused on areas within the City limits proper. The City has grown considerably since that time. Other, more recent studies have been limited in area/coverage (e.g. the proposed Lone Ranch development) or limited in detail (e.g. the *Public Facilities Plan for Urban Growth Expansion for Brookings and Harbor Study Areas, W&H Pacific, 1999*). Mapping of the existing storm water infrastructure was largely limited to a single 11" x 17", 1" = 1200' plate from the 1985 study.

Area drainage is currently accommodated by a combination of creeks, ditches, and culverts. Several creeks have been re-routed or routed to subsurface piping, to facilitate development. Detention/sedimentation facilities are limited. Much of the hydraulic conveyance system is old and undersized (according to current design standards).

Development throughout the UGB is ongoing and extensive. Potential impacts on downstream infrastructure, properties, water quality, and (within the Harbor Bench) ground water levels have raised concerns among many residents and highlight the need for a comprehensive stormwater plan as well as coordination between the City and County on these matters.

1.2 STUDY AREA

The study area focuses on the entire current UGB. Areas uphill and tributary to the UGB are also included because of current and potential future impacts from these areas on the UGB. The study area borders the Pacific Ocean and the Chetco River, and is located in southwestern Curry County. Approximately 33 square miles are included in the study area. Study area boundaries are shown in Figure 5.1.

1.3 PURPOSE AND SCOPE

The purpose and scope of the plan is to develop a single comprehensive document that includes, for the study area, mapping of the existing stormwater drainages and facilities, modelling of the systems, evaluation of current conditions and needs, and recommendations for improvements and policies to address current issues and to accommodate future growth.

1.4 FUNDING ACKNOWLEDGMENT

This project has been funded in part with financial (grant) assistance provided by the Coastal Zone Management Act of 1972, as administered by The Ocean and Coastal Management Program, Department of Land Conservation and Development. Matching funds have been provided by the City of Brookings and Curry County.

1.5 AUTHORIZATION

The City of Brookings and Curry County retained HGE, Inc., Architects, Engineers, Surveyors & Planners on May 15, 2006 to complete this Storm and Surface Water Facilities Plan.

1.6 FACILITIES PLANNING OPINIONS OF PROBABLE COST (OPCs)

1.6.1 General

Opinions of probable cost (OPCs) presented in this plan include four components, each of which is discussed separately in this section. It must be recognized that opinions of probable cost are preliminary, and based on the level of planning presented. As specific improvements proceed forward, it may be necessary to update the costs to reflect changes in project complexity or approach.

1.6.2 Construction Cost

Opinions of probable cost in this plan are based on preliminary layouts of the proposed improvement, actual construction bidding results for similar work, published cost guides and the author's construction cost experience within the state of Oregon.

Future changes in the cost of labor, equipment, and materials may justify comparable changes in the opinions of probable cost presented herein. For this reason, it is common engineering practice to relate the costs to a particular index that varies in proportion to long term changes in the national economy. The Engineering New Record (ENR) Construction Cost Index is most commonly used. It is referenced to an initial value of 100 for the year 1913.

All costs in this plan are based on the October 2006, ENR Construction Cost Index value of 7883. Opinions of probable costs should be updated at the actual time of completing funding applications, and prior to a general obligation bond election.

When the community secures financing, a "reserve factor" should be added at that time for estimated increased cost due to inflation. Since 1996, construction costs have increased an average of 3.4 percent each year. Opinions of probable costs can be prepared at any future day by comparing the future ENR Construction Cost Index with the index value of 7833; however, this approach is generally only considered valid for a 2 or 3 year period since construction techniques and materials change with time. If time has elapsed in excess of 2 or 3 years, opinions of probable cost should be updated by an engineer.

1.6.3 Contingencies

In recognizing that the opinions of probable cost are based on preliminary design, allowances must be made for variations in final quantities, bidding market conditions, adverse construction conditions, unanticipated specialized investigations, and other difficulties that cannot be foreseen at this time. A contingency factor of 10 percent of the construction cost has typically been added.

1.6.4 Engineering, Construction Observation, and Construction Management

Engineering, construction observation, and construction management costs have been assumed at 20 percent of the construction cost. This includes costs for the engineering company to conduct preliminary surveys, perform detailed design analyses, prepare construction drawings, prepare construction specifications, conduct construction stakeout surveys, provide partial construction observation during construction, administer construction related activities such as change orders, and to prepare record drawings.

1.6.5 Legal and Administrative

An allowance of 5 percent of the projected construction cost has been added for legal and administration. This allowance is intended to include internal project planning and budgeting, grant administration, liaison, interest on interim financing, legal services, review fees, legal advertising, and other related expenses associated with the project.

1.6.6 Opinion of Probable Cost Summary

Opinions of probable costs presented in this plan include a combined allowance of 35 percent for contingencies, engineering, legal and administrative costs.

SECTION 2: PHYSICAL ENVIRONMENT

2.1 GENERAL

This section includes discussions of physical features (climate, topography, and soils) of the study area that directly bear on hydrologic analyses and designs. A discussion of recent flood events is also included in Section 2.5.

2.2 CLIMATE

The study area has a marine-influenced climate with summer temperatures moderated by cooler air blowing in over the Pacific Ocean. The near coastal area averages two days per year of temperatures equal to or over 90° F. Winter temperatures are also moderate with approximately six days equal to or less than 32° F. Mean temperatures range from 48.3° F in December to 60.1° F in August. Fog is also common, occurring on approximately 100 days each year.

Rainfall accumulations are heaviest during the period of November through March. Transition in the Fall from relatively dry "summer" conditions to wet "winter" conditions is often abrupt and associated with the advent of large storms originating over the Pacific. Average annual rainfall is 73.48 inches (Oregon Climate Service, 1971-2000). There have been seven years (1937, 1945, 1950, 1953, 1983, 1996, 1998) since 1914 with annual rainfall totals in excess of 100 inches. (The highest recorded annual total was 123.90 inches in 1996.) For the same period, the highest monthly accumulation was 30.60 inches in December 1996. (December mean rainfall is 11.99 inches for the period 1971-2000.) Additional rainfall data is included in Table 2.1 and in Appendix 2.1.

Table 2.1: Precipitation Totals
City of Brookings

Month	Period 1942 to 1971		Period 1971 to 2000	
	Monthly Mean	Maximum Day	Monthly Mean	Maximum Day
January	13.49	6.19	11.28	4.80
February	10.11	6.25	10.14	4.01
March	9.32	8.79	9.61	5.00
April	5.70	4.38	5.72	2.80
May	4.57	5.97	3.61	2.68
June	1.68	6.00	1.83	2.92
July	0.65	4.26	.51	1.81
August	0.96	2.75	1.04	3.61
September	2.03	3.27	1.95	2.67
October	7.22	4.68	5.22	5.45
November	12.28	5.53	10.58	5.15
December	12.98	6.88	11.99	5.56
Year	**80.99**	**8.79**	**73.48**	**5.56**

Precipitation events for the study area have been mapped by the National Oceanic and Atmospheric Administration (NOAA)[1]. A summary of precipitation depths for different frequency events are summarized below.

Frequency Events	Rainfall Accumulated Depth
2-yr, 24-hour	5.0 inches
5-yr, 24-hour	6.0 inches
10-yr, 24 hour	7.0 inches
25-yr, 24 hour	8.0 inches
50-yr, 24-hour	9.0 inches
100-yr, 24-hour	9.5 inches

The highest 24-hour rainfall recorded since 1961 was 5.97 inches on May 6, 1963. This would appear to be a "5-year" event based on the NOAA summary (above); however, the correlation of reported daily rainfall totals with the NOAA summary is often unclear. The NOAA total is for a continuous 24 hour period that may start at anytime on one day and

1 Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume X - Oregon. National Oceanic and Atmospheric Administration, National Weather Service, Silver Springs, Md.

terminate at the same time on the following day, while reported daily rainfall totals typically reflect a fixed period, for example: 7:00 a.m. on day one to 7:00 a.m. on the following day. On May 5, 1963, 4.74 inches was recorded. Depending on when the rainfall occurred on both days, the wettest 24-hour period may have included a rainfall accumulated depth corresponding to, as little as, the 5-year event, or, as much as, the 100-year event. The NOAA statistics are used as a basis for hydrologic modelling in this study.

2.3 LANDSCAPE FEATURES

Key landscape features include the Pacific Ocean to the west, the Chetco River which approximately bisects the study area in an east-west direction, the coastal hills which parallel the coast, and the inland hills that which define the catchments tributary to the Chetco River in the area of the easternmost extension of the UGB.

The coastal hills north of the Chetco extend to an elevation of approximately 1700 feet. Major drainages in this area include, from north to south: Lone Ranch Creek and its major tributary Duley Creek, Ram Creek, Taylor Creek, Shy Creek, Harris Creek, Eiler Creek, Ransom Creek, and Maclyn Creek. These are all tributary to the Pacific Ocean. The Macklyn Creek drainage includes much of the highly developed portions of the City of Brookings. West of Highway 101, the Macklyn Creek drainage and adjacent areas to the south form a gently sloping tableland that ends abruptly at the coastal cliffs above the Pacific. The area east of Highway 101 is quite hilly with the exception of the airport area (elevation 460 feet) located high in the Harris Creek-Ransom Creek drainage areas.

The coastal hills south of the Chetco River extend to an elevation of approximately 1340 feet. Major drainages include, from south to north, McVay Creek, Camilla Creek, Johnson Creek, Pedrioli Creek, and Dahlia Creek. These are all tributary to the Pacific. The hillsides extend down to Highway 101; west of the highway, the land slopes gently toward cliffs along the Pacific Ocean. The area west of Highway 101 is known as the Harbor Bench and is an agricultural area of national significance, growing most of the nation's easter lily bulbs.

The coastal hills extend inland. Major drainages entering the Chetco River from the north include Ferry Creek and Joe Hall Creek. The Ferry Creek drainage includes a municipal water impoundment (Ferry Creek Reservoir). Several smaller drainages originate within the City of Brookings and flow south to the Chetco; however, most of the City drains directly to the Pacific.

Major drainages entering the Chetco River from the south and passing through the more developed areas of unincorporated Harbor include Tuttle Creek, Delevan Creek, and Fish House Creek. These flow through or near the boat basin located on the Chetco River estuary

near the river's mouth. The southeast part of the study area includes the relatively large drainage of Jack Creek and its major tributaries: Jordan Creek and Hamilton Creek.

Many of the creeks located in the more developed areas of Brookings and Harbor, and in some agricultural areas of the Harbor bench, have been redirected to flow in pipelines to permit development or utilization of the riparian land for other purposes. Several streams on the Harbor Bench have been channelized and redirected to flow along field or property lines.

The Chetco River originates in the mountainous Kalmiopsis Wilderness and flows approximately 55.5 miles to the Pacific Ocean. It drains an area of 271 square miles. There are no dams and little development or agriculture upstream from Brookings and Harbor. 44.5 miles of the upper Chetco was designated as a Wild and Scenic River in 1988. There is a USGS gauge (#14400000) located at river mile 10.7. Records since commencement of operation on October 1969 indicate a maximum discharge or 76,100 cfs on November 19, 1996 (gauge height: 28.56 feet) and a minimum discharge of 42 cfs on October 14, 1987. Highest extrapolated flow outside the period of record was 85,400 cfs on December 22, 1964 (stage: 32.25 feet).

DEQ is currently conducting a total maximum daily load (TMDL) study for the Chetco Subbasin. Its purpose is to establish water quality goals within the Chetco Subbasin. A TMDL is the total quantity of a specified pollutant that enters the water body without violating water quality standards. The Federal Clean Water Act (CWA) requires establishment of TMDLs for water quality limited bodies under Section 303 (d) of the CWA. Parameters of particular concern for the Chetco include: dissolved oxygen (DO), bacteria, pH, and temperature. DEQ anticipates completion of the TMDL study in 2007.

Groundwater resources are generally limited in the study area. The urbanized areas are provided with municipal water (City of Brookings and Harbor Water District); other areas are served by individual wells of relatively shallow construction. The Harbor Bench includes a local, shallow groundwater aquifer that supplies water for both domestic and agricultural use. Concern has been expressed regarding potential impacts of development in the Harbor Hills on this resource.

2.4 SOIL CHARACTERISTICS

The study area has been mapped by the Natural Resources Conservation Service

(NRCS)[2,3]. The full document (1,044 pages) is available online at: http://soildatamart.usda.gov/Manuscripts/OR015/1/Curry.pdf.

Soils maps are included in the above referenced document and in Curry County's GIS mapping.

Approximately 40 different soil classifications occur across the study area. Soils identified are included in Table 2.2.

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2 Formerly the Soil Conservation Service (SCS).

3 Natural Resources Conservation Service. 1994 (fieldwork). Soil Survey of Curry County, Oregon. United States Department of Agriculture Natural Resources Conservation Service in cooperation with USDA, Forest Service; US Department of the Interior, BLM; and Oregon Agricultural Experiment Station, Washington, D.C.

Table 2.2: NRCS Soil Classifications (for Study Area)

Map Symbol	Soil Name	Hydrologic[4] Group	Drainage Class	Permeability	Erosion Hazard	Flooding
11F	Atring	B	Well Drained	Moderately Rapid	Severe	None
15A	Bagness	B	Well Drained	Moderately Slow	Slight	Occasional, brief, Nov-Apr
18A	Bayside	D	Poorly Drained	Slow	Slight	Occasional, brief, Nov-Apr
26A	Bigriver	B	Well Drained	Moderately Rapid	Slight	Frequent, brief, Dec-Apr
39D	Bullards	B	Well Drained	Moderate	Moderate-Severe	None
	Ferrelo	B	Well Drained	Moderately Rapid	Severe	None
	Hebo	D	Poorly Drained	Very Slow	Slight	None
43D	Burnthill	B	Well Drained	Moderately Slow	Moderate	None
	Cashner	C	Poorly Drained	Very Slow	Slight	None
44E	Burnthill	B	Well Drained	Moderately Slow	Moderate	None
51G	Cassiday	C	Well Drained	Moderate	Very Severe	None
	Grouslous	D	Well Drained	Moderately Slow	Very Severe	None
	Bravo	B	Well Drained	Moderately Slow	Very Severe	None
65A	Crofland	C	Somewhat Poorly Drained	Slow	Slight	None
69D, 69E	Cunniff	C	Well Drained	Slow	Moderate	None
95G, 96G	Dulandy	B	Well Drained	Moderate	Very Severe	None
	Bosland	C	Well Drained	Moderately Slow	Very Severe	None
	Floras	C	Well Drained	Slow	Very Severe	None
98G	Dulandy	B	Well Drained	Moderate	Very Severe	None
	Guerin	D	Well Drained	Moderate	Very Severe	None
	Rock	D	-	-	-	None

[4] For definition and discussion of hydrologic soil groups, see Section 6.3.3.

Map Symbol	Soil Name	Hydrologic Group	Drainage Class	Permeability	Erosion Hazard	Flooding
111A	Ettersburg	B	Well Drained	Moderate	Slight	None
115F	Ferrelo	B	Well Drained	Moderately Rapid	Severe	None
	Bullards	B	Well Drained	Moderate	Severe	None
117F,118F	Floras	C	Well Drained	Slow	Mod./Severe	None
	Bosland	C	Well Drained	Mod. Slow	Severe	None
	Dulandy	B	Well Drained	Moderate	Severe	None
122F,123F	Fritsland	B	Well Drained	Moderate	Mod./Severe	None
	Bravo	B	Well Drained	Mod. Slow	Severe	None
	Cassiday	C	Well Drained	Moderate	Severe	None
142E	Hazelcamp	B	Well Drained	Slow	Mod./Severe	None
	Averlande	D	Well Drained	Mod. Slow	Mod./Severe	None
	Rock	D	-	-	-	-
149E,150F	Hooskanaden	D	Somewhat Poorly Drained	Very Slow	Moderate	None
	Loneranch	B	Moderately Well Drained	Mod. Slow	Moderate	None
	Reinhart	D	Well Drained	Mod. Slow	Mod./Severe	None
153A	Huffling	D	Poorly Drained	Slow	Slight	None
162A,162B	Klooqueh	B	Well Drained	Mod. Slow	Slight	None
165D,165E	Loeb	C	Well Drained	Mod. Slow	Slight	None
	Maclyn	C	Well Drained	Mod. Slow	Slight/Mod.	None
170F	Loneranch	B	Mod. Well Drained	Mod. Slow	Severe	None
	Hooskanaden	D	Somewhat Poorly Drained	Very Slow	Mod./Severe	None
	Reinhart	D	Well Drained	Mod. Slow	Severe	None
205F	Reedsport	C	Well Drained	Moderate	Severe	None
	Whaleshead	B	Well Drained	Mod. Slow	Mod./Severe	None

Map Symbol	Soil Name	Hydrologic Group	Drainage Class	Permeability	Erosion Hazard	Flooding
214	Riverwash	D	Excessively Drained	Rapid	Very Severe	Frequent, long, Oct-Jul
217	Rock Orthents	D A/D	- Well/Excessively Drained	- Rapid	- Very Severe	None None
238D	Skookumhouse	B	Well Drained	Slow	Slight	None
266	Urban Land	-	-	-	-	None
270E, 271F, 271G	Wedderburn Zwagg	B B	Well Drained Well Drained	Moderate Moderate	Moderate Mod./Slow	None None
272F	Whaleshead Reedsport	B C	Well Drained Well Drained	Mod. Slow Moderate	Mod./Severe Severe	None None
274A, 274D	Winchuck	C	Well Drained	Slow	Slight/Mod.	None

2.5 RECENT FLOODING

The largest recent flood occurred in December 1964 along the Chetco River. A 150-year return interval was estimated for the event. FEMA reports note the event was accompanied by high tides and that damage was relatively minor along the undeveloped floodplain immediately adjacent to the river. Log debris accumulated against the Highway 101 bridge. The bridge was declared unsafe and replaced at a higher elevation. Other notable floods occurred in 1996, 1971, 1955, 1890, and 1861. Current FEMA mapping indicates that both the North Bank Road and the South Bank Road, that follow the river upstream, are outside the 100-year floodplain with the exception of a short stretch of the North Bank Road opposite and slightly downstream of the confluence with Jack Creek.

FEMA maps also indicate a narrow floodplain along Ransom Creek from the eastside of Highway 101 upstream to near the City Limits. This is not explained - there is a culvert that could become obstructed with the result of a backup. It is not clear if this is based on a recorded occurrence or merely inferred.

Notable recent flooding occurred in the vicinity of City Hall at the end of December 2005

and the beginning of January 2006. Reports vary as to the onset and progress of the flood. There is a 24 inch culvert along the north end of the parking lot that discharges to Macklyn Creek just ahead of the 36 inch culvert that carries Macklyn Creek. It was speculated at the time that the Macklyn Creek culvert may be of insufficient capacity. On November 7, 2006, ponding was observed upstream of the 24 inch line while at the discharge end water was shooting out of a half filled pipe. Macklyn Creek was relatively low and easily accommodated by the 36" line. Later in the day the "pond" extended to the edge of City Hall. Nevertheless, the overall hydraulic capacity of either the 24" of the 36" line may have been exceeded in the 2005/2006 event since it occurred during a period of unusually high rainfall (20.91 inches of rain fell between December 18, 2005 and December 31, 2005 with 3.25 inches falling on December 31st). Average December rainfall is 11.99 inches, so the two week period preceding the flood experienced approximately four times the normal rainfall.

Other flooding that has occurred is generally associated with culvert backups. Culverts are susceptible to obstruction, so in some cases it may be unclear whether the backup is due to an obstruction or inadequate hydraulic capacity.

Early winter storms often coincide with leaf drop; the first flush can cause accumulation of leaves, debris, and other materials on or in the stormwater infrastructure. Brookings City staff check known problem areas on a daily basis. On a November 7, 2006 outing, staff retrieved several pumpkins from storm grates and cleared several lines that had plugged with accumulated leaves and debris. Balls, such as basketballs, have also caused local obstructions and consequent backups.

Lastly, road construction and development, especially when accompanied by a redirection of storm flow, can cause new problems or exacerbate existing problems. Given the variables of weather, obstructions (especially transient obstructions that clear or appear to clear on their own), and development, it is often unclear as to what is the true cause or causes of any localized flooding event.

SECTION 3: SOCIO-ECONOMIC ENVIRONMENT

3.1 GENERAL DEMOGRAPHIC CHARACTERISTICS

A summary of 2000 Census data is provided in Table 3.1 as documentation of recent demographic characteristics with emphasis on economic elements. Data is provided for the City of Brookings and unincorporated Harbor. Harbor is a census-designated place (CDP) that occupies 1.9 square miles of land area. The study area includes more sparsely developed portions of Curry County outside both the City of Brookings and Harbor CDP; detailed information for those areas has not been developed or incorporated into this section.

Table 3.1: 2000 Census Demographic Characteristics

	City of Brookings	Harbor CDP
Population:		
Total:	5,447	2,622
Median Age (years):	43.1	59.5
65 years and over:	1,302 (23.9%)	1,073 (40.9%)
Housing:		
Housing Units (Total):	2,614	1,691
Occupied:	2,309 (88.3%)	1,333 (78.8%)
Vacant:	305 (11.7%)	358 (21.2%)
Owner Occupied:	1,313 (56.9%)	1,072 (80.4%)
Renter Occupied:	996 (43.1%)	261 (19.6%)
Housing Units Constructed Since 1970:	1,751 (67.0%)	1,277 (75.5%)
Housing Units Constructed Since 1990:	862 (33.0%)	376 (22.2%)
Average Household Size (persons per household):	2.30	1.93
Median Housing Value:	$145,100	$143,100
Median Rent per Unit:	$597	$535
Education:		
High School Graduate or Higher:	84.7%	$75.2

	City of Brookings	Harbor CDP
Employment:		
Persons in Labor Force:	2,371	991
Employed:	2,234	929
Unemployed:	137	62
Persons Not in Labor Force:	1,851	1,419
Mean Travel Time to Work (minutes)	11.8 min.	15.2 min
Income:		
Median Household Income	$31,656	$30,171
Poverty Status (% of Population)	11.5%	14.8%

3.2 POPULATION

3.2.1 Historic Population

Decennial census populations figures for Brookings, Harbor CDP, and Curry County are presented in Table 3.2. The figure for 1980 Harbor CDP is omitted; the CDP boundary was changed, consequently any comparison of the 1980 and 1990 figures would be misleading.

Table 3.2: Historic Population
(Source: U.S. Census Bureau)

Census Area	Census Total (persons)			Average Annual Growth Rate (AAGR)		
	1980	1990	2000	1980-1990	1990-2000	1980-2000
City of Brookings	3,384	4,400	5,447	2.66%	2.16%	2.41%
Harbor CDP	-	2,143	2,622	-	2.04%	-
Curry County	16,992	19,327	21,137	1.30%	0.90%	1.10%

3.2.2 Recent Population

The Center for Population Research and Census at Portland State University (PSU) prepares annual (July 1) population estimates for Oregon municipalities and counties.

PSU does not prepare estimates for Harbor CDP. Recent population estimates are presented in Table 3.3.

Table 3.3: Recent Population
(Source: Center for Population Research and Census, Portland State University)

Area	July 1 Population Estimates					AAGR (2001-2005)
	2001	2002	2003	2004	2005	
City of Brookings	5,680	5,760	5,950	6,050	6,185	2.15%
Curry County	21,550	21,250	21,100	21,150	21,190	-0.42%

The Curry County figures show an initial decrease in population followed by modest gains; consequently, the overall decrease of -0.42% AAGR is likely a product of the limited time horizon rather than indicative of any long term trends.

3.2.3 Projected Future Population Growth

The Office of Economic Analysis (OEA), Department of Administrative Services, State of Oregon prepares official forecasts of county populations in Oregon. Using the PSU July 1, 2003 estimate of 21,100 persons as a base, the forecast indicates a 2040 Curry County population of 23,432 persons, an increase of 2,332 persons and an AAGR of 0.28%.

The OEA forecasts are for counties. There is no uniform methodology for allocating county forecasts to individual municipalities or areas. If all the allocated growth occurs in Brookings and Harbor, and if there is no net loss in other areas of Curry County, then adding the 2,332 person figure to the combined 2000 Census total of 8,069 persons in Brookings/Harbor yields 10,401 persons in 2040, representing an AAGR of 0.64%. The OEA's forecast suggests modest long-term growth in the study area.

Not withstanding the OEA forecast and possible interpretations; recent, ongoing, and anticipated development in the area suggest both more rapid and more extensive growth in both the short-term and the long-term. Of particular note are two very large proposed developments: Lone Ranch, and Harbor Hills. The Lone Ranch development involves approximately 533 acres with a projected population of 2,500

persons[1]. The area was annexed in 2002 by the City of Brookings and represents the northwest extension of the City. The Harbor Hills (or HW3) development involves approximately 632 acres with an estimated (projected) population of 5,000 persons[2]. The area is within the southern extension of the Brookings-Harbor UGB. Potential impact on local population growth by these developments is well beyond the AAGRs utilized in other recent local planning documents.

The City of Brookings Water System Master Plan[3] used an AAGR of 3.0%, a figure that was adopted in the City's Comprehensive Plan. The City of Brookings Transportation System Plan[4] projected a 2017 population of 17,104 persons for the Brookings-Harbor Urban Growth Study Area, reflecting an AAGR of 2.83% (from a base population of 8,749 persons in 1993).

3.3 LAND USE

3.3.1 Current Land Use

Land use within the study area is highly varied.

In areas outside of the UGB, forest uses predominate along with scattered residences and large lot subdivisions. Other uses, such as agriculture or industry, are very limited; however, a notable exception is Samuel Boardman State Park. Within the UGB, north of the Chetco River, land use is dominated by the City of Brookings urban core with a relatively dense mix of urban residential, commercial, and industrial development. North of Ransom Creek, the UGB includes an airport, large wood products industry, several large urban residential developments, Harris Beach State Park, and forested steep ground and riparian areas along several of the major creeks. Also located in the north extension of the UGB is the currently forested Lone Ranch Master Plan Area.

South of the Chetco River, within the UGB, predominate land use is a mix of

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1 *Lone Ranch Master Plan Utilities Report*, Otak Inc., Lake Oswego, OR, April 2004.

2 *Harbor Hills Annexation Utility Feasibility Study*, EGR and Associates, Inc., Eugene, Oregon, May 2005.

3 *City of Brookings Water System Master Plan*, HGE, Inc., Coos Bay, Oregon, May 2000.

4 *City of Brookings Transportation System Master Plan*, David Evans and Associates, Inc. and H. Lee & Associates, August 2002.

residential, commercial, and industrial development associated with unincorporated Harbor. Harbor includes a relatively large boat basin and associated commercial and industrial development near the mouth of the Chetco River. Residential and commercial development extends south, primarily easy of Highway 101 and west of Ocean View Drive. The Harbor Bench (area west of Highway 101 and south of Tuttle Creek) includes some agricultural uses within the UGB; however, the most extensive agricultural use is on the Bench area that is surrounded by the UGB. The area produces most of the Easter Lily bulbs grown in the United States. The hills east of Highway 101 toward the south end of the UGB, known as the Harbor Hills, are currently sparsely developed with isolated residences and large lot subdivisions. Much of the area is included in the Harbor Hills Special Plan Area (HHSPA) in anticipation of its potential transition to an area with urban densities of development. Ongoing residential development is extensive in the north part of the Harbor Hills. Development of any kind is sparse within the UGB along the south bank of the Chetco River with the exception of the Jack Creek area which includes the Salmon Run Golf Course, extending along both sides of Jack Creek, and some limited residential development along South Bank Road, north of Jack Creek.

3.3.2 Current Zoning

Both Curry County and the City of Brookings have highly developed zoning ordinances: the Curry County Comprehensive Plan Ordinance (Ordinance 82-1 and subsequent amendments) and the Land Development Code of the City of Brookings (Ordinance 89-0-446 §1.). Curry County maintains a website (http://www.co.curry.or.us/) that includes an interactive GIS map with zoning layers and keys for both the City of Brookings and Curry County.

3.3.3 Future Development

Within the UGB, residential development, and ancillary commercial development, are anticipated to remain highly active into the foreseeable future. The most extensive development is likely in the Harbor Hills and in the Lone Ranch Master Plan Area. Curry County has recently adopted changes to its Rural Residential (RR) zones to reduce minimum lot sizes to two acres in areas formerly zoned for five or ten acre minimum lot sizes. Actual development potential of these areas, within the study area, does not appear to be extensive. In general, only nominal development is anticipated in the study area outside the UGB. This assessment could change, however, if any Measure 37 claims are successful and pursued. Agricultural land on the Harbor Bench, and privately owned timber lands outside the UGB but inside the study area, are probably the most vulnerable target for this approach. Urbanized

areas within the City of Brookings and Harbor are likely to see some increased density associated with redevelopment and infill. Lastly, it should be noted that several factors in addition to current zoning are considered before either jurisdiction allows a development to go forward. These factors include such considerations as site stability, stream impacts, and nature and availability of utilities, and conformance with other state and/or local requirements. Addressing these issues may result in a development with less density or impact than a cursory reading of the zoning ordinance would suggest.

SECTION 4: REGULATORY CONSIDERATIONS

4.1 OREGON DRAINAGE LAW

Oregon adheres to the civil law doctrine of drainage which stems from common law or court-made law. This doctrine provides for the maintenance of natural drainage across adjoining properties. There are three basic provisions:

1. A landowner may not divert water onto adjoining land that would not otherwise have flowed there. "Diverted water" is a broad term that may include water diverted from one drainage area to another or water that may normally pond, infiltrate, or evaporate.

2. A landowner may not change the place where water flows onto a lower, adjoining property.

3. A landowner may not accumulate large quantities of water, then release it with the result of greatly accelerating on the flow on the lower, adjoining property. The intent of this provision is to prevent substantial increases in flow that could cause problems downstream.

4.2 MUNICIPAL DISCHARGES

The **Environmental Protection Agency (EPA)** is implementing recently adopted rules for storm water discharges from small municipal separate storm sewer systems (MS4s). The rules are referred to as the "Phase II regulations" and stem from the storm water program included in the Federal Clean Water Act. Phase II regulations provide for the development and issuance of National Pollution Discharge Elimination System Permits (NPDES) for MS4s.

For municipalities that are outside urbanized areas (as determined by the 2000 U.S. Census) and have populations of less than 10,000 persons, a Phase II permit can be required by the **Oregon Department of Environmental Quality (DEQ)** under its discretionary authority. The basis for the requirement is a determination that a community's storm water discharges violate water quality standards.

Phase II permits will focus primarily on six component measures:

1. Pollution prevention in municipal operations.

2. Public education and outreach.

3. Public involvement and participation.

4. Illicit discharge detection and elimination.

5. Construction site run-off control.

6. Post-construction run-off control.

Current permit fees are $670 for the initial application and $330 for each year of coverage under the permit.

DEQ is currently conducting a total maximum daily load (TMDL) study for the Chetco Subbasin. Its purpose is to establish water quality goals within the Chetco Subbasin. A TMDL is the total quantity of a specified pollutant that enters the water body without violating water quality standards. The Federal Clean Water Act (CWA) requires establishment of TMDLs for water quality limited bodies under Section 303 (d) of the CWA. Parameters of particular concern for the Chetco include: dissolved oxygen (DO), bacteria, pH, and temperature. DEQ anticipates completion of the TMDL study in 2007.

Brookings is outside a Census determined urbanized area; currently, a Phase II permit is not required.

4.3 FISH AND WILDLIFE

Storm water improvements often involve natural waters such as streams or rivers and may directly impact fish passage or health. In 2001, Oregon adopted laws regarding fish passage requirements that must be addressed prior to the installation, replacement, or abandonment of an artificial obstruction. This applies to waters in which native, migrating fish are currently or historically present. **Oregon Department of Fish and Wildlife (ODF&W)** has developed a set of fish passage guidelines that reflect the new laws.

NOAA Fisheries and the **U.S. Fish and Wildlife Service (USFWS)** share responsibility for implementing the Endangered Species Act (ESA). NOAA manages marine species including anadromous salmon while USFWS manages freshwater species. Listing of an endangered species protects it from a "take" as defined by federal law. "Take" can be construed as harm, harassment, pursuit or hunting, shooting, catching, killing, wounding, trapping, or collecting. A take can also result from actions, which if repeated sufficiently, could result in harm; consequently, activities that reduce habitat, food supply, or affect water quality could also

qualify as a "take". All federal agencies, including funding agencies, are required to consult with NOAA Fisheries (or USFWS) on any activity that may affect a listed species.

4.4 REMOVAL AND FILL REGULATIONS

Removal or fill of 50 cubic yards or more of material in waters of the State requires a permit from the **Oregon Department of State Lands (DSL)**. "Waters of the State" include bays, flowing, and intermittent streams, lakes, wetlands, and other natural waterways. Streams that are designated as essential salmon habitat require a permit regardless of the quantity of removal or fill. Certain activities or projects are exempt from state removal-fill requirements. These activities include, but are not limited to: maintenance or reconstruction of existing serviceable structures (such as drainage ditches); maintenance or reconstruction of recently damaged parts of roads or transportation structures; fish passage structures; or maintenance, repair, removal, and replacement of culverts.

Permits issued by DSL include various conditions and may require some type of mitigation to compensate for environmental impacts to wetlands. Permits specify when in-water work can be conducted consistent with information provided by ODF&W.

Projects requiring a DSL permit will often require a permit from the **U.S. Army Corps of Engineers**. DSL and the Corps have a joint permit application form which streamlines the application process.

4.5 RIGHT-OF-WAY (ROW) CROSSINGS

Crossings of state highways require coordination and approval by the **Oregon Department of Transportation (ODOT)**. ODOT maintains stringent design standards that must be incorporated into approved projects. ODOT also coordinates with other agencies such as ODF&W on issues and requirements applicable to the project.

4.6 OTHER REGULATIONS

Construction activities within a floodplain as designated by the **Federal Emergency Management Agency (FEMA)** should be coordinated with the agency to ensure compliance with all agency requirements. FEMA's primary concern is to not adversely impact the floodplain.

For construction activities that disturb one acre or more, an NPDES General Permit 1200-C is required. This is issued by **DEQ** and requires the preparation, submittal, and review of an application for the permit. Requirements include: general project and site information, a land

use compatibility statement signed by the local planning department, and the $670 application fee. An erosion and sedimentation control plan specific to the project must also be prepared. The plan must be approved by DEQ prior to the commencement of any construction activities.

4.7 CURRY COUNTY ORDINANCES AND REQUIREMENTS

The Curry County Zoning Ordinance (CCZO) includes sections applicable to riparian areas, erosion prevention and sedimentation control, and storm and surface water management standards. The complete text of these sections (Section 3.280 - Section 3.450) is included in Appendix 4.1. Sections on erosion prevention and sedimentation control, and storm and surface water management standards, were developed and adopted in 2006.

Key provisions include:

- A required erosion prevention and sediment control plan for (almost) any development activity that:

  > "Will result in the excavation of 800 square feet or more of soil surface, or will result in the construction of either 2,000 square feet or more of impervious surface on a site, or will result in the coverage of 25% or more of the area of a site in impervious surfaces, whichever is less."

- A required stormwater management plan for development or redevelopment activities affecting 5,000 or more square feet of area. Areas of less than 5,000 feet also have plan requirements that vary in scope according to area size and the presence of sensitive conditions such as wetlands, steep slopes, or fish bearing streams.

- Guidelines for surface water conveyance, pollution reduction, flow control, infiltration, treatment, and detention.

4.8 CITY OF BROOKINGS

The City of Brookings' Land Development Code includes a section (17.168.150) describing storm drainage system requirements in general terms that express objectives and grant the City Engineer authority to review and evaluate stormwater related proposals.

An updated (2006) Section 100 of the Land Development Code includes provisions to reduce

the effects of flooding, erosion, landslides, and siltation on all lots within the City and to reduce hazards associated with construction on steeper hillsides and beach fronts. Development requirements include an erosion control plan, and a drainage plan to control groundwater and storm runoff.

Section 8.10 of the Brookings Municipal Code includes provisions for maintenance of natural drainage (watercourses).

The complete text of the specific sections discussed above are included in Appendix 4.2.

SECTION 5: EXISTING DRAINAGE SYSTEM

5.1 BACKGROUND

While constructed storm drainage infrastructure is extensively represented in the study area, most of it is either undocumented or poorly documented. Mapping of the existing storm water infrastructure was hitherto largely limited to a single 11"x17", 1"=1200' plate from Brooking's 1985 Stormwater Study[1]. Area drainage is currently accommodated by a combination of creeks, ditches, and culverts. Several creeks have been re-routed, or routed to subsurface pipings, to facilitate development. Detention/sedimentation facilities are limited. Much of the hydraulic conveyance system is old and undersized (according to current design standards).

5.2 EXISTING DRAINAGE SYSTEM MAPPING

5.2.1 Basemap

The basemap was prepared using Curry County GIS as a primary source. GIS layers include: aerial photography, 5-foot and 20-foot elevation contours, property and right-of-way boundaries, soil surveys, zoning, City and UGB limits, and street names. Extent of the basemap was determined by using topography (20-foot contours) to outline the overall study area tributary to the UGB, excluding the area that is both tributary to the Chetco and upstream of where the UGB crosses the Chetco River. North-South orientation of the resulting map was rotated to facilitate the efficient creation of multiple plates encompassing the study area. Mapping was created, for various purposes, at scales of: 1"=250' (32 - 22"x34" plates), 1"=500' (8 - 22"x34" plates), and 1"=1000' (8 - 11"x17" plates). Numerous modifications were necessary to accommodate the re-orientation of the map, data corrections and additions, and offsetting of text to provide clarity in areas where stormwater features were added. Line weights were also modified for purposes of the study. The base map was created using AutoCAD software.

5.2.2 Existing Drainage Features

As noted in Section 5.1 above, the only map of existing stormwater infrastructure was a 1985, 11"x17" study figure that showed, in a simplified format, the general

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1 *A Comprehensive Plan for Storm Drainage Development (for Brookings, Oregon)*, HGE, Inc., Engineers, & Planners, June 1985.

location of identified culverts, within the core part of the City of Brookings. The current study area is considerably larger than was the case in 1985 and extensive area growth has occurred since that time. Considerable efforts were required to create the existing system maps; those efforts included:

- Thorough review of City of Brookings records including water, street, sewer, and development plans. Ideally, these would have been accurate "as-built" or record drawings; however, it was unclear in many cases as to what stormwater infrastructure, in anything, was actually constructed. Details were transcribed onto (primarily) 1"=250' scale maps with either a ROW and contour background or with an aerial photo background. Information was later added to the digital map. Since stormwater features, whether existing or proposed, are generally not emphasized on many plans, it was necessary to carefully examine each plan sheet to determine if there was any useable infrastructure information.

- Review of ODOT maps for Highway 101 culvert crossings. These were generally useful and accurate; however, several crossings are either not indicated or do not appear to accord with infrastructure found in the field.

- Review of relevant County plan sets for various projects in the study area. These were relatively limited in extent but, nevertheless, helpful in several areas around Harbor and Ocean View Drive.

- Review of relevant Harbor Sanitary District plan sets for various projects in Harbor.

- Extensive fieldwork in the Harbor area, primarily west of the Harbor Hills and south of the Chetco River to the south end of the study area boundary. Most of the roads in this area were walked with stormwater features noted on basemaps with aerial photo backgrounds. Mapped features were altered as warranted by findings in the field. Driveway culverts were generally added since it was relatively easy to do in the field and since they are an important part of the drainage system in many parts of the Harbor area. Mapping was not as extensive on the higher parts of the Harbor Hills, in part because of the difficulty in locating features on the basemaps, and in part because the survey was restricted to areas of public access.

Similarly, agricultural and other private properties on the Harbor Bench were not entered to search for relevant infrastructure. Some areas, with limited constructed stormwater infrastructure, were surveyed by a combination of slow driving and walking surveys. Overgrowth or access difficulties made it necessary at times to estimate pipe diameters or to not verify mapped culverts previously copied from plan sheets.

- Staff of the Curry County Road Department conducted a field survey along both the North Bank Road and the South Bank Road and provided sizing and location information on culverts crossing these roads. County staff also reviewed draft mapping, completed in County areas, and provided helpful comments and corrections.

- Brookings City staff provided review of draft mapping and provided helpful comments and corrections. Staff also conducted numerous field visits to add detail in undocumented areas and to resolve some discrepancies.

The overall mapping effort was highly iterative with numerous draft versions prepared, reviewed, field checked, and modified. Nevertheless, the maps should still be viewed as provisional.

Both the City and the County are encouraged to add detail and corrections as more and better information is provided or discovered.

5.2.3 Basin Delineation

Basins were delineated based on topographic information (5-foot contours in the UGB; 20-foot contours outside the UGB) and flow paths as defined by creeks, drainways, roadways, culverts, and other stormwater related features. Basins were delineated during the relatively dry periods of summer and early fall 2006; consequently, surface water flow patterns could not be observed to clarify flow directions (and catchment boundaries) in relatively flat areas or where ditch slopes appeared to vary from surrounding ground slopes. In such areas, boundary locations were estimated based on available information, topography, and visual determinations.

Where possible, roadways and mapped stormwater infrastructure was used to help determine basin extent, since this more truly represents the basin's tributary area of

surface water flow. Precipitation that is intercepted by the ground, and subject to subsurface transport, is likely to follow flow paths within a tributary area defined by the original area topography[2]. This latter consideration may be more important in evaluating total flow (over a longer period such as a year) or basin recharge. Emphasis of this study, however, is on surface water and associated peak discharges.

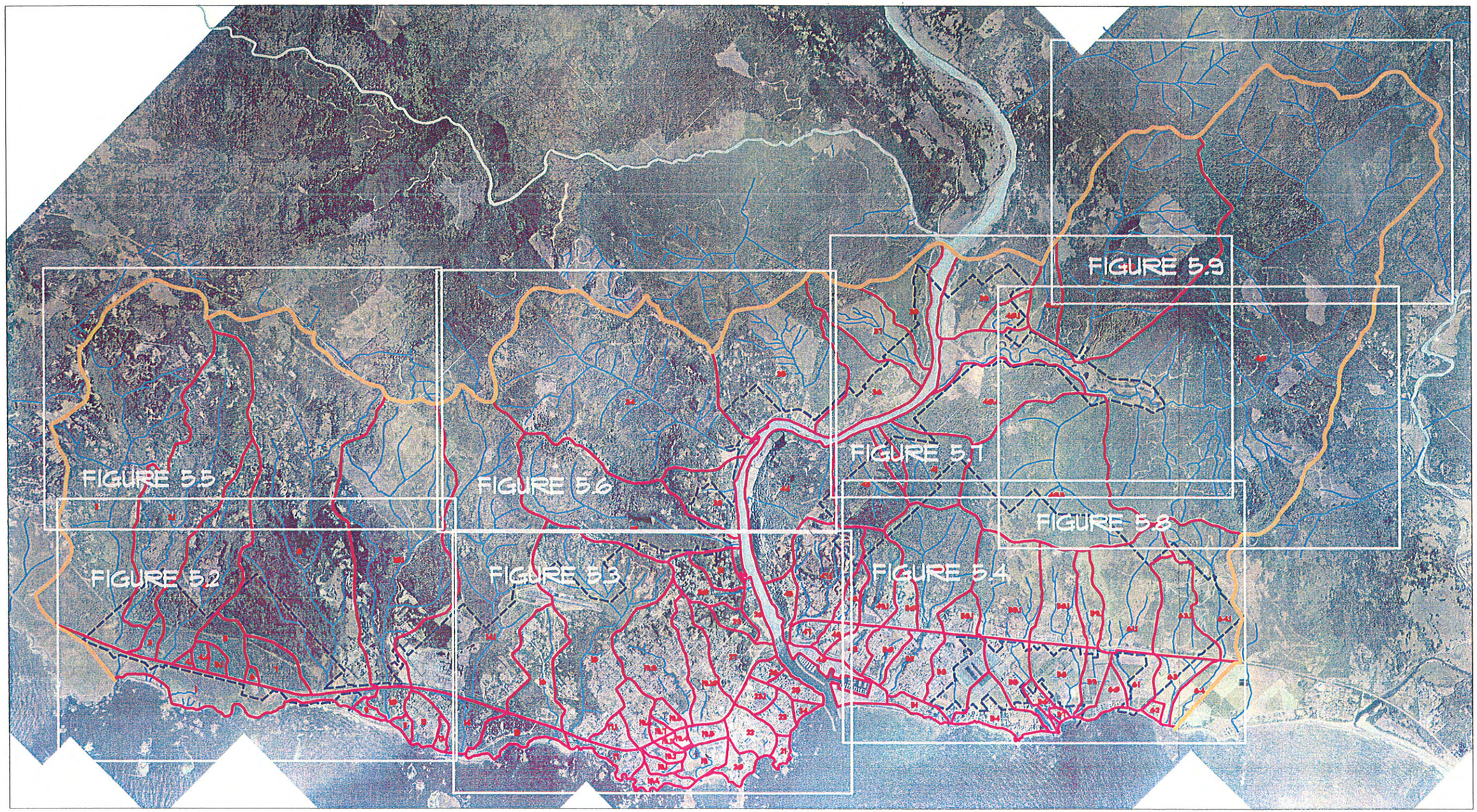
Overall, the study area is characterized by having a very large number of independent basins, which are tributary to the Chetco River or the Pacific Ocean. Subbasins were created to facilitate modelling of design flows associated with crossings of significant highways or roads (Highway 101, North Bank Road, South Bank Road, and Ocean View Drive); consequently, many basins consist of only two or three basins. Several basins along the Pacific Ocean or along the Chetco River are independent, representing areas that may drain, via several flow paths, to either the river or the Ocean. In some cases, these areas are "residual" areas, falling between delineated basins, that must, nevertheless, be accounted for. The most complex area delineated is Macklyn Creek which involves 11 subbasins. Overall, 101 subbasins were delineated. While this is a substantial and workable number for purposes of this study; future studies or predesign efforts may find it necessary or desireable to further subdivide the selected subbasin(s) as much as ten or twenty fold in order to more accurately model flows in an area of interest.

5.2.4 Existing Drainage System Maps

Existing drainage system infrastructure, and mapped subbasins, are shown on Figures 5.1-5.9. Map scale is 1" = 1000'. Larger, more easily read, maps have been provided to Curry County and the City of Brookings. The more developed parts of the UGB are shown in Figure 5.10-5.16. Map scale for these sheets is 1" = 500'. Figures 5.1 and 5.10 are key sheets and are not to scale.

2 With the exception of any water migrating via pipe trenches to another basin.

FIGURE 5.1: Existing Storm and Surface Water Facilities Map



Legend For Figures 5.2-5.9

- Study Area
- Basin
- UGB
- City limits
- Streams
- Culvert/pipe & Line Diameter (in)
- Property Line
- 5' Contour Line
- 20' Contour Line

PLAN NORTH

Not to Scale

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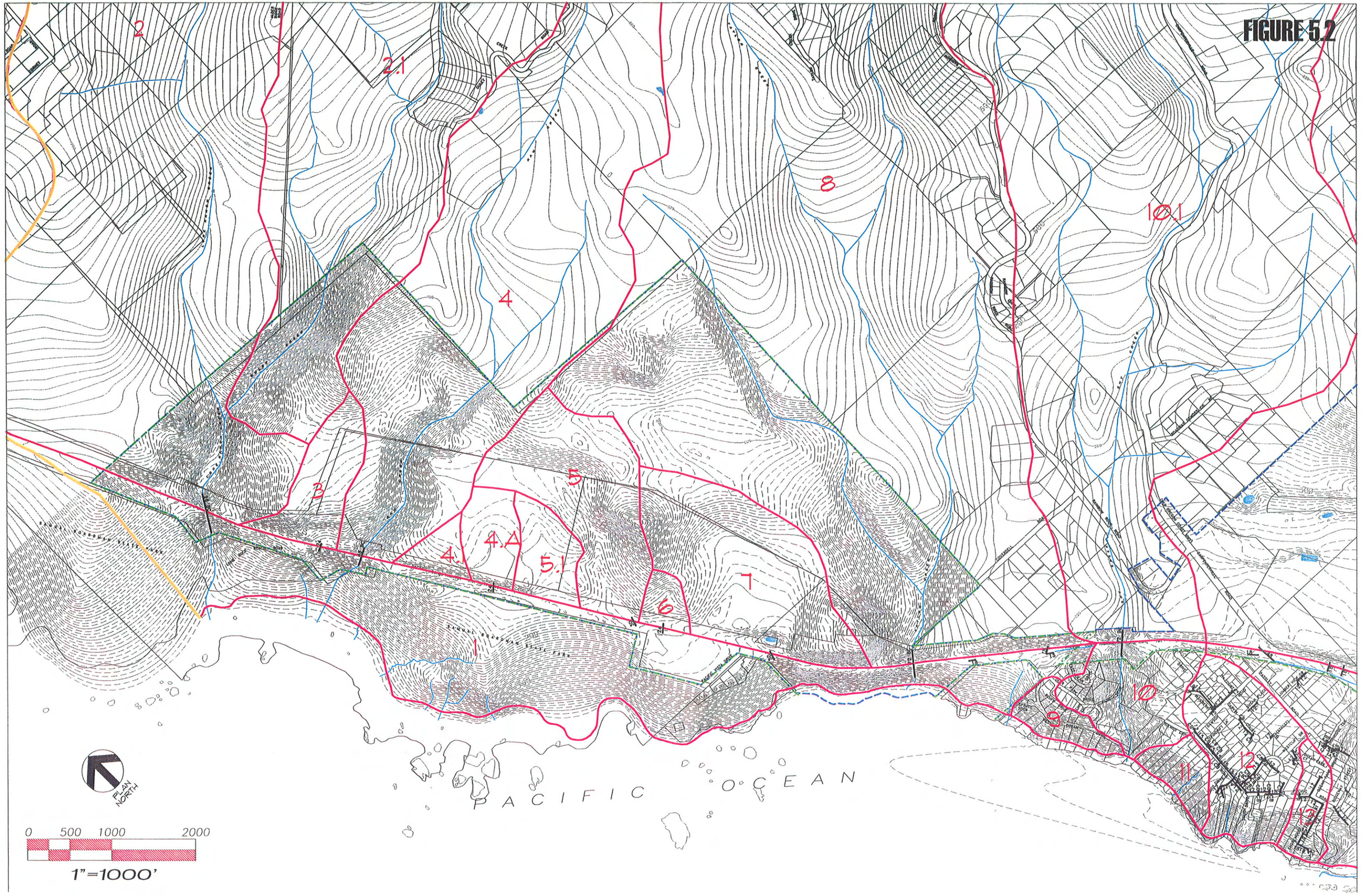


FIGURE 5.2
2
2.1
8
10.1
4
3
5
4.1
4.A
5.1
7
6
1
10
9
11
12
13
PACIFIC OCEAN
PLAN NORTH
0 500 1000 2000
1"=1000'

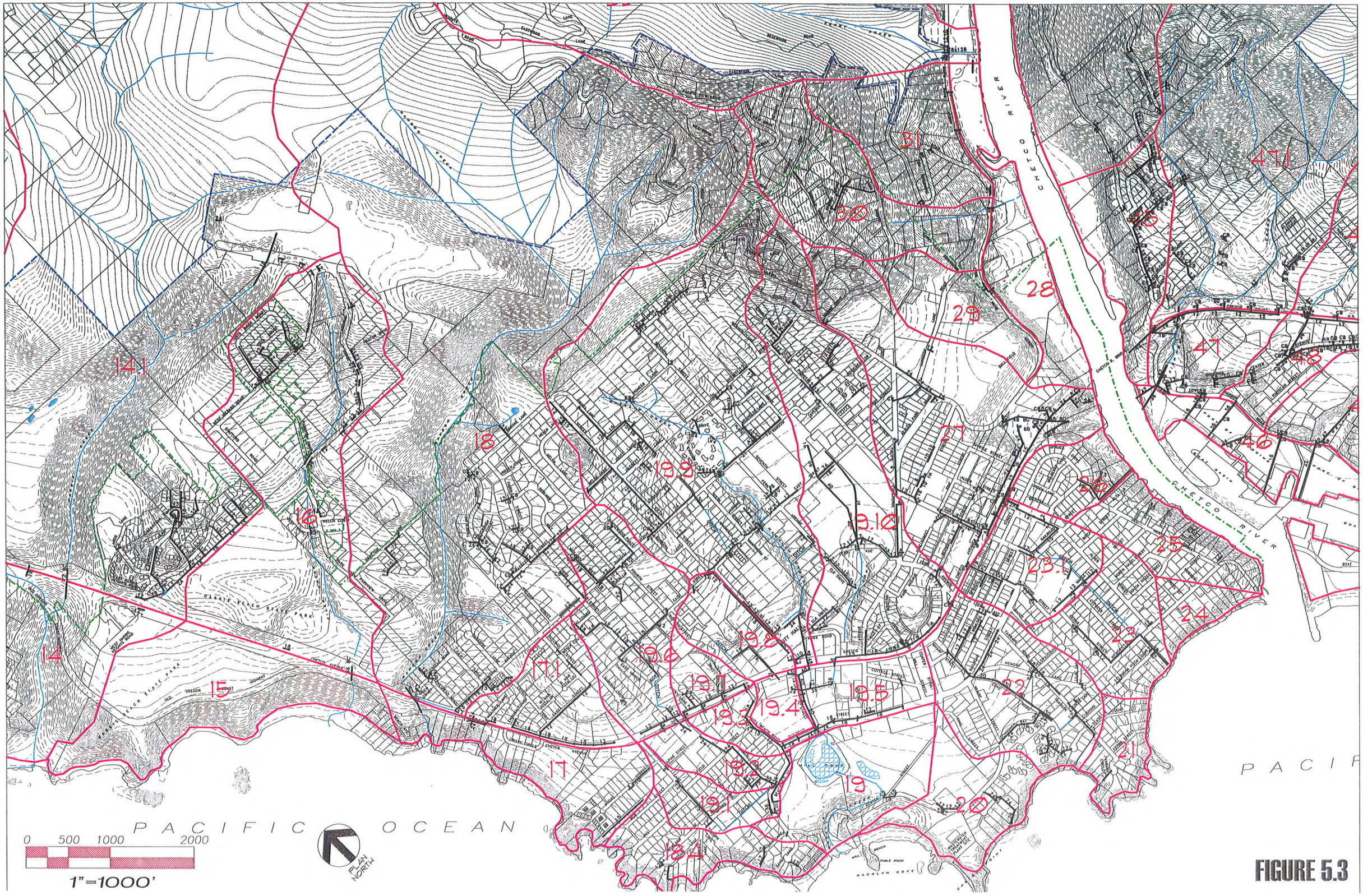

PACIFIC OCEAN
CHETCO RIVER
HARRIS BEACH STATE PARK
0 500 1000 2000
1"=1000'
PLAN NORTH

FIGURE 5.3

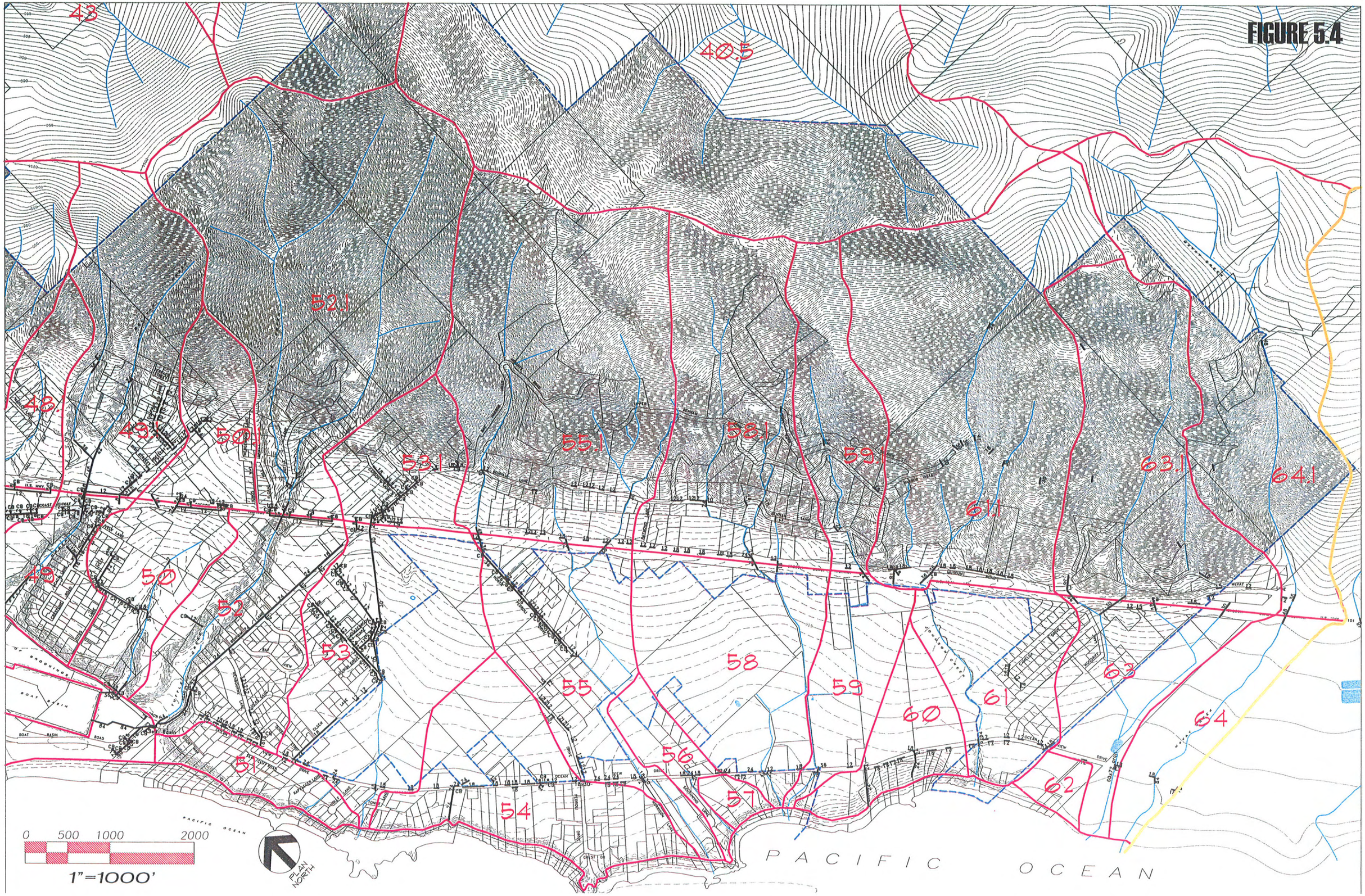


FIGURE 5.4
43
40.5
52.1
48.
49.
50.1
53.1
55.1
58.1
59.
63.1
64.1
61.1
49
50
52
53
55
58
59
60
61
63
64
51
54
56
57
62
0 500 1000 2000
1"=1000'
PLAN NORTH
PACIFIC OCEAN

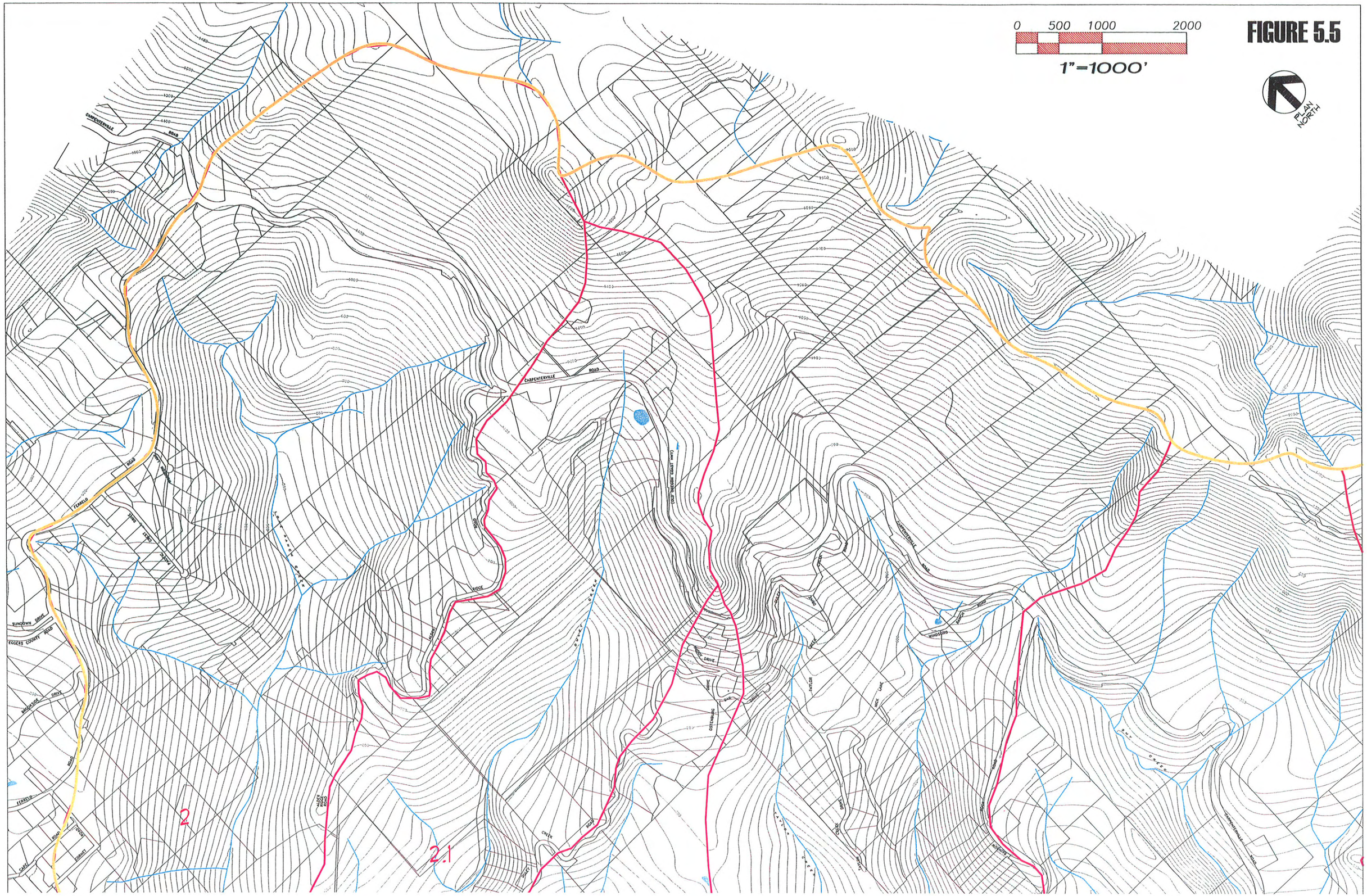

0 500 1000 2000
1"=1000'
PLAN NORTH
CARPENTERVILLE ROAD
FERRELO ROAD
SUNDOWN DRIVE
EGGERS COUNTY ROAD
2
2.1

FIGURE 5.5

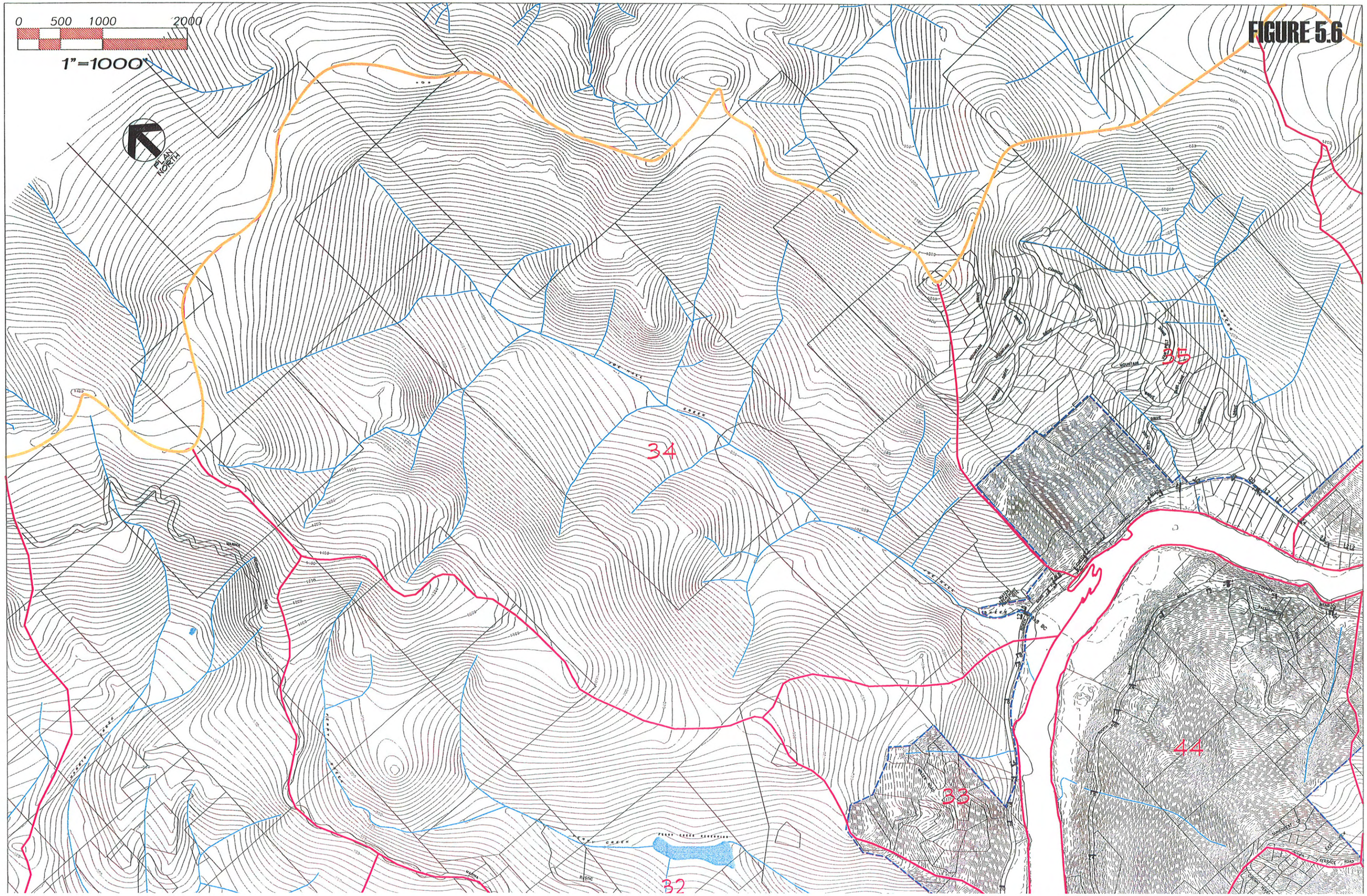


FIGURE 5.6
0 500 1000 2000
1"=1000'
PLAN NORTH
34
35
33
44
32

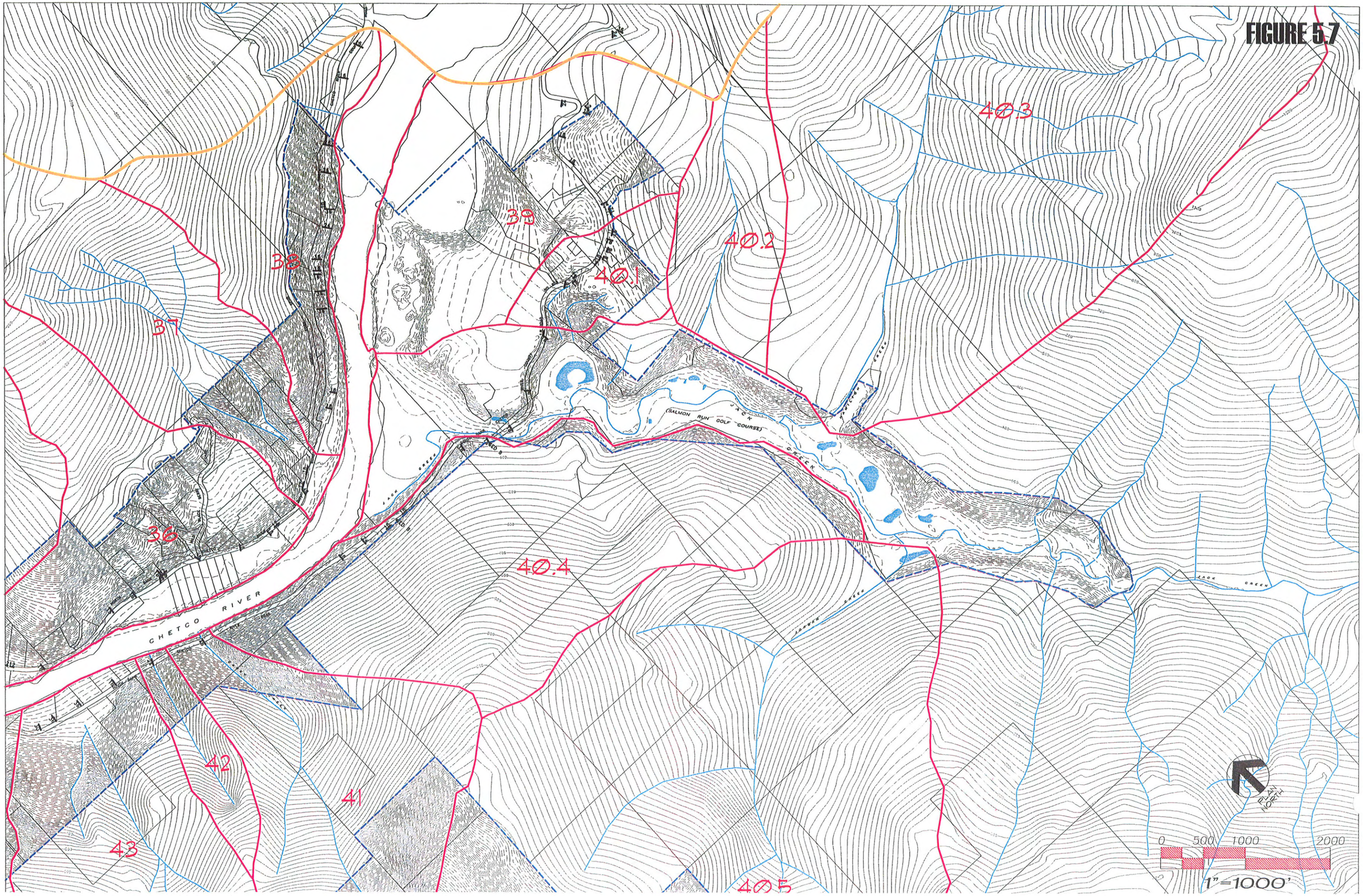


FIGURE 5.7
37
38
39
40.1
40.2
40.3
40.4
40.5
41
42
43
36
CHETCO RIVER
JACK CREEK
(SALMON RUN GOLF COURSE)
0 500 1000 2000
1"=1000'

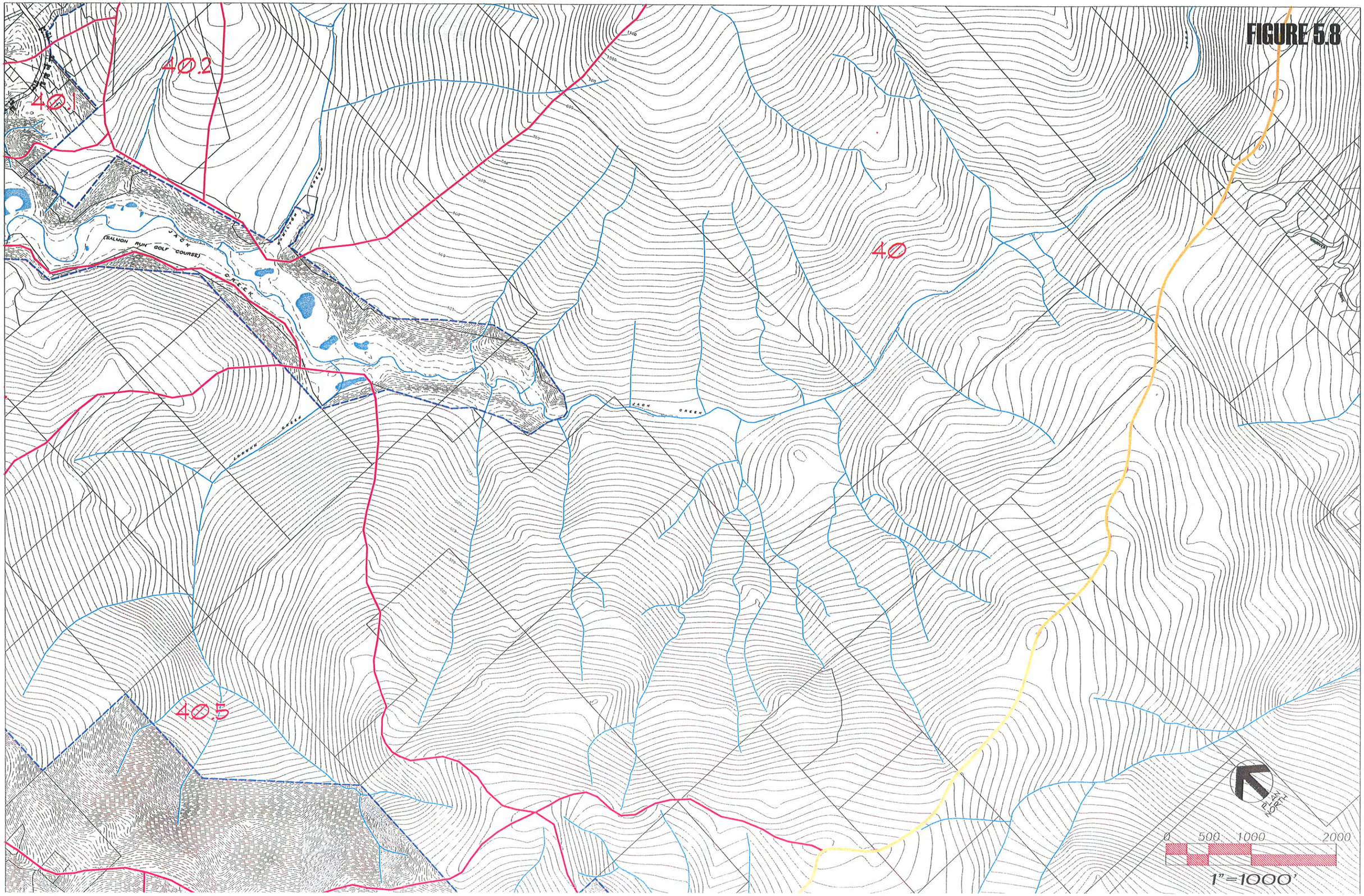


FIGURE 5.8
40.1
40.2
40
40.5
(SALMON RUN GOLF COURSE)
JACK CREEK
PLAN NORTH
0 500 1000 2000
1"=1000'

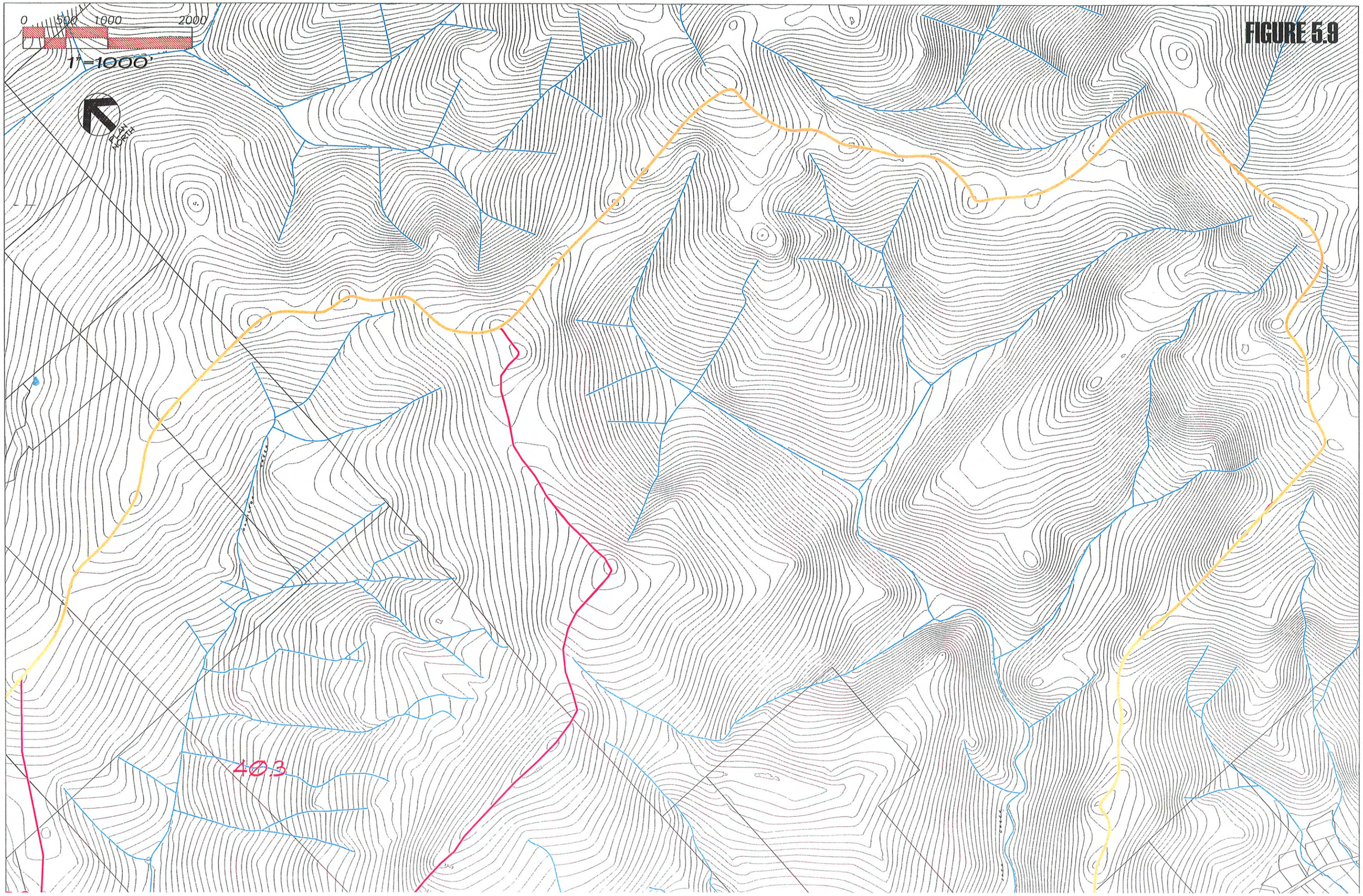
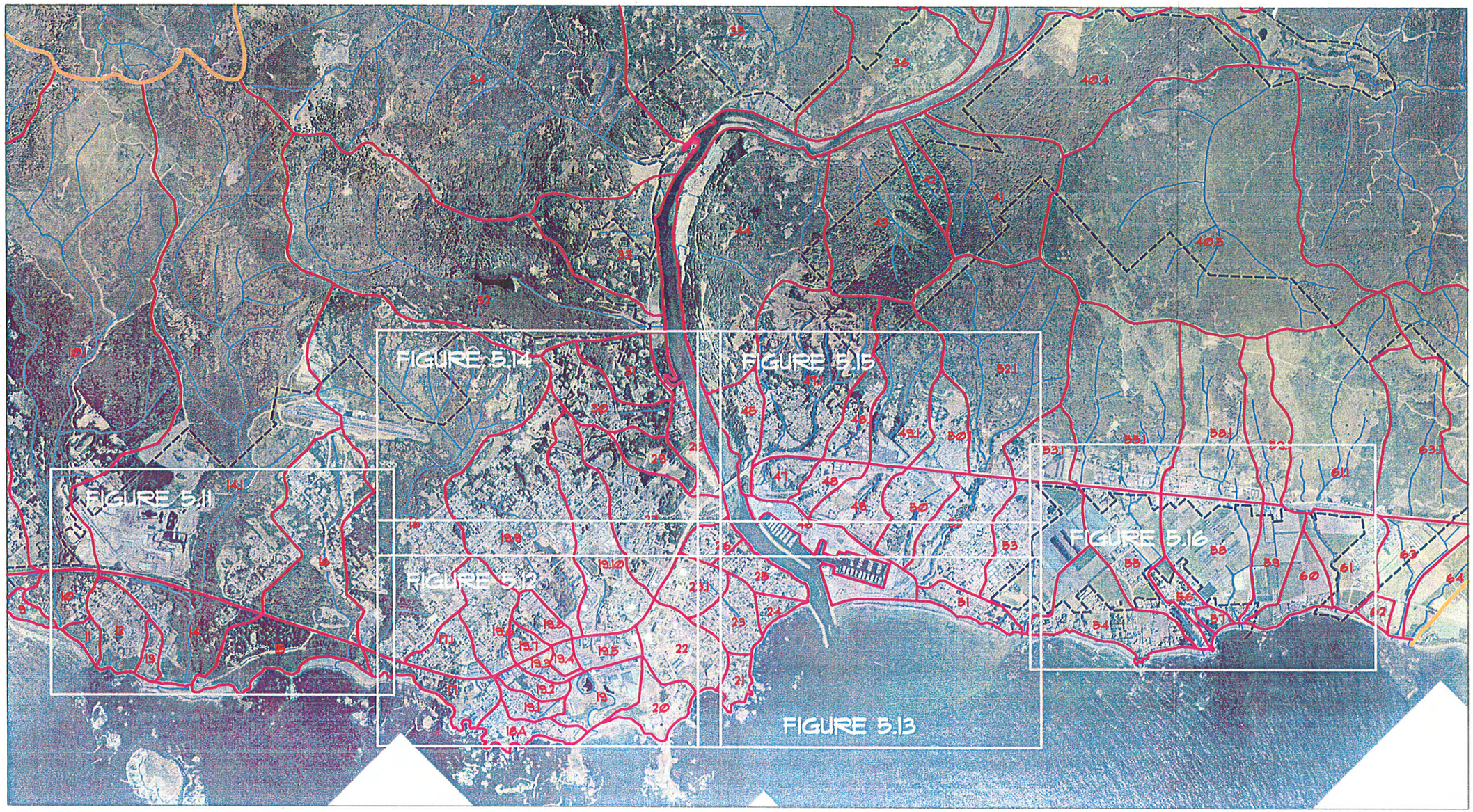


FIGURE 5.9
0 500 1000 2000
1"=1000'
PLAN NORTH
403

FIGURE 5.10: Existing Storm and Surface Water Facilities Map



Legend For Figures 5.11-5.16

- Study Area
- Basin
- UGB
- City limits
- Streams
- Culvert/pipe & Line Diameter (in)
- Property Line
- 5' Contour Line
- 20' Contour Line

PLAN NORTH

Not to Scale

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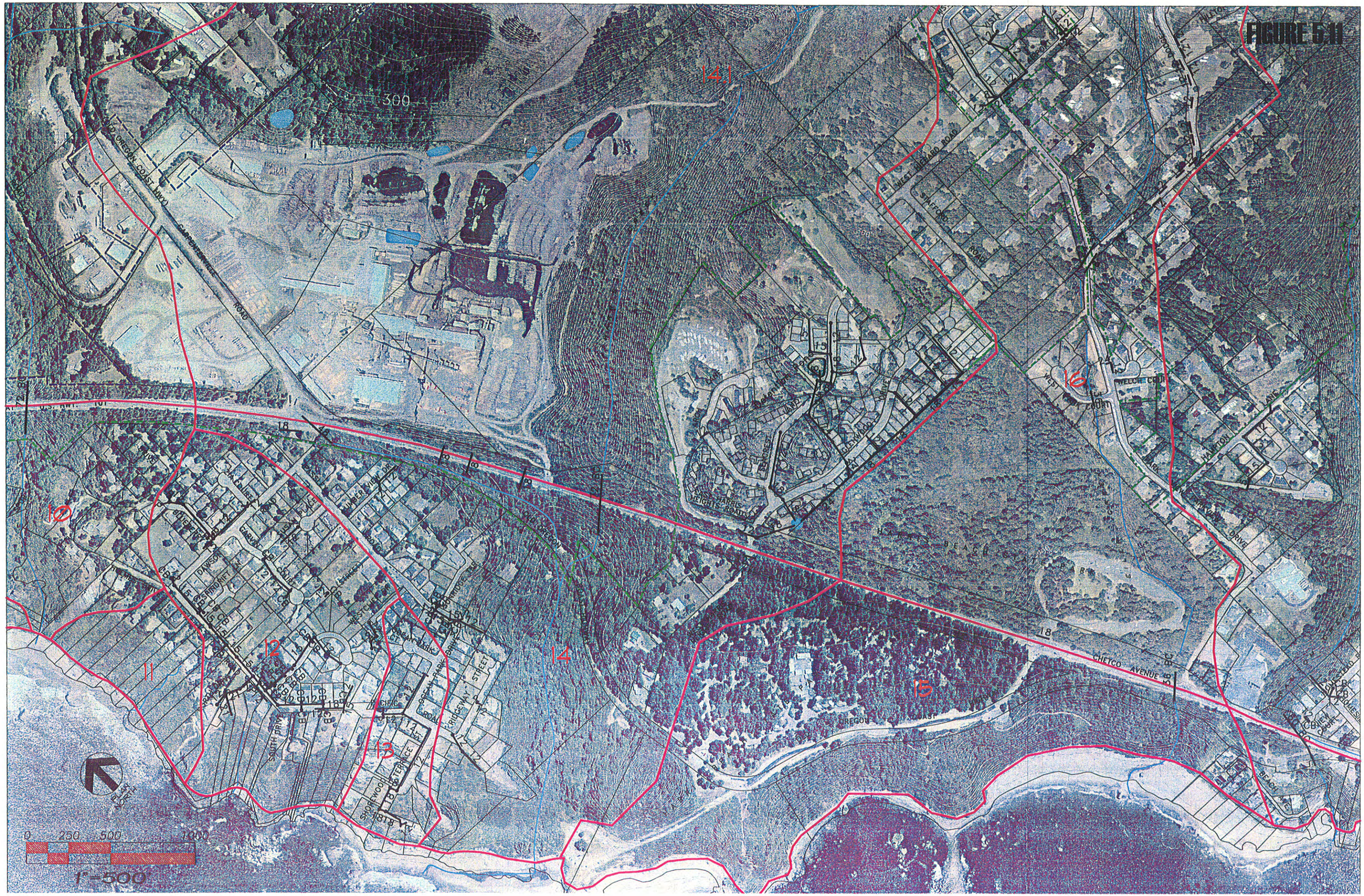
FIGURE 5.11
141
300
10
11
12
13
14
15
16
CHETCO AVENUE
0 250 500 1000
1"=500'

18
19.9
26
23.1
19.6
19.8
17.1
19.7
19.5
22
19.4
19.3
19.2
17
19.1
20
18A
1"=500
CITY HALL
ROSS ROAD
ELK DRIVE
CHETCO AVENUE
PACIFIC STREET
COTTAGE STREET
MILL BEACH ROAD
RAILROAD
CRISTY CREEK
MACKLYN COVE
MILL BEACH
TABLE ROCK
WASTEWATER TREATMENT PLANT SITE
MEMORY LANE
CENTER STREET
SANDY LANE
ALLEN LANE
BARCLAY LANE
ROWLAND
DITCH
FIRST STREET
SECOND STREET
THIRD STREET
FOURTH STREET
SEVENTH STREET
WHARF STREET
OAK STREET
SPRUCE
HEMLOCK
DEGROO STREET
FERN AVENUE
PARK AVENUE
CHETCO AVENUE
HIGHLAND WAY
MILLER LANE
BACON
HOLLY LANE
EAST MANOR DRIVE
WHALEY LANE
HAWTHORN
ASH
PINE STREET
FIELD
KING LANE
BEACH ROAD
CREEK
CENTER
COVE
ROAD
KING STREET
ISHBONEER BAY DR
TIMBERLINE
MAPLE LANE
MENUE
LAWSON
WIMAN
EVERGREEN COURT
HOMESITE
CRISTY CREEK
CHETCO AVENUE

FIGURE 5.12

CHETCO RIVER
PACIFIC OCEAN
PACIFIC OCEAN
BOAT BASIN ROAD
Bed Basin
26
25
24
23
21
46
52
53
51
0 250 500 1000
1"=500'

FIGURE 5.13

FIGURE 5.14
0 250 500 1000
1"=500'
PLAN NORTH
31
30
29
28
27
26
18
19.10
19.9
PACIFIC
LOOP
MARINA
WESTWOOD
HEIGHTS
SEVENTH
STREET
EASY
FERN
HELEN LANE
HIDDEN COURT
THIRD
MIDLAND
SPRUCE
LINDEN LANE
MULBERRY LANE
DITCH
ALDER
STREET
PIONEER
RANSOM
MECHELLE LANE
KRISTA LANE
JODEL LANE
HASSETT
LIMBAUGH WAY
SIXTH
CB

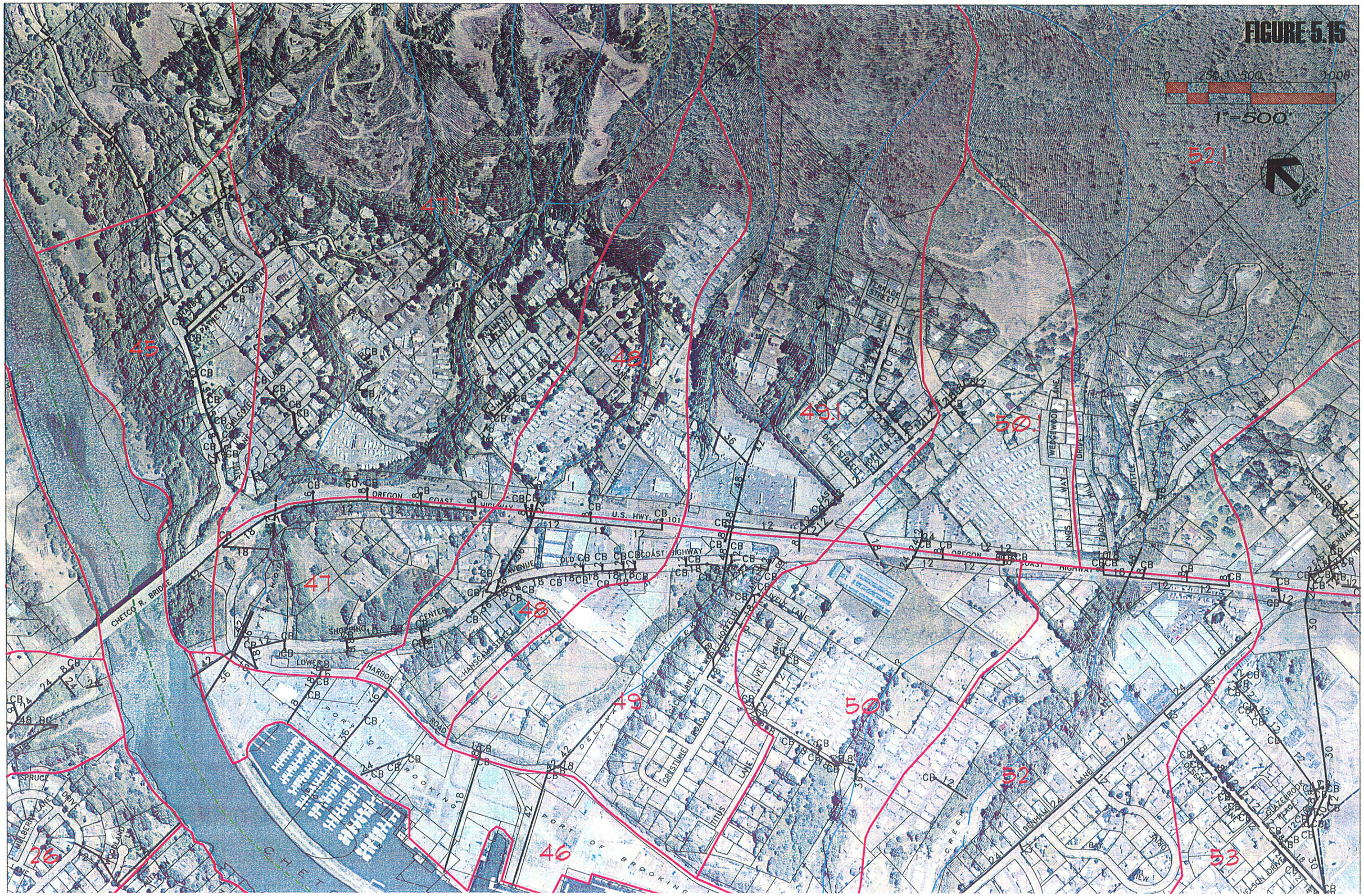
FIGURE 5.15
0 250 500 1000
1"=500'
52.1
47.1
45
48.1
49.1
50.1
47
48
49
50
52
53
46
26
OREGON COAST HIGHWAY
U.S. HWY. 101
CHETCO R. BRIDGE
HARBOR ROAD
PORT OF BROOKING
CRESTLINE ROAD
TITUS LANE
WEDGEWOOD LANE
KINGS WAY
FLORAL HILL
BENHAM LANE
GLAZEBROOK PLACE
SPRUCE DRIVE
MULBERRY LANE
HANSCAM STREET
SHOPPING CENTER
LOWER
OLD COAST HIGHWAY
DIXIE STREET
HOFFELDT LANE
VELY LANE
CAVIN LANE
CARSON LANE
EAST BENHAM
TERRACE STREET
PRINCE ST.
CHAPMAN LANE
CHILCOTE LANE
PAYNE ROAD
CHETCO

FIGURE 5.16
531
591
611
58
55
59
60
61
56
57
54
BENHAM LANE
RAYMOND LANE
HARBOR VISTA
OREGON COAST HIGHWAY
MUSEUM ROAD
NORTH PEDROLI DRIVE
PEDROLI DRIVE
OCEAN
MORRISON LANE
SOUTHWIND
CREST DR
JOHNSON CREEK
CAMELLIA
PACIFIC
0 250 500 1000
1"=500'

5.3 EXISTING DRAINAGE SYSTEM - DISCUSSIONS

Refer to Section 6.5 for a discussion of existing drainage system features; refer to Section 5.4 for a discussion of noted problem areas.

5.4 PROBLEM AREAS

5.4.1 General

Section 5.4 focuses on hydraulic issues; water quality issues are discussed in Section 5.5. Specific issues for the City of Brookings are included in Section 5.4.2; and for areas outside the City, but within the UGB, in Section 5.4.3. In general, stormwater issues arise with the advent and progress of the wet-weather season typically starting in November. This is also when leaf drop occurs. The combination of leaf drop and winter storms can result in local culvert or catch basin obstruction and consequent back-ups or flooding. Accumulations of sediment or debris within pipes can also compromise hydraulic capacity until flushed. While larger pipes or alternate designs may reduce the propensity for problems at any given location, the provision of such does not always ensure that problems will not occur. Stormwater infrastructure maintenance is conducted by both City and County staffs; however, since obstructions can occur rapidly during storm events, some problems may arise even though recent maintenance was conducted. Because of this, City staff typically check certain problem areas on a daily basis during the work week.

5.4.2 City of Brookings

Problem areas were identified for HGE by City staff on several occasions, including one field visit during the November 7, 2006 storm event. Many of these problems are strictly maintenance related and very local and minor in effect. Problem areas (PAs) are referred by number below and indicated on Figure 5.17.

PA1. City staff have, "within the last three years," cleared out and debrushed the detention pond associated with the Harris Heights subdivision. It is currently brushed out. The problem has broader significance insofar as such structures require maintenance but responsibility for providing the maintenance is not clearly delineated.

PA2. Open ditches along Ransom Avenue tends to collect debris. City staff drive by on their daily maintenance route to monitor and clear (if needed).

PA3. A small catch basin located under a pine tree, at Ransom Avenue and Third Street, tends to become obstructed by pine needle accumulation.

PA4. A suspected obstruction in the 12" line, at Easy Street and Second Street, resulting in slow drainage. City has tried jetting without success and now plans to televise the line to better ascertain the problem.

PA5. Shallow ditch along Easy Street tends to over top.

PA6. The drainway coming down the hillside tends to accumulate debris on the grate in front of the 18" culvert that conveys flow under Highway 101. A berm has been constructed that protects nearby businesses by diverting flow (either flow in excess of the culvert's capacity or diverted flow associated with an obstructed intake grate) to the southeast (toward what is now Lucky Lane). Infrastructure at Lucky Lane was not designed to handle the diverted flow; consequently, excess flows have run down Lucky Lane to Highway 101. The culvert passing under Highway 101 is known by staff to be in poor condition where it outlets (PA 24) on the west side of the highway behind the gas station.

PA7. The small (10" diameter) corrugated metal culvert under Lpine Street is in extremely poor condition. Alder leaves and twigs tend to catch on the ragged edges of the pipe. The pipe is approximately 25 feet in length; the street is more like a gravel driveway in overall character and appearance.

PA8. The ditch south of Rowland Lane tends to accumulate debris but cannot be readily accessed by City Staff.

PA9. The 46" corrugated metal culvert under Mill Beach Road is severely deteriorated and has no bottom. Soil around the junction box, on the northwest side of road, tends to subside into the box and pipe via the voids in the degraded pipe.

PA10. The grass covered swale south of Fred Meyer tends to concentrate grass clippings and obstruct the receiving culvert. This type of problem occurs in other areas as well when people discard lawn trimmings, weeds, and other debris into the drain ditches adjacent to their property

PA11. There is a large mesh-wire fence across Maclyn Creek on private property. Staff check periodically to ensure debris does not collect and obstruct flows.

FIGURE 5.17: Noted Problem Areas

Obstructed flows that back-up and release suddenly could adversely affect downstream infrastructure and properties - in this case, the intake and area near City Hall.

PA12. City staff check and clear out materials that could cause obstructions (for reasons described under PA3 above).

PA13. Background information on potential backups and flooding of Macklyn Creek near City Hall is discussed in Section 2.5. Ponding at City Hall appears to originate at the upstream end of the 24" culvert that runs along the north edge of the parking lot. Observations on November 7, 2006 noted this and it accords with some, not all, reports of flooding that occurred in December 2005. The grade ahead of the culvert is minimal and flow in the ditch is slow. Flow at the discharge is very fast and shallow with a hydraulic jump occurring a few feet outside of the pipe. The culvert appears either to be operating under inlet control with a consequent reduction in flow capacity or to have a partial obstruction somewhere in the barrel. There were also reports of Macklyn Creek itself backing up in December 2005; however, these reports were second hand and may have reflected a misunderstanding. Nevertheless, it should be noted that the inlet to the 24" line is lower than the berm that contains Macklyn Creek; consequently, it would be possible for the 24" line to operate in reverse if Macklyn Creek surcharged sufficiently.

There is also potential for Macklyn Creek to backup if an obstruction occurred downstream, inside the pipe barrel. A similar situation recently occurred on South Fork Creek (subbasins 19.10 and 19.5)[3]. Last summer and early fall, there was a serious odor (hydrogen sulfide) problem in the vicinity of the 36" line that carries South Fork Creek across Highway 101. While investigating the problem, staff found, in the manhole located where the 36" line makes a 90° bend (subbasin 19.5), a few large branches approximately 10 feet long and 2"-3" thick. The manhole lid was ajar, suggesting surcharging and overflows. The manhole is a square box approximately 8' x 8' and 12' deep and located in a large blackberry patch. It is quite likely that an obstruction occurred in the box resulting in backups upstream. If the backups lasted long enough, the resulting slow flow could allow sedimentation to occur and solids to accumulate on the pipe invert. If the obstruction cleared slowly, the solids would remain. Biological action on the

[3] This was communicated to HGE after the draft mapping figures were printed (December 21, 2006); consequently, it has not been given a separate PA number or indication on Figure 5-17.

remaining solids could account for the odor. Macklyn Creek has a similar 90° bend, so similar obstructions could occur downstream.

PA14. At Ransom Avenue and Pioneer Road, a catch basin was installed approximately 1 ½" too high resulting in some ponding (approximately 6' x 12').

PA15. The catch basin at Fir Street and Old County Road tends to become obstructed. Staff note it needs to be checked several times per day. Some gravel gets washed downstream onto Old County Road.

PA16. Ditch backups along Railroad Street are associated with the minimal pipe grade and hydraulic capacity.

PA17. The crossing at Willow Street and Railroad Street has insufficient hydraulic capacity during heavy rains. Mapping indicates an 8" culvert.

PA18. The 30" culvert across Railroad Street at Oak Street is severely degraded and lacks a bottom.

PA19. The open drainway runs through the middle of the block with backyard fences running along both sides and hindering access. Lawn clippings, debris, and household objects (balls, tricycles, pumpkins, etc.) may appear in the drainway or in accumulations downstream. In one place, the drainage flows through the roots of a very large fir tree that straddles the drainway. Obstructions have resulted in temporary flooding of yards.

PA20. The culvert at Memory Lane and Buena Vista Loop (that accepts flow from PA13 above) if obstructed by debris, runs across the road to the southeast. The redirected flows have entered the garage of the corner house on occasion. This location is on the City's daily maintenance route. Potential problems at this location are directly related to problems associated with PA13.

5.4.3 UGB (Outside the City of Brookings)

Problem areas within the UGB, exclusive of the City of Brookings, were identified at a public meeting held on October 11, 2006, and in follow up communications. County staff maintain ditches and culverts within County right-of-ways. The County Road department has effected extensive upgrades of infrastructure including relining or replacement of degraded pipe and increasing the size of under capacity culverts.

Such efforts are particularly notable along North Bank Road, South Bank Road, and Ocean View Drive. Much of the infrastructure and many of the drainways are on private property and not maintained by County staff.

The Harbor Bench was studied extensively in the 1970's and a report was completed in 1977 by Frederick Lissner of the Oregon Water Resources Department[4]. Emphasis of the study was on the nature and adequacy of the groundwater resource; however, it also provides information and insight relevant to current stormwater related concerns. Several paragraphs from pages 28-29 of the report are quoted below:

> "Because the ground water body is shallow and because of the limited areal extent of the aquifer, surface water has a direct effect upon the ground water body. Ground water recharge is dependent upon runoff from the foothills percolating downward into the ground water reservoir at the base of the hills and incident precipitation percolating directly downward to the aquifer. Surface water is also important because of its effect upon the natural drainages on the bench. Any erosional deepening of the drainage channels below the water table will increase the ground water discharge to the creeks.
>
> Several of the local farmers have drained marshy Hebo and Knappa soils in order to expand their crop production capability. The drain tiles now carry precipitation to surface streams quickly during and immediately after rain storms, whereas this water used to pond on the surface and run off very slowly. The result is that less recharge occurs to the aquifer because the water is channeled away, and the streams continue to downcut because of the increased peak discharge.
>
> Urbanization has also had an effect on surface water runoff. The construction of parking lots, driveways, buildings and streets and roads and their associated drainage ditches has had the same two effects as draining the Hebo soils; namely, 1) they have eliminated recharge to the ground water body through the land they occupy, and 2) they cause rapid diversion of surface runoff to the natural drainages where the increased discharge causes increased down-cutting in the creek beds.
>
> The construction of U.S. Highway 101 at the base of the foothills has also had a disruptive effect on ground water recharge and storage. Highway construction and subsequent widening in 1970 have eliminated land from recharge and increased the amounts of runoff water entering the surface drainages. In addition, much water which used to move downslope off the foothills and spread into the alluvial fans and gentle slopes of the terrace and gradually be absorbed is now channeled laterally adjacent to the highway to culverts which concentrate the flow and discharge it to surface streams increasing the peak flows and causing the streams to cut deeper."

As noted above, factors which have contributed to stream downcutting (erosion) and

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4 *Ground Water Conditions on the Harbor Bench, Southwestern Curry County, Oregon*, Frederick G. Lissner, Salem, Oregon, March 1977.

reduced groundwater storage include: agricultural drainage, urbanization, and Highway 101 construction. To this could be added stream relocation, channelization, or piped conveyance, and vegetation removal adjacent to the water course. Most of the streams that flow over the bench exhibit these characteristics to varying extents. Only Johnson Creek (Subbasin 61) and McVay Creek (Subbasin 64) appear to have retained a largely natural flow pattern and maintenance of vegetation along the margins.

Specific problem areas identified at the public meeting held on October 11, 2006 (and in follow up discussions) are indicated on Figure 5.18 and described below.

PA21. Several people noted problems with high flows at the end of Toner Lane. The seasonal stream drains through a 48" culvert across Ocean View Drive and then flows in an open ditch to the property of the last house at the end of Toner Lane. Infrastructure on the property included two 36" culverts and a wood lined trench through the front yard. The property is on the bluff above the ocean. The stream has caused considerable erosion near the edge of the bluff, including the creation of a plunge pool. The owner and neighbors expressed concern that upstream development had resulted in excessive flows responsible for the recent damage. To avoid further property loss, the owner plans to install a 48" culvert and concrete channel.

PA22. The channelized seasonal creek that runs along the westside of the residential development has exhibited excessive erosion that impacts the small backyards of the adjacent development.

PA23. The property indicated receives flow from a ditch along the south edge of Subbasin #61 that ultimately discharges over the bluff near the house. The owner is concerned about recent high flows that could cause property damage and impact the bluff near her house. Flows through the 24" culvert across Ocean View Drive were reportedly followed upstream to developments further up on the Harbor Bench.

PA24. Winharbor Farms has experienced flood damage in 1995 and in December of 2005. Approximately one-half of their lily crop was destroyed in the most recent event. A DOT evaluation in 1996 attributed the 1995 events to both an upstream diversion by an unidentified landowner and to a culvert obstruction. In general, the owner is concerned with upstream activities that directly impact the farm. The owner has worked with a hydrologist, Mr. Gerald LaRue, in monitoring discharges to the property from actual or

proposed developments upstream. Efforts were summarized in a report by Mr. LaRue, "Winharbor Farms Monitoring Report, Winter of 2002-2003."

PA25. This parcel, located high on the hillside, has a single dwelling with a private, shallow well. The owner reports a degradation in water quality which coincided with construction activities above her property. While the problem is not stormwater related per se, it does suggest that developed properties that have shallow wells on the Harbor Hills could be impacted by developments higher on the hills that result in reduced groundwater recharge or impacts to groundwater quality.

5.5 WATER QUALITY

5.5.1 Chetco River Water Quality

The Department of Environmental Quality (DEQ) maintains an index, the Oregon Water Quality Index (OWQI), which describes general water quality for selected sites in terms of a numeric score. The OWQI incorporates several water quality parameters, including: biochemical oxygen demand (BOD), pH, temperature, dissolved oxygen (DO), total solids, bacteria (fecal coliform prior to 2002; e coli afterwards), nitrate and ammonia nitrogen, and total phosphorous. The Chetco River site (LASAR No. 11483) is located at river mile 10.8 at the USGS river gauge. For water years 1996-2005[5], the Chetco has a summer mean score of 91 and a fall through spring score of 92. The scores are based on a 100-point scale with a score of 90-100 considered excellent water quality. On this basis, the Chetco's water quality, upstream of the USGS gauge, is excellent. Nevertheless, federal Clean Water Act standards for temperature (64° F) have been exceeded in areas (such as just below the Kalmiapsis Wilderness boundary) where there are no human induced factors. The Chetco appears on Oregon's 303(d) list of water quality limited streams and is listed for exceeding the rearing (64°) temperature parameter during the summer season.

The Chetco estuary is one of the smallest in Oregon in terms of estuary surface area to drainage area. The lower estuary is highly modified and filled in - it is approximately one-half its original size based on comparisons with 1891 navigational charts. Construction of two jetties, 1000 feet of dike, and the first boat basin, and dredging of a 120' wide navigational channel, was completed in 1957-1958. In 1968-

5 State of Oregon Department of Environmental Quality, May 2006. "Oregon Water Quality Index Summary Report, Water Years 1996-2005."

1970, the navigational channel was deepened to 14 feet. In 1974-1976, the second boat basin was constructed and the shallow lagoon, south of the jetty, was filled in. Approximately 109 acres of estuary was filled in, and approximately 36 acres of boat basin subtidal habitat was added. There is less than 5 acres of intertidal habitat.

Overall stream gradient is relatively steep, resulting in a limited upstream tidal extent of approximately 3.5 miles. The river transports heavy loads of sand and gravel during the high winter flows. As the annual higher flows subside, silt and clay overlay the gravel base in the upper estuary and provides a seasonal substrate for benthic organisms. The clay and silt layer is flushed with the advent of higher seasonal flows. Plant life is the estuary is largely limited to algae.

Water quality issues are most evident and problematic in the boat basins. The South Coast Watershed Council and OSU Extension conducted extensive water quality sampling from August 2002 through May 2003[6]. Major concerns in the basins included: low dissolved oxygen (DO), poor circulation within the basins (and exchange between the basins and the river), excessive summer algae growth, nutrient sources, and periodic fish kills. Sampling results indicated complex processes with tidal, diurnal, and seasonal variables. The basins tend to accumulate nutrients both from ocean upwelling, and pipes that discharge creeks and storm water to the basins. With the advent of warmer water temperatures and increased sunlight in spring, algae begins to grow. Excessive algae growth can cause large diurnal fluctuations in DO and pH; decomposing algae contributes BOD that further reduces DO, especially in areas with poor circulation. Violations of both pH and D.O. standards have occurred (in places) in the boat basins. The study included recommendations for additional water quality monitoring to better understand water quality in the estuary and boat basins. It further notes that the primary problem, excessive algae growth, is influenced by water temperature, sunlight, and nutrients. Water temperature and sunlight cannot be practically addressed, nor can ocean sources of nutrients. Practicable solutions include reduction of nutrient inputs from pipes discharging to the basins or providing a better connection between the basins and river to enhance flushing. The latter solution would result in lower nutrient concentrations because of dilution.

A 1979 ODF&W report recommended strict pollution controls on potential inputs (sewage, fish processing, mills, boats, etc.) and that if pollution controls proved to

6 *"Chetco Estuary and Boat Basin Water Quality Monitoring,"* South Coast Watershed Council and OSU Extension Service, 2003.

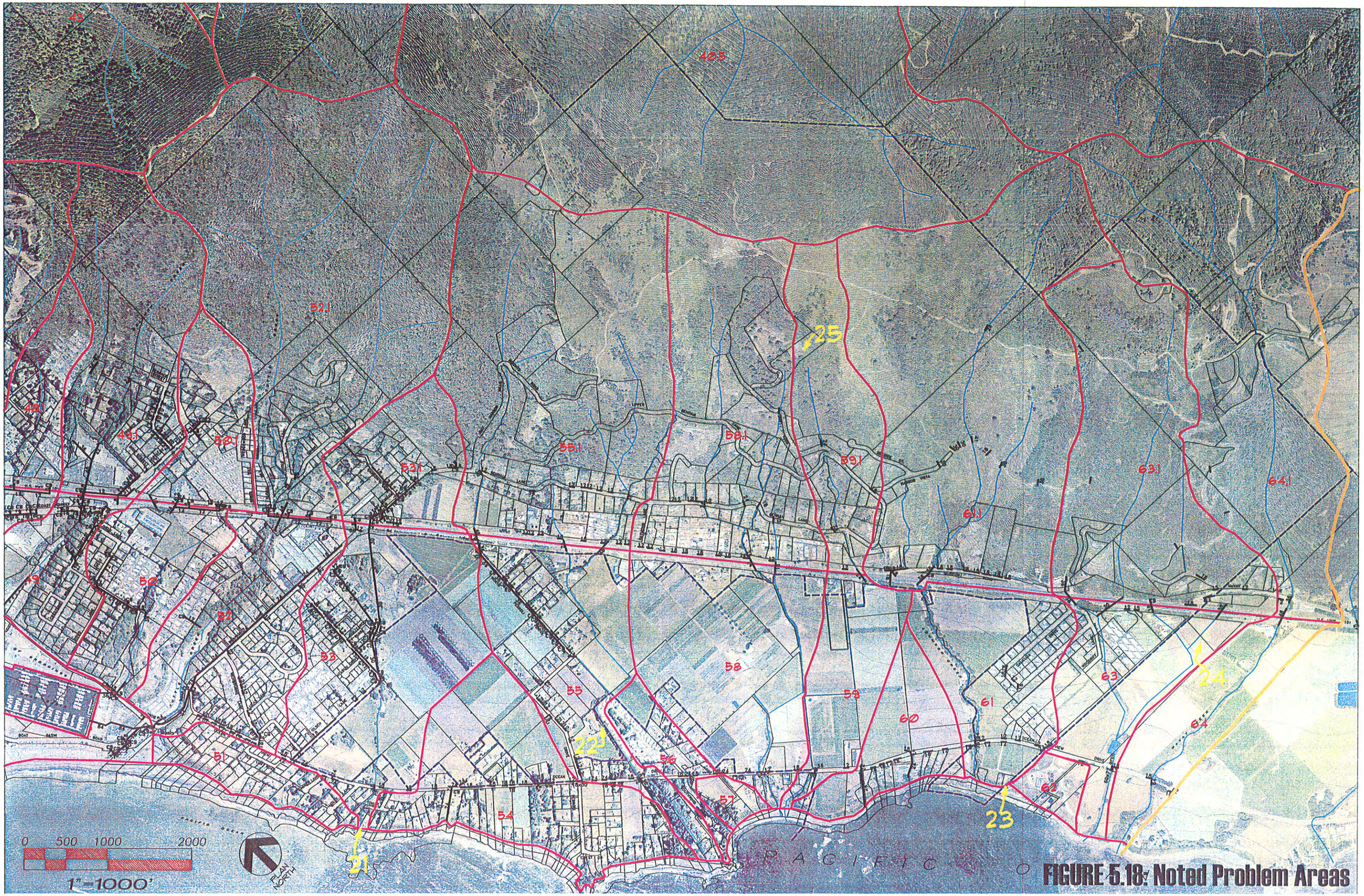

FIGURE 5.18: Noted Problem Areas

be inadequate, then the basins should be modified to improve flushing[7].

In 2003, West Consultants, Inc. and the Corps of Engineers studied the Brookings Harbor area in relation to surge problems in the boat basins. The study confirmed the transformation of short-period waves offshore to longer-period waves that resonate in the basins and likely account for reported vessel damage. The preferred solution involves relocation of the boat basin entrance further upstream and blocking the existing entrance.

Based on the water quality studies noted above, it is likely that the hydraulic improvements recommended in the West study to address surging in the basins, would exacerbate water quality by further reducing circulation in the basins. On the other hand, any proposed modifications to the boat basins for water quality improvements will need to consider potential hydraulic impacts to the use and functionality of the basins.

5.5.2 UGB Water Quality

Specific sources of water quality contaminants were not identified or monitored as part of this study. The following information is provided as an acknowledgment of potential contaminants/pollutants of concern within the study area.

Pesticides, herbicides, and fertilizers. These pollutants are associated with agricultural and forestry management practices; and with residential grounds/park, or golf course maintenance. The study area includes extensive areas of forestry management, the Harbor Bench agricultural area, a golf course (along the lower reach of Jack Creek), and extensive rural and urban residential development. Residential development is of particular concern, since most people are not well versed in determining the minimal amount of a given chemical necessary to achieve results; consequently, an excess or residual may remain. Also, residential users may not be as concerned with timing of applications and may not monitor or control irrigation to avoid runoff.

Fungicides or other roofing treatment. Quantity and timing of treatment are the primary concerns. Again, homeowners with limited experience or product knowledge may contribute disproportionately to this potential problem.

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7 *"Natural Resources of Chetco Estuary, Estuary Inventory Report, Vol. 2, No. 9"*, Oregon Department of Fish and Wildlife, 1979.

Fuel, solvents, paint, or oil. Proper storage and disposal are key to reducing these pollutants in the environment. Whole the most egregious cases are the intentional disposal of excess or used materials directly into storm drains; other, less direct pathways also occur such as disposal in holes or on the ground surface.

Sanitary sewer exfiltration or overflows. Exfiltration from sewers may occur when the groundwater table drops below the sewer pipe and when pipe defects are sufficiently large enough to allow sewage to leak out of the pipe. Exfiltration is not a commonly documented problem in sanitary sewer systems - even those with relatively high seasonal inflow and infiltration problems. Overflows are a potential source; however, overflows are generally uncommon and limited in duration. DEQ design guidelines allow for an overflow during the five-year storm event. Overflows at other times, even those due to mechanical failures, constitute a violation of the state issued NPDES permit for the wastewater facility. Documented overflows can become a basis for agency actions to require facility upgrades to eliminate the problem. Septic, or other onsite system failures can also result in adverse water quality impacts.

The City of Brookings owns and operates a municipal wastewater collection and treatment system, The Harbor Sanitary District maintains a wastewater collection system. On-site (septic) systems are present throughout the remaining portions of the study area.

Sediment and turbidity. Soil erosion can result in sediment transport and increased water turbidity. Sediments can settle out in catch basins or fill in pipes and culverts, and in both cases severely impact the hydraulic capabilities of the infrastructure. Suspended solids (turbidity) often carry a charge that attracts and binds with charged pollutants. Turbidity thereby enhances the transport of pollutants and contaminants. Turbidity also reduces the hydraulic boundary layer and results in faster, and presumably more erosive, flow in natural channels.

Bacteria. While wastewater systems can contribute bacteria, other sources, such as pet/domestic animal wastes or wild animal sources, may be of even greater significance. Microbial pollution is usually indicated though testing and monitoring for indicator organisms such as fecal coliform or e. coli. Conventional wastewater facilities, such as the City of Brookings' Wastewater Treatment facility, disinfect effluent and monitor and report results to DEQ to demonstrate compliance with the state issued NPDES permit. Fecal coliform is associated with all warm blooded animals (mammals and birds). Potential sources within the study area include beavers, waterfowl, and resident or transient herds of deer or elk. Dogs are likely the

most prevalent and problematic source of pet/domestic animal waste. In an informal conversation with Mr. Frank Burris of the OSU extension, who is currently monitoring and studying water quality in several streams and along several beaches in the study area, the data collected to date suggest an interesting correlation between height of tide and high bacteria concentrations along several beaches. In general, high concentrations of bacteria correlate with tides above four feet and are sustained until the tide drops back below four feet. The data suggests a bacterial reservoir, probably dog feces. This is a preliminary and tentative supposition. Mr. Burris' work is ongoing, - if the final report includes this determination, it may also offer or suggest practicable management techniques to reduce bacterial contamination and consequent beach closures.

Biochemical Oxygen Demand (BOD), nutrients, pH, dissolved oxygen (DO) and temperature. These are lab parameters rather than specific pollutants. BOD refers to organic materials that can be decomposed through microbial action. The process requires oxygen to complete and thereby reduces the DO concentration in the carrier and receiving waters. Low D.O. concentrations can stress or kill fish. Nutrients, specifically nitrogen, and phosphorus, can contribute to excessive algae growth and attendant water quality problems that include highly fluctuating diurnal charges in D.O. and pH. Temperature is primarily a concern in regulated waters that provide habitat for cold water fish species such as trout and salmonids.

SECTION 6: HYDROLOGIC/HYDRAULIC ANALYSIS

6.1 GENERAL

Hydrologic/hydraulic analysis involves computations that predict runoff and routes stormwater through a drainage system. Hydrologic computations result in estimates of peak flows and runoff volume. Peak flows are used to size pipes, culverts, or open channels (ditches). Runoff volume is used in sizing detention facilities if they are required to protect downstream reaches of a drainage system. The analysis was accomplished by use of computer models that simulate runoff from a defined storm intensity, and parameters that describe land use and soil characteristics.

6.2 DESIGN STORM FREQUENCY

Storm recurrence frequencies of 25 years and 50 years for a 24-hour event were modeled for all subbasins. The storm frequency indicates the period over which the occurrence of one storm of that magnitude is statistically probable. Storm intensity, and consequent stormwater flow, increases with larger recurrence frequencies. Selection of the appropriate design storm affects sizing of proposed improvements which, in turn, affects construction costs. Many communities have infrastructures sized for 5-year events; however, sizing for 25-year events is the current standard for smaller urban streets. ODOT requires a 50-year design storm basis for drainage across state highways. For the study area, a 25-year event is recommended for general planning, and a 50-year event for planning of all work along or across Highway 101 (in accordance with the ODOT requirements). For capacity evaluations of ODOT crossings, a 25-year event basis is adequate, since it is only construction within the ODOT right-of-way that requires the 50-year event design basis. Regardless of the event selected as the basis for analysis and design, it is possible that some areas may still exhibit localized flooding during large storm events.

Precipitation-frequency statistics were obtained from the 1973 *NOAA Atlas 2, precipitation-frequency atlas of the western United States, Volume X -Oregon, and are listed in Section 2.2.*

6.3 HYDROLOGIC ANALYSIS

6.3.1 Hydrologic Model

Hydrologic and hydraulic modelling was performed using HydroCAD Version 7 software. HydroCAD is based on hydrologic techniques developed by the U.S.

Department of Agriculture Soil Conservation Service (SCS) of which, the principal technique for runoff determination is the SCS Unit Hydrograph procedure (SCS Technical Release 20, also known as TR-20). The Santa Barbara Urban Hydrograph (SBUH) method was used to determine runoff for this study. The SBUH method uses many of the same data inputs as the SCS unit hydrograph; however, it allows for a time delay in routing the hydrograph through the subbasin that is equal to the time of concentration.

The model consists of linked HydroCAD files in an effort to comply with the expressed desire for a single model covering the study area. As the project moved forward, the single model approach did not match well with available data and resources. Most of the 101 modeled subbasins discharge directly to either the tidally influenced Chetco River or to the Pacific Ocean. Combining these discharges is hydraulically meaningless because of nature and dilution of the receiving bodies; however, the modelling could be used with appropriate rainfall statistics and water quality estimates (based on sampling and testing) to estimate pollutant loads on the receiving bodies.

6.3.2 Synthetic Rainfall Distribution

The SCS and SBUH procedures utilize a synthetic rainfall distribution of the selected 24-hour design storm. A fraction of the total rainfall is allocated to each time interval over a 24-hour period. The allocation is non-linear and reflects the variations in rainfall intensity in a 24-hour period associated with typical storms in a given area. Brookings and Harbor are located in an area having a Type IA distribution[1]. HydroCAD automatically creates the synthetic rainfall distribution for the entered storm total and selected distribution type.

6.3.3 Curve Number

SCS developed a numerical characterization of potential runoff associated with various soil types and ground covers (land use). Curve numbers (CN) also reflect consideration of runoff and infiltration rates for surfaces subject to prolonged wetting. This latter consideration resulted in the development of four hydrologic soil group categories:

Group A: well drained.
Group B: moderate drainage.

[1] There are three other distributions (I, II, and III) used in other parts of the United States.

Group C: poor drainage.
Group D: very poor drainage.

Hydrologic soil group categories for each soil identified in the study area are included in Table 2.2. Group B and C soils predominate in the study area. Generally, subbasins include a mix of soil groups; however, some subbasins or areas are almost exclusively one or the other. Examples include the Jack Creek drainage area which is almost exclusively Group C and the southern Harbor Hills (subbasin 55.1 and south) which is almost exclusively Group B. For modelling, soil group selection can markedly affect the curve number selected.

The modelling is based on current land use and was determined by identifying and outlining selected land use types on aerial photographs and determining, by computer, acreage associated with each type within each subbasin. Preliminary consideration was given to using zoning for estimating either current or future land use; however, zoning classifications within the study area may allow for a range of permissible development densities or may not allow otherwise permissible developments because of geotechnical limitations, water availability, or other restrictions. Furthermore, existing developments may include lot sizes and densities at less than permissible magnitudes in areas that are less likely to change because of the established nature of the area. Both the City and the County have moved in the direction of requiring new developments to restrict post-development flows so as not to adversely impact downstream infrastructure. Based on these considerations, modelling focused on current conditions.

Table 6.1 includes land use categories selected for use in this study and curve numbers associated with the four hydrologic soil groups.

Table 6.1: Existing Land Use Categories and Curve Number Allocations[2]

Land Use Category	Curve Numbers for Hydrologic Soil Group			
	A	B	C	D
Woods with good coverage	25	55	70	77
Woods with poor coverage	45	66	77	83
Cultivated Land	62	71	78	81
Open Space	49	69	79	84
Waterbody	100	100	100	100
Commercial	89	92	94	95
Industrial	81	88	91	93
Paved	98	98	98	98
Residential (approx. density)				
8 units/acre	77	85	90	92
4 units/acre	61	75	83	87
3 units/acre	57	72	81	86
2 units/acre	54	70	80	85
1 unit/acre	51	68	79	84

For each subbasin, the relative proportion (in decimal fractions) of each soil group was estimated from soil mapping. For each land use category of the subbasin, a curve number (CN) was determined by multiplying each CN by the corresponding decimal fraction of each soil group present in the subbasin. After this computation was complete for each land use category, a similar computation was completed that multiplied each averaged curved number by the decimal fraction of the acreage of the land use category in relation to total subbasin acreage. Summing the results yield the subbasin curve number that is incorporated in the hydraulic model.

Appendix 6.1 includes tables of soil group allocations, land use allocations, and computed curve numbers.

6.3.4 Time of Concentration

Other input parameters for HydroCAD include (for each subbasin): total area and time of concentration. Time of concentration (T_C) is the time it takes for runoff to travel from along the longest flow path (hydraulic length) in the basin. The lag (or curve number) method was used to determine T_C for all subbasins. It is generally applicable for basins of 2000 acres or less. The T_C equations are:

2 Based on curve number allocations included in *"SCS Urban Hydrology for Small Watersheds, 2nd ed., (TR-55),* June 1986.

$$T_C = \frac{L}{6}$$

$$L = \frac{I^{0.8}(s+1)^{0.7}}{1900Y^{0.5}}$$

$$S = \frac{1000}{CN} - 10$$

Where:

T_C = Time of concentration (hrs.)
L = Lag time (hrs.)
I = Hydraulic length (ft.)
Y = Average land slope (percent)
S = Potential maximum retention (in.)
CN = Weighted curve number

and:

$$Y = 100\,\frac{Cc}{A}$$

Where:

C = Total contour length (ft.)
c = Contour interval (ft.)
A = Area (ft^2)

HydroCAD computes T_C based on entry of needed data and selection of the T_C method desired.

6.3.5 Reach Routing

Related subbasins were connected via a reach - typically a pipe or channel (representing a stream or drainway) for longer distances and as a single

(dimensionless) connection for relatively short distances. Pipe and stream average slopes were estimated based on surface topography (5' contours). Stream beds were approximated by a parabolic channel. Manning's equation,

$$V = \frac{1.486\, R^{2/3} S^{1/2}}{n}$$

where: V= Average flow velocity (ft./sec.)
R= Hydraulic Radius (ft.)
S = Slope of channel (ft./ft.)
n = Manning's number

also: $R = \frac{A}{P}$

where: A = Flow area (ft.^{2})
P = Wetted perimeter (ft.)

and: $Q = VA$

where: Q = flow (ft.^{3}/sec.)

was used for flow computations. A Manning number of 0.13 (typical of concrete pipe) was used for pipe modelling; a Manning number of 0.40 was used for stream modelling on the Harbor Bench.

6.4 MODEL RESULTS

Model results for each subbasin are summarized in Table 6.2. A culvert capacity evaluation is included in Table 6.3. The capacity evaluation is based on the total pipe area of all noted crossings in the subbasin and therefore assumes that all noted pipes/culverts are proportionately loaded. This is not likely the case in reality; however, more detail and additional subbasin creation would be required to accurately model the differences. The capacity evaluation also focuses on pipe velocity and, since this is the sole indicator of adequacy employed, it is suggestive, rather than indicative, of the relative adequacy of the infrastructure involved. To be definitive, additional data would need to be obtained. Such data would include upstream and downstream invert elevations, and elevation data indicative of upstream surcharge potential. In general, pipes are usually designed to carry flow at a minimum of 2.5 - 3.0 fps without surcharging. With several feet of upstream surcharging, higher velocities, 3-10 fps, are typically achievable. With greater pipe slopes and/or

surcharging, higher velocities of 20 fps or more may be achieved. In general, the lower the velocity required to accommodate the peak flow, the more likely the actual pipe capacity is adequate.

Table 6.2: Subbasin Modelling Summaries
(SBUH Model)

Subbasin No.	Discharges To:	Receives Flow From:	Area (Ac.)	Hydrologic Soil Group (Approx. Decimal Fraction) A	B	C	D	Curve Number CN	Hydraulic Length (LF)	Contour Length 5 Ft. Contours (LF)	20 Ft. Contours (LF)	Average Slope (ft./ft.)	T_c (min.)	Subbasin Peak Flow 25-yr (cfs)	50-yr (cfs)	Total Flow 25-yr (cfs)	50-yr (cfs)
1	Pacific		239.3			0.9	0.1	76	3,875		107,304	0.206	23.3	240.1	286.7	240.1	286.7
2	Pacific	2.1	1260.8		0.15	0.7	0.15	72	16,130		770,629	0.281	70.1	695.1	847.4	1,058.8	1,290.5
2.1	2		607.5		0.3	0.4	0.3	72	13,103		378,315	0.286	58.8	364.4	443.8	364.4	443.8
3	Pacific		26.5		0.7	0.3		63	1,874	35,305		0.153	21.5	16.8	21.4	16.8	21.4
4	Pacific	4.1	352.4		0.9	0.1		59	10,416		125,771	0.164	90.9	97.2	126.1	97.2	130.8
4.1	4		7.9			1		72	1,333	8,342		0.121	14.5	8.0	9.7	8.0	9.7
4.A	Pacific		16.5			1		70	1,217	6,909		0.048	22.6	13.7	16.8	13.7	16.8
5	Pacific	5.1	67.0		0.3	0.5	0.2	67	3,286	83,626		0.143	31.4	43.9	54.6	58.9	72.9
5.1	5		17.8			1		71	1,682	10,690		0.069	23.8	15.1	18.4	15.1	18.4
6	Pacific		7.4			0.8	0.2	75	774	9,490		0.148	7.8	9.1	10.9	9.1	10.9
7	Pacific		84.4		0.3	0.4	0.3	68	2,783	105,905		0.144	26.7	61.4	75.9	61.4	75.9
8	Pacific		1374.0		0.9	0.1		60	17,819		791,031	0.264	107.2	370.2	477.3	370.2	477.3
9	Pacific		11.5			0.3	0.7	82	696	29,373		0.292	4.1	52.1	60.5	52.1	60.5
10	Pacific	10.1	37.0		0.4	0.4	0.2	74	2,320	79,931		0.248	14.9	39.7	47.7	454.9	561.9
10.1	10		878.0		0.6	0.4		69	12,872		419,343	0.219	71.8	427.0	527.7	427.0	527.7
11	Pacific		11.5			0.3	0.7	83	638	23,901		0.239	4.1	52.9	61.2	52.9	62.0
12	Pacific		50.6		0.1	0.9		81	2,648	37,852		0.086	22.9	120.7	140.9	120.7	140.9
13	Pacific		12.2		0.3	0.7		80	1,716	12,645		0.119	14.2	36.0	42.1	36.0	42.1
14	Pacific	14.1	91.9		0.7	0.3		66	4,290	124,333		0.155	38.4	103.6	173.5	1,289.7	1,555.9
14.1	14		983.8		0.5	0.5		71	14,474		502,362	0.234	72.3	868.7	1,055.0	868.7	1,055.0
15	Pacific		80.3		1			62	1,257	125,141		0.179	14.8	133.0	166.8	133.0	166.8
16	Pacific		170.7		0.7	0.3		66	5,509	164,029		0.110	55.6	150.0	186.9	150.0	186.9
17	Pacific	17.1	45.2		0.8	0.2		74	1,315	60,410		0.153	12.1	122.7	146.2	177.4	210.1
17.1	17		34.6		0.6	0.4		81	5,230	19,930		0.066	45.0	55.7	65.2	55.7	65.2
18	Pacific		593.7		0.6	0.4		67	10,803		266,910	0.206	67.9	473.6	585.0	473.6	585.0
18.A	Pacific		30.7		0.5	0.5		78	1,044	22,486		0.084	12.1	92.1	108.3	92.1	108.3
19	Pacific	Subbasins 19.x	49.8		0.5	0.1	0.4	83	2,416	32,576		0.075	21.3	61.7	71.9	420.4	444.6
19.1	19	19.2	18.3		0.8	0.2		77	2,570	4,977		0.031	41.9	15.0	17.9		
19.2	19.1	19.6	17.5		0.6	0.4		79	1,507	5,078		0.033	24.9	18.7	22.1		
19.3	19	19.7	11.3		0.5	0.25	0.25	90	1,778	3,483		0.036	18.8	16.6	19.0		
19.4	19		9.3				1	95	870	2,572		0.032	8.9	16.7	18.9		
19.5	19		25.5		0.5	0.1	0.4	93	1,874	7,724		0.035	17.4	39.9	45.3		
19.6	19.2		58.2		0.5	0.5		80	3,247	27,124		0.054	35.3	56.1	66.1		
19.7	19.3		12.7		0.8	0.2		82	1,682	7,920		0.072	16.9	16.4	19.2		
19.8	19		22.5		0.2	0.6	0.2	89	1,798	13,632		0.070	14.1	35.0	40.0		
19.9	19		224.6		0.3	0.7		78	6,764	164,024		0.084	53.9	170.3	202.5		
19.10	19		123.8		0.1	0.9		85	5,876	193,529		0.179	26.2	15,012.0	174.0		
20	Pacific		36.4		0.3	0.7		81	1,894	33,753		0.107	15.7	104.5	121.8	104.5	121.8
21	Pacific		16.3			1		79	832	27,085		0.191	6.5	61.9	72.5	61.9	72.5
22	Pacific		66.0		0.5	0.5		87	3,093	20,968		0.037	32.4	77.3	89.1	77.3	89.1
23	Pacific	23.1	39.3			0.6	0.4	84	2,203	9,938		0.029	30.8	44.0	51.2	93.5	108.1
23.1	23		36.4		0.5	0.25	0.25	87	1,991	14,633		0.046	20.2	49.8	57.4	49.8	57.4
24	Pacific		12.2			1		80	792	15,733		0.148	6.8	17.3	20.2	17.3	20.2
25	Chetco		32.5		0.1	0.9		79	2,241	39,728		0.141	16.7	39.1	46.1	39.1	46.1
26	Chetco		21.3		0.9	0.1		72	1,816	16,266		0.088	21.8	19.2	23.3	19.2	23.3
27	Chetco		125.3		0.1	0.9		81	4,619	106,723		0.098	33.5	126.4	148.5	126.4	148.5
28	Chetco		44.2		0.6	0.4		79	774		14,581	0.152	6.9	61.0	71.8	61.0	71.8
29	Chetco		32.4			1		75	1,566		12,478	0.177	12.6	37.2	44.5	37.2	44.5
30	Chetco		69.7			1		77	3,711		37,827	0.249	19.9	75.7	90.0	75.7	90.0
31	Chetco		51.1			1		76	2,183		31,332	0.282	12.6	60.5	72.1	60.5	72.1

Table 6.2: Subbasin Modelling Summaries (Continued)
(SBUH Model)

Subbasin No.	Discharges To:	Receives Flow From:	Area (Ac.)	Hydrologic Soil Group (Approx. Decimal Fraction) A	B	C	D	Curve Number CN	Hydraulic Length (LF)	Contour Length 5 Ft. Contours (LF)	20 Ft. Contours (LF)	Average Slope (ft./ft.)	T_c (min.)	Subbasin Peak Flow 25-yr (cfs)	50-yr (cfs)	Total Flow 25-yr (cfs)	50-yr (cfs)
32	Chetco		511.0		0.15	0.85		73	9,469		386,957	0.348	40.0	377.0	456.6	377.0	456.6
33	Chetco		136.3			1		76	3,247		79,852	0.269	17.7	148.8	177.5	148.8	177.5
34	Chetco		1226.0		0.4	0.6		71	11,402		1,054,663	0.395	46.0	793.2	969.4	793.2	969.4
35	Chetco		519.4		0.1	0.9		73	6,551		399,699	0.353	29.6	435.0	526.1	435.0	526.1
36	Chetco		197.8		0.05	0.95		73	4,947		101,939	0.237	28.8	167.4	202.4	167.4	202.4
37	Chetco		195.2		0.3	0.7		70	7,499		120,990	0.285	39.8	129.7	159.1	129.7	159.1
38	Chetco		138.1		0.45	0.55		64	2,899		98,454	0.327	20.3	93.6	118.0	93.6	118.0
39	Chetco		200.2		0.05	0.85	0.1	74	3,749		527,103	1.209	9.9	233.0	279.5	233.0	279.5
40	Chetco	Subbasins 40.x	3520.0		0.05	0.95		70	24,149		2,249,930	0.294	131.9	1,323.4	1,623.6	2,450.9	3,365.5
40.1	40		46.4			1		78	2,416		17,778	0.176	16.3	54.8	64.8	54.8	64.8
40.2	40		83.4			1		75	3,846		37,005	0.204	24.0	80.4	96.3	80.4	96.3
40.3	40		977.9		0.05	0.95		72	11,460		507,216	0.238	57.9	590.8	719.6	590.8	719.6
40.4	40		304.8			1		71	3,943		209,258	0.315	22.0	265.4	323.2	265.4	323.2
40.5	40		726.3		0.1	0.9		69	8,774		461,048	0.292	45.9	436.2	538.0	436.2	538.0
41	Chetco		180.8		0.3	0.7		66	4,638		162,833	0.414	25.0	124.2	155.1	124.2	155.1
42	Chetco		31.8		0.4	0.6		64	2,879		31,805	0.460	17.1	22.7	28.6	22.7	28.6
43	Chetco		196.1		0.2	0.8		67	4,175		152,357	0.357	24.1	142.3	176.7	142.3	176.7
44	Chetco		349.0		0.05	0.95		75	3,614		249,890	0.329	18.0	368.1	440.7	368.1	440.7
45	Chetco		45.7		0.25	0.5	0.25	77	2,396	78,164		0.196	15.8	52.9	62.8	52.9	62.8
46	Chetco		62.8				1	93	754	17,507		0.032	8.7	110.3	125.1	110.3	125.1
47	Chetco	47.1	28.9		1			68	2,532	37,138		0.148	24.5	21.7	26.8	224.0	268.5
47.1	47		206.5		0.1	0.9		76	5,314		136,256	0.303	24.8	202.8	242.2	202.8	242.2
48	Chetco	48.1	25.2		1			81	2,203	22,926		0.104	17.9	31.4	36.8	75.7	89.4
48.1	48		40.3		0.5	0.5		78	2,899	57,423		0.164	19.6	45.2	53.6	45.2	53.6
49	Chetco	49.1	50.5		0.8	0.2		78	2,377	67,742		0.154	17.2	58.7	69.5	146.8	178.1
49.1	49		114.2		0.5	0.5		69	4,252		87,054	0.350	23.4	90.6	111.3	90.6	111.3
50	Chetco	50.1	57.5		1			75	2,977	45,771		0.091	29.2	51.6	61.9	108.4	128.5
50.1	50		45.6		0.4	0.6		81	2,744	84,368		0.213	15.0	59.2	69.4	59.2	69.4
51	Pacific		27.7		0.8	0.2		73	561	23,777		0.099	7.8	32.2	38.8	32.2	38.8
52	Chetco	52.1	95.8		0.65	0.3	0.05	79	3,652	87,248		0.105	28.6	97.4	115.1	251.4	311.0
52.1	52		278.6		0.5	0.5		64	5,759		273,725	0.451	30.0	163.0	206.2	163.0	206.2
53	Pacific	53.1	131.1		0.5	0.5		77	4,735	43,859		0.038	61.6	90.8	108.4	142.8	171.0
53.1	53		49.0		0.4	0.6		74	2,087	103,055		0.241	13.9	53.5	64.3	53.5	64.3
54	Pacific		98.9		0.6	0.35	0.05	73	2,241	42,697		0.050	33.4	78.9	95.5	78.9	95.5
55	Pacific	55.1	98.0		0.7	0.1	0.2	74	5,527	33,168		0.039	75.6	55.8	67.5	189.1	236.4
55.1	55		232.6		0.9	0.1		64	4,542	652,772		0.322	29.4	137.3	173.6	137.3	173.6
56	Pacific		21.4		0.1	0.1	0.8	82	2,241	6,090		0.033	31.4	22.7	26.6	22.7	26.6
57	Pacific		7.5		0.4	0.6		71	696	4,325		0.067	12.0	7.6	9.3	7.6	9.3
58	Pacific	58.1	113.8		0.3	0.5	0.2	78	3,827	36,720		0.037	51.4	88.1	104.8	185.4	225.7
58.1	58		146.1		0.95	0.05		68	4,697	336,944		0.265	30.0	101.5	125.5	101.5	125.5
59	Pacific	59.1	48.2		0.6	0.4		74	3,208	15,155		0.036	50.8	33.1	40.0	73.9	91.5
59.1	59		67.2		1			65	4,155	180,835		0.309	27.2	42.8	53.8	42.8	53.8
60	Pacific		41.5		1			70	2,029	25,143		0.070	28.3	31.8	39.0	31.8	39.0
61	Pacific	61.1	71.6		0.9	0.1		72	3,168	36,837		0.059	41.6	50.2	61.0	186.9	234.2
61.1	61		255.8		1			64	5,663		170,000	0.305	36.0	138.2	174.9	138.2	174.9
62	Pacific		10.3		0.7	0.1	0.2	73	754		1,886	0.084	10.7	11.5	13.8	11.5	13.8
63	Pacific	63.1	67.9		0.6	0.4		77	3,730		8,445	0.057	41.8	55.8	66.6	152.6	188.2
63.1	63		152.0		1			65	4,232		116,195	0.350	25.9	99.0	124.3	99.0	124.3
64	Pacific	64.1	54.1		0.9	0.1		71	3,923		4,419	0.038	63.6	30.1	36.9	135.7	171.3
64.1	64		220.7		1			63	6,783		151,275	0.315	42.0	106.3	135.4	106.3	135.4

Table 6.3: Culvert Capacitity Evaluation

Subbasin	Culvert/ Pipe Description(s)	Pipe Diameter (in.)	Total Cross-sec Area (sq.ft.)	Capacities @3fps (cfs)	Capacities @10fps (cfs)	25-year event Flow (cfs)	25-year event Avg. Velocity Required to Accomodate Flow (fps)	25-year event % of Capacity @ 3 fps	25-year event % of Capacity @ 10 fps	50-year event Flow (cfs)	50-year event Avg. Velocity Required to Accomodate Flow (fps)	50-year event % of Capacity @ 3 fps	50-year event % of Capacity @ 10 fps
2	8'x8' BC Hwy Xing		64.00	192.0	640.0	1058.8	16.5	551.5	165.4	1290.5	20.2	672.1	201.6
3	Hwy Xing	24	3.14	9.4	31.4	16.8	5.3	178.3	53.5	21.4	6.8	227.1	68.1
4	4'x4' BC Hwy Xing		16.00	48.0	160.0	97.2	6.1	202.5	60.8	130.8	8.2	272.5	81.8
4.A	Hwy Xing	24	3.14	9.4	31.4	13.7	4.4	145.4	43.6	16.8	5.3	178.3	53.5
5	Hwy Xing	30	4.91	14.7	49.1	58.9	12.0	400.0	120.0	72.9	14.9	495.0	148.5
6	Hwy Xing	24	3.14	9.4	31.4	9.1	2.9	96.6	29.0	10.9	3.5	115.7	34.7
7	Hwy Xing	30	4.91	14.7	49.1	61.4	12.5	416.9	125.1	75.9	15.5	515.4	154.6
8	6'x6' BC Hwy Xing		36.00	108.0	360.0	370.2	10.3	342.8	102.8	477.3	13.3	441.9	132.6
10.1	6'x6' BC Hwy Xing		36.00	108.0	360.0	427.0	11.9	395.4	118.6	527.7	14.7	488.6	146.6
14.1	Hwy Xings												
	(4-18"; 48"; 6'x6' BC)		55.64	166.9	556.4	868.7	15.6	520.5	156.1	1055.0	19.0	632.1	189.6
16	3'x3' BC Hwy Xing		9.00	27.0	90.0	150.0	16.7	555.7	166.7	186.9	20.8	692.1	207.6
17.1	Hwy Xings (2-24")		6.28	18.8	62.8	55.7	8.9	295.3	88.6	65.2	10.4	345.6	103.7
18	5'x5' BC Hwy Xing		25.00	75.0	250.0	473.6	18.9	631.5	189.4	585.0	23.4	780.0	234.0
19.1	Outlet to Subbas #19	48	12.57	37.7	125.7	73.3	5.8	194.5	58.3	75.6	6.0	200.5	60.2
	To 48" Outlet	36	7.07	21.2	70.7	73.3	10.4	345.8	103.7	75.6	10.7	356.5	106.9
19.2	Outlet to Subbas #19.1	36	7.07	21.2	70.7	74.7	10.6	352.3	105.7	88.1	12.5	415.6	124.7
	near Rowland Ln. and Smith	30	4.91	14.7	49.1	74.7	15.2	507.3	152.2	88.1	18.0	598.5	179.6
	near Rowland Ln. and Smith	24	3.14	9.4	31.4	74.7	23.8	792.7	237.8	88.1	28.1	935.2	280.6
19.3	near Outlet	15	1.23	3.7	12.3	25.9	21.1	703.0	210.9	28.2	23.0	767.1	230.1
	near Outlet	18	1.77	5.3	17.7	25.9	14.6	488.2	146.5	28.2	16.0	532.7	159.8
	Outlet	24	3.14	9.4	31.4	25.9	8.2	274.6	82.4	28.2	9.0	299.6	89.9
19.5	near Outlet	18	1.77	5.3	17.7	33.9	19.2	640.0	192.0	45.3	25.6	854.5	256.3
	near Outlet	24	3.14	9.4	31.4	33.9	10.8	360.0	108.0	45.3	14.4	480.6	144.2
	Outlet to Subbas #19	60	19.64	58.9	196.4	33.9	1.7	57.6	17.3	45.3	2.3	76.9	23.1
19.6	Hwy Xing	24	3.14	9.4	31.4	56.1	17.8	594.7	178.4	66.1	21.0	701.2	210.4
19.7	Hwy Xing	18	1.77	5.3	17.7	16.4	9.3	309.7	92.9	19.2	10.9	362.0	108.6
19.8	Hwy Xing (24" only)	24	3.14	9.4	31.4	35.0	11.1	370.8	111.2	40.0	12.7	424.5	127.4
	Hwy Xings (24" and 18")		4.91	14.7	49.1	35.0	7.1	237.3	71.2	40.0	8.2	271.7	81.5
	Hwy Xings (24" and 30")		8.05	24.2	80.5	35.0	4.3	144.7	43.4	40.0	5.0	165.7	49.7
19.9	Hwy Xing	48	12.57	37.7	125.7	170.3	13.5	451.6	135.5	202.5	16.1	537.1	161.1
	Near 48" Line	36	7.07	21.2	70.7	170.3	24.1	802.9	240.9	202.5	28.6	954.9	286.5
19.10	Hwy Xing	36	7.07	21.2	70.7	150.1	21.2	707.9	212.4	174.0	24.6	820.4	246.1
	across Fern Ave.	48	12.57	37.7	125.7	150.1	11.9	398.2	119.5	174.0	13.8	461.5	138.4
20	Outlet (12",15",24")		5.15	15.5	51.5	104.5	20.3	675.6	202.7	121.8	23.6	787.8	236.4
22	Outlet (3-12",18",24",30")		12.17	36.5	121.7	77.3	6.3	211.7	63.5	89.1	7.3	244.0	73.2
23	Outlet	48	12.57	37.7	125.7	93.5	7.4	247.9	74.4	108.1	8.6	286.8	86.1
23.1	Outlet	36	7.07	21.2	70.7	49.8	7.0	234.9	70.5	57.4	8.1	270.5	81.2
27	4'x4' BC Outlet and 24" Outlet		19.14	57.4	191.4	126.4	6.6	220.1	66.0	148.5	7.8	258.6	77.6
29	Hwy Xing	48	12.57	37.7	125.7	37.2	3.0	98.7	29.6	44.5	3.5	118.0	35.4
30	Hwy Xing	24	3.14	9.4	31.4	75.7	24.1	802.8	240.8	90.0	28.6	954.8	286.4
31	Hwy Xings (15" and 22")		3.87	11.6	38.7	60.5	15.6	521.3	156.4	72.1	18.6	621.2	186.3
32	Hwy Xings (78"x128")		55.47	166.4	554.7	377.0	6.8	226.5	68.0	456.6	8.2	274.4	82.3
33	Hwy Xings												
	(15", 4-18", 20", 2-24")		16.76	50.3	167.6	148.8	8.9	295.9	88.8	177.5	10.6	353.0	105.9

Table 6.3: Culvert Capacitity Evaluation (Cont.)

Subbasin	Culvert/ Pipe Description(s)	Pipe Diameter (in.)	Total Cross-sec Area (sq.ft.)	Capacities @3fps (cfs)	Capacities @10fps (cfs)	25-year event Flow (cfs)	25-year event Avg. Velocity Required to Accomodate Flow (fps)	25-year event % of Capacity @ 3 fps	25-year event % of Capacity @ 10 fps	50-year event Flow (cfs)	50-year event Avg. Velocity Required to Accomodate Flow (fps)	50-year event % of Capacity @ 3 fps	50-year event % of Capacity @ 10 fps
34	Hwy Xings												
	(8'x8' BC, 15", 24")		68.37	205.1	683.7	*793.2*	11.6	386.7	116.0	*969.4*	14.2	472.6	141.8
35	Hwy Xings												
	(2-18", 2-20", 2-24", 36", 48",												
	and 60")		53.45	160.4	534.5	*435.0*	8.1	271.3	81.4	*526.1*	9.8	328.1	98.4
36	Hwy Xings												
	(15", 6-18", 36")		18.90	56.7	189.0	*167.4*	8.9	295.2	88.6	*202.4*	10.7	357.0	107.1
37	Hwy Xing	48	12.57	37.7	125.7	*129.7*	10.3	344.0	103.2	*159.1*	12.7	422.1	126.6
38	Hwy Xings												
	(5-16", 2-18", 24", 5-36")		49.00	147.0	490.0	*93.6*	1.9	63.7	19.1	*118.0*	2.4	80.3	24.1
41	Hwy Xing	48	12.57	37.7	125.7	*124.2*	9.9	329.4	98.8	*155.1*	12.3	411.3	123.4
42	Hwy Xing	24	3.14	9.4	31.4	*22.7*	7.2	240.7	72.2	*28.6*	9.1	303.2	91.0
43	Hwy Xings												
	(18",2-30", 2-36")		25.72	77.2	257.2	*142.3*	5.5	184.4	55.3	*176.7*	6.9	229.0	68.7
44	Hwy Xings												
	(12", 6-18", 3-24", 1-28", 2-36")		39.23	117.7	392.3	*368.1*	9.4	312.8	93.8	*440.7*	11.2	374.5	112.4
45	Hwy Xings												
	(2-24")		6.28	18.8	62.8	*52.9*	8.4	280.5	84.1	*62.8*	10.0	333.3	100.0
47	Outlets												
	(18", 36", 42")		18.46	55.4	184.6	*224.0*	12.1	404.6	121.4	*268.5*	14.5	484.8	145.4
47.1	Hwy Xing	48	12.57	37.7	125.7	*202.8*	16.1	537.9	161.4	*242.2*	19.3	642.5	192.7
48	Harbor Rd. Xing	36	7.07	21.2	70.7	*75.7*	10.7	357.2	107.1	*89.4*	12.6	421.5	126.5
48.1	Hwy Xing	36	7.07	21.2	70.7	*45.2*	6.4	213.1	63.9	*53.6*	7.6	252.5	75.8
49	Harbor Rd. Xing (18", 42")		11.39	34.2	113.9	*146.8*	12.9	429.6	128.9	*178.1*	15.6	521.1	156.3
49.1	Hwy Xing	48	12.57	37.7	125.7	*90.6*	7.2	240.2	72.1	*111.3*	8.9	295.3	88.6
50	Harbor Rd. Xing	48	12.57	37.7	125.7	*108.4*	8.6	287.4	86.2	*128.5*	10.2	340.9	102.3
50.1	Hwy Xings												
	(18", 24")		4.91	14.7	49.1	*59.2*	12.1	402.1	120.6	*69.4*	14.1	471.2	141.4
52	Harbor Rd. Xing	82	36.67	110.0	366.7	*251.4*	6.9	228.5	68.5	*311.0*	8.5	282.7	84.8
52.1	Hwy Xing	48	12.57	37.7	125.7	*163.0*	13.0	432.5	129.7	*206.2*	16.4	547.0	164.1
53	Ocean View Xings												
	(24", 48")		15.71	47.1	157.1	*142.8*	9.1	303.1	90.9	*171.0*	10.9	362.8	108.8
53.1	Hwy Xing	24	3.14	9.4	31.4	*53.5*	17.0	568.0	170.4	*64.3*	20.5	682.0	204.6
54	Ocean View Xings												
	(2-24")		6.28	18.8	62.8	*78.9*	12.6	418.6	125.6	*95.5*	15.2	506.7	152.0
55	Ocean View Xings												
	(72", 18"x30")		31.27	93.8	312.7	*189.1*	6.0	201.5	60.4	*236.3*	7.6	251.8	75.5
55.1	Hwy Xings												
	(24", 2-48")		28.27	84.8	282.7	*137.3*	4.9	161.8	48.6	*173.6*	6.1	204.7	61.4
56	Ocean View Xing	24	3.14	9.4	31.4	*22.7*	7.2	240.7	72.2	*26.6*	8.5	281.8	84.5
58	Ocean View Xings												
	(24", 72")		31.42	94.2	314.2	*185.4*	5.9	196.7	59.0	*225.7*	7.2	239.5	71.8
58.1	Hwy Xings												
	(18", 24")		4.91	14.7	49.1	*101.5*	20.7	689.0	206.7	*125.5*	25.6	852.4	255.7
59	Hwy Xing	36	7.07	21.2	70.7	*73.9*	10.5	348.6	104.6	*91.5*	12.9	431.2	129.4
59.1	Hwy Xings												
		24	3.14	9.4	31.4	*42.8*	13.6	454.1	136.2	*53.8*	17.1	570.5	171.2

Table 6.3: **Culvert Capacitity Evaluation (Cont.)**

Subbasin	Culvert/ Pipe Description(s)	Pipe Diameter (in.)	Total Cross-sec Area (sq.ft.)	Capacities @3fps (cfs)	Capacities @10fps (cfs)	25-year event Flow (cfs)	25-year event Avg. Velocity Required to Accomodate Flow (fps)	25-year event % of Capacity @ 3 fps	25-year event % of Capacity @ 10 fps	50-year event Flow (cfs)	50-year event Avg. Velocity Required to Accomodate Flow (fps)	50-year event % of Capacity @ 3 fps	50-year event % of Capacity @ 10 fps
60	Ocean View Xings												
	(2-24")		6.28	18.8	62.8	*31.8*	5.1	168.8	50.6	*39.0*	6.2	206.7	62.0
61	Ocean View Xings												
	(24", 76"x64")		30.16	90.5	301.6	*186.9*	6.2	206.5	62.0	*234.2*	7.8	258.8	77.6
61.1	Hwy Xing (18", 36")		8.84	26.5	88.4	*138.2*	15.6	521.1	156.3	*174.9*	19.8	659.5	197.9
63	Ocean View Xings												
	(12", 60"x72")		24.79	74.4	247.9	*152.6*	6.2	205.2	61.6	*188.2*	7.6	253.1	75.9
63.1	Hwy Xing												
	(18", 2-30", 36")		18.65	56.0	186.5	*99.0*	5.3	176.9	53.1	*124.3*	6.7	222.1	66.6
64	Ocean View Xing	84	38.48	115.5	384.8	*135.7*	3.5	117.5	35.3	*171.3*	4.5	148.4	44.5
64.1	Hwy Xing	48	12.57	37.7	125.7	*106.3*	8.5	282.0	84.6	*135.4*	10.8	359.2	107.8
	(upstream of 48")	36	7.07	21.2	70.7	*106.3*	15.0	501.4	150.4	*135.4*	19.2	638.6	191.6

6.5 INTERPRETATION OF RESULTS

6.5.1 General

The following subsections consider modelling results in relation to existing development, infrastructure, future growth, and other issues. Subsections are based on geographic proximity or similarity of the subbasins involved. Table 6.4 provides a key that indicates where discussions relevant to the individual subbasins are located.

In general, storm water pipelines and culverts throughout the study area, do not meet capacity requirements to accommodate the 25-year, 24-hour modeled peak flow at typical design velocities of 3 feet per second (fps). With additional pipe slope (common in hillside construction and roadway crossings), or potential for surcharging (pooling) upstream, it is possible to achieve considerably higher flows. 3-10 fps is a common operating range and flows in excess of 10 fps may also be accommodated, though such high flows could result, in some cases, in damage to the infrastructure. Pipe elevation and location data was not precise enough to estimate actual pipe capacities. Capacity estimates are therefore somewhat probabilistic in nature: it is likely that most pipes will carry at least 3 fps, many will carry 3-10 fps, and some will carry flows in excess of 10 fps.

The overall modelling effort appears to be conservatively high in its flow estimates. This is evidenced by the relative lack of reported problems associated with existing infrastructure. More basin detention could be occurring than is incorporated in the SBUH model; however, addressing this supposition would require considerable data acquisition and analysis. Much of the existing infrastructure was designed to accommodate recurrence intervals of less than 25 years. The 1985 Brookings Storm Drainage Development Plan used a 5-year recurrence interval for the design basis. It also used the Rational Method (which typically results in higher design flows than the SBUH model) and designs flows of 2.5-5.0 fps. With allowances for surcharging, such infrastructure is likely to be adequate for events well beyond the 5-year, 24-hour event. Given the investment and extent of the existing infrastructure, the relative lack of manifest problems, the possibility of model over-prediction, the following approach is incorporated herein:

1) Assume future development will be required to maintain pre-development flows off-site.

2) Assume existing infrastructure is hydraulically adequate except where

specific problems have been noted.

3) In general, new or replacement infrastructure should be sized for the 25-year, 24-hour peak event. An exception is ODOT crossings which will have to follow current ODOT Standards where design is based on the 50-year event. Another exception is in areas where the City or County Engineer believe the increased sizing is either inconsistent with connecting infrastructure or would otherwise adversely impact downstream areas.

Table 6.4: Subbasin Discussion Key

Subbasin No.	Discussion in Section No.	Subbasin No.	Discussion in Section No.	Subbasin No.	Discussion in Section No.
1	6.5.2	19.8	6.5.6	45	6.5.12
2	6.5.2	19.9	6.5.6	46	6.5.15
2.1	6.5.2	19.10	6.5.6	47	6.5.14
3	6.5.2	20	6.5.5	47.1	6.5.13
4	6.5.2	21	6.5.5	48	6.5.14
4.1	6.5.2	22	6.5.8	48.1	6.5.13
4.A	6.5.2	23	6.5.8	49	6.5.14
5	6.5.2	23.1	6.5.8	49.1	6.5.13
5.1	6.5.2	24	6.5.5	50	6.5.14
6	6.5.2	25	6.5.6	50.1	6.5.13
7	6.5.2	26	6.5.6	51	6.5.18
8	6.5.2	27	6.5.9	52	6.5.14
9	6.5.5	28	6.5.6	52.1	6.5.13
10	6.5.3	29	6.5.9	53	6.5.17
10.1	6.5.3	30	6.5.9	53.1	6.5.16
11	6.5.5	31	6.5.9	54	6.5.18
12	6.5.5	32	6.5.10	55	6.5.17
13	6.5.5	33	6.5.10	55.1	6.5.16
14	6.5.3	34	6.5.10	56	6.5.17
14.1	6.5.3	35	6.5.10	57	6.5.18
15	6.5.5	36	6.5.10	58	6.5.17
16	6.5.4	37	6.5.10	58.1	6.5.16
17	6.5.5	38	6.5.10	59	6.5.17
17.1	6.5.8	39	6.5.11	59.1	6.5.16
18	6.5.4	40	6.5.11	60	6.5.18
18.A	6.5.5	40.1	6.5.11	61	6.5.17
19	6.5.6	40.2	6.5.11	61.1	6.5.16
19.1	6.5.6	40.3	6.5.11	62	6.5.18
19.2	6.5.6	40.4	6.5.11	63	6.5.17
19.3	6.5.6	40.5	6.5.11	63.1	6.5.16
19.4	6.5.6	41	6.5.12	64	6.5.17
19.5	6.5.6	42	6.5.12	64.1	6.5.16
19.6	6.5.6	43	6.5.12		
19.7	6.5.6	44	6.5.12		

6.5.2 North UGB Extension

This subsection includes subbasins numbered 1 through 8.

The northern extension of the UGB and City limits constitute the Lone Ranch Master Plan area. Major drainages include Lone Ranch Creek and its tributary, Duley Creek; Ram Creek and Taylor Creek. The UGB area consists of forested hillsides with nominal development exclusive of the Highway 101 right-of-way. The area uphill and tributary to the UGB is primarily forested with scattered low density residential development. Subbasin 1 is primarily wooded with very little development. Most of Subbasin 1 is included in Samuel Boardman State Park and outside the UGB.

The proposed Lone Ranch development is one of the two major developments anticipated for the study area (see section 3.2.3). Development proposals[3] include a provision for detaining the 25-year, 24-hour design storm and releasing it at rates not exceeding pre-development conditions. Water quality facilities (bio-filtration swales, filter strips, and ponds) are also proposed with a design basis of two-thirds of the 2-year, 24-hour design storm.

In the area uphill and tributary to the UGB, anticipated development is nominal - even with recent modifications of the RR-5 and RR-10 zoning to allow one dwelling unit per 2 acres. Development in Subbasin 1 is also anticipated to be nominal.

Infrastructure within the UGB is limited to culvert crossings of Highway 101. Model results for the area are probably conservative since they do not take into account potential detention associated with wetlands known to exist within the UGB. No specific problems have been noted for this area. Based on the developer's proposed approach, there should be limited impact on downstream infrastructure. Subbasin 1 includes multiple flow paths (subbasins); individual developments need to determine the area impacted and design accordingly. Detention in Subbasin 1 should not be needed; however, adequate erosion protection is essential.

6.5.3 Shy Creek and Harris Creek Basins

This subsection includes subbasins numbered 10, 10.1, 14, and 14.1.

The Shy Creek drainage is largely wooded and underdeveloped. Subbasin 10.1 is almost entirely outside the UGB. It includes limited, scattered, low density

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3 *Lone Ranch Master Plan Utilities Report*, Otak, Inc., April 2004

residential development and the edge of the larger industrial area near Highway 101 (Subbasin 14.1). Subbasin 10 is within the UGB (and City limits) and is largely wooded on the hillsides above Shy Creek; residential development occurs along the north and south boundary of Subbasin 10.

The Harris Creek drainage includes extensive wooded areas in the basin above and along the creek. Subbasin 14.1 includes the north half of the airport and a very large wood products industrial development near Highway 101. The southwest part of Subbasin 14.1 that is located within the City limits includes a fairly dense residential subdivision (Harbor Heights). Subbasin 14 is largely within the City limits; development is primarily residential along the north boundary.

Development potential within the area is limited with the possible exception of redevelopment, or limited expansion in or near the existing subdivisions.

Infrastructure within the Shy Creek basin is limited to the 6' x 6' box culvert across Highway 101. No problems have been noted.

Infrastructure within the Harris Creek basin is more extensive. The Highway 101 crossings include a 6' x 6' culvert with considerable potential for head development associated with surcharging; consequently, capacity potential is probably adequate. Problems have occurred at the detention pond (off Highway 101 and Glenwood Drive) associated with the Harris Heights Subdivision (PA1). Further development in the area should address, by the developer, performance and maintenance issues associated with the detention pond and outlet.

6.5.4 Eiler Creek and Ransom Creek Basins

This subsection includes subbasins numbers 16 and 18.

The Eiler Creek basin (subbasin 16) extends up to the airport and, within the upper two-thirds of the subbasin, is largely developed with relatively low density residential development and scattered, denser clusters of residences. The lower one-third is occupied by the predominantly wooded Harris Beach State Park. The City/County boundary is highly complex within the subbasin. Development potential is largely limited to infill of undeveloped lots or redevelopment.

Ransom Creek (Subbasin 18) is largely within the UGB. The area outside the UGB is largely wooded with nominal development potential; approximately, one-half of the area within the UGB is also wooded with nominal development potential (due to

steep topography). Developed areas include the south half of the airport and associated commercial development, and relatively dense urban residential development predominantly on the southwest side of Subbasin 18. Subbasin 18 has limited development potential.

Infrastructure within the subbasins tends to serve smaller areas that drain directly to the creeks. The Ransom Creek crossing of Highway 101 is a 5' x 5' box culvert. A flow velocity of approximately 19 fps would be needed to accommodate the 474 cfs (25-year event) flow. The crossing is set deep in a ravine; consequently, short-term surcharging would likely provide enough head to achieve the needed velocities. No problems have been noted, but the area upstream of the culvert is shown as a floodplain on FEMA maps. There are no problem areas of note other than the ditches along Ransom Avenue that tend to collect debris (PA2) and a catch basin at Ransom Avenue and Third Street that tends to become obstructed (PA3).

6.5.5 Coastal Brookings

This subsection includes subbasins numbers 9, 11, 12, 13, 15, 17, 18A, 20, 21, and 24.

The coastal subbasins named above share common characteristics: they are largely built out and typically include a moderately steep to extremely steep drop to the beaches below. In addition, they typically have multiple drainage paths and may only contribute a limited flow to subbasins discharging across them. Development is almost exclusively residential with the notable exception of the wooded Harris Beach State Park (Subbasin 15) and the industrial areas, wastewater treatment facility, and City park located in Subbasin 20.

Infrastructure is generally limited with the exception of Subbasins 12 and 13. There are no noted problems.

6.5.6 Macklyn Creek Basin

This subsection includes subbasin number 19 and subbasins numbered 19.1 through 19.10.

The Macklyn Creek basin largely defines the City of Brookings urban core. Commercial development is largely concentrated along either side of Highway 101. The largest commercial development is Fred Meyer. The store and parking lot constitute most of Subbasin 19.4. Subbasin 19 includes extensive industrial (wood

products) development. Relatively dense single and multi-family residential development extends throughout the basin outside of the commercial/industrial/institutional core. Natural and underdeveloped areas are limited - primarily steeper hillsides, and riparian areas near Macklyn Creek. Subbasin 19 also includes a large mill pond and adjacent wetland that provides flow equalization and water quality improvements to lower Macklyn Creek prior to its discharge to the Pacific Ocean.

Development potential is relatively limited; however, some subbasins, such as Subbasin 19.7, have a relatively large underdeveloped area relative to the overall subbasin area. Redevelopment and infill are also possibilities within the Macklyn Creek basin.

The Macklyn Creek basin represents the most highly developed and complete stormwater infrastructure within the study area. Existing infrastructure is dominated by the 60" diameter central trunk line that runs along Fifth Street from just south of Highway 101 to its discharge just south of Railroad Street.

Subbasin 19.8 includes one known (24") highway crossing (which is inferred to connect to the 60" trunk line) and one inferred crossing that connects the 18" line (Subbasin 19.8) to the 30" line (Subbasin 19.4). Modelled capacities appear to be adequate and there are no noted problems.

Subbasin 19.4 discharges to the trunk line. The only noted problem is related to maintenance of the drainage swale (PA10).

Subbasin 19.7 discharges to Subbasin 19.3 via an 18" connection (the connection was not located during a field survey, but does appear in the 1985 Storm Drainage Plan). In Subbasin 19.3, the 18" line transitions to 15" along Mill Beach Road, then transitions to 18" and 24" lines respectively along Railroad Street. A problem for these subbasins is the impact of bypassed flows from Subbasin 19.6 that get routed to Lucky Lane (PA6) and thereby enter this drainage. Capacity of the 15" and 18" lines in Subbasin 19.3 are questionable based on the modelling.

Subbasin 19.6 discharges to Subbasin 19.2 via an 18" line that transitions to a 24" line under Highway 101. The 24" line daylights to an open channel midway between Pifeld Street and Highway 101 before reentering a 24" line that passes under a building on its way to Pifeld Street. Routing continues via 24", 30", and 36" lines to Subbasin 19.1. The 18" culvert represents an ongoing problem (PA6) due to the lack of capacity. Capacity of the main line through Subbasin 19.2 is also questionable;

currently, there are no noted hydraulic problems, but an improved conveyance from Subbasin 19.6 could result in problems downstream.

Subbasin 19.2 discharges to Subbasin 19.1 via a 36" line, then ditch and 36" line to a 48" crossing of Mill Beach Road to a discharge in Subbasin 19. Much of Subbasin 19.1 flows through a ditch that runs east-west to its discharge near Smith Drive. Problems include the Pine Street crossing (PA7) which is in extremely poor condition, the ditch (PA8) which is difficult to access and keep clear, and the 48" crossing (PA9) which is in poor condition.

Subbasin 19.9 has extensive stormwater infrastructure. Infrastructure in the upper basin tends to reflect more modern sizing with a relatively high presence of larger diameter (such as 18" and 24") lines. Crossings of Ransom Avenue include a 30" line and two parallel 48" lines at Macklyn Creek. Downstream, at Easy Street, the Macklyn Creek crossing consists of parallel 30" and 48" lines. Further downstream, behind City Hall, the entire subbasin drains to a 36" line which transitions to a 48" line before crossing Highway 101 and connecting to the 60" trunk line down Fifth Street. There is a progressive decrease in carrying capacity as flow moves down through Subbasin 19.9. Upstream problems (PA11 and PA12) are primarily maintenance related. The problem of greatest significance is the flood potential at the 36" inlet on Macklyn Creek behind City Hall (PA13). To accommodate the 25-year, 24-hour peak flow (170 cfs), a flow velocity of 24 fps would be required. With a 48" line, the velocity requirement would be 13.5 fps. The velocity is still higher than typical design and may or may not be practically achievable; nevertheless, a 48" line replacing the 36" line, would be consistent with downstream infrastructure and would approximately double existing capacity.

In Subbasin 19.10, South Fork Creek, and drainage along Highway 101, drain to a 36" crossing of Highway 101, then via a 36" line to the 60" trunk line on Fifth Street. Only a maintenance related problem (PA14) associated with minor pooling has been noted; however, capacity issues with the 36" line appear to be similar to those discussed for Subbasin 19.9 above. A pipe velocity of 21 fps would be necessary to accommodate the 25-year, 24-hour peak flow of 71 cfs.

Subbasin 19.5 generally drains toward Railroad Street where it flows via 18" and 24" lines to the 60" trunk line on Fifth Street. No problems are noted for this subbasin.

6.5.7 Brookings Chetco

This subsection includes subbasins number 25, 26, and 28.

These subbasins are within the City limits and extend along the north bank of the Chetco River. Subbasins 25 and 26 are primarily residential and fully developed with the exception of the wooded hillside that extends down to the Chetco River. Subbasin 28 lies between North Bank Road and the Chetco River. Much of this area is relatively low in elevation and parts are likely within the 100-year floodplain. Development in Subbasin 28 is largely limited to the central one-third. Future development in Subbasin 28 is probably limited to the higher elevation areas adjacent to North Bank Road and within the City Limits.

All three subbasins are likely to have multiple drainage paths across each subbasin.

Infrastructure is generally limited and there are no noted problems.

6.5.8 Brookings (Remaining Basins Tributary to Pacific Ocean)

This subsection includes subbasins number 17.1, 22, 23, and 23.1.

This is a catchall category that includes City of Brookings subbasins ultimately tributary to the Pacific Ocean, but not fitting under subsections developed above. All three subbasins are almost fully developed with few buildable vacant lots. Future development is largely limited to redevelopment or infill.

Subbasin 17.1 infrastructure is primarily developed along Highway 101. Noted problems include a slow draining line (possible obstruction) at Easy Street and Second Street (PA4) and a shallow ditch that tends to overtop along Easy Street (PA5).

Subbasins 22, 23, and 23.1 have fairly extensive infrastructure. Hydraulic capacities at the discharge points of each subbasin appear to be adequate with required pipe velocities of 6-7 fps to accommodate the 25-year, 24-hour peak flows. Noted problems in Subbasin 23.1 include: inadequate capacity along Railroad Street (PA16) and at Willow Street and Railroad Street (PA17); and a 30" culvert in poor condition at Railroad Street and Oak Street. Noted problems in Subbasin 23.1 include maintenance issues associated with the ditch between Maple Street and Memory Lane (PA19) and the culvert at Memory Lane and Buena Vista Loop (PA20).

6.5.9 Brookings (Remaining Basins Tributary to Chetco River)

This subsection includes subbasins number 27, 29, 30, and 31.

This is a catchall category that includes City of Brookings subbasins ultimately tributary to the Chetco River, but not fitting under subsections developed above. Most of Subbasin 31 is outside the City limits, but has similar development characteristics. Larger lot, residential development predominates with notable exception of the west one-half Subbasin 27 which includes urban residential development densities and commercial development along Highway 101.

Infrastructure is extensive in Subbasin 27. Subbasin 27 outlet capacities appear to be adequate with a 6.6 fps velocity required to accommodate the 25-year, 24-hour peak flow of 126 cfs. Infrastructure in Subbasins 29, 30, and 31 are largely limited to crossings of North Bank Road. The 24" crossing in Subbasin 30 appears to have insufficient capacity based on the modelling; however, flow patterns in the upper part of the subbasin should be examined more carefully to verify subbasin delineation prior to increasing the crossing capacity. A noted problem in Subbasin 27 is the potential obstruction and bypass of flow and gravel on to Old County Road (PA15).

6.5.10 Chetco River North Bank

This subsection includes subbasins numbered 32 through 38.

These subbasins define the study area along the North Bank of the Chetco River. The UGB defines a relatively narrow band of low density residential development, though tree cover still predominates. Hillsides above the UGB are forested and generally undeveloped with the notable exception of the large lot Mountain Drive subdivision in Subbasin 35. Development potential in the areas above the UGB are nominal. Subbasin 32 defines the Ferry Creek basin. The City of Brookings holds water rights on Ferry Creek Reservoir. The City also has water rights on Joe Hall Creek (Subbasin 34). The Brookings' Water Treatment Plant is located just upstream of the confluence of Joe Hall Creek and the Chetco River. Subbasin 34 includes a 20 acre (100 unit) development near the Chetco River that has been planned and designed, but not yet constructed. Subbasins 36, 37, and 38 are still resource zoned within the UGB - a re-zoning would be needed to allow for new development. Development densities would be low (likely one dwelling unit per two acres).

Infrastructure in these subbasins is largely limited to crossings of North Bank Road. There are no noted capacity or problem issues. The Couty has lined or replaced many pipes along North Bank Road.

6.5.11 Jack Creek Basin

This subsection includes subbasins 39, 40, 40.1, 40.2, 40.3, 40.4, and 40.5.

These subbasins define the Jack Creek basin, although parts of Subbasins 40 and 40.4, and all of Subbasins 39, discharge by various paths, directly to the Chetco River. Major drainages, other than Jack Creek, include Hamilton Creek (Subbasin 40.3) and Jordan Creek (Subbasin 40.5). Overall, the area is predominantly undeveloped wooded hillsides. The UGB includes the lower stretch of Jack Creek, which upstream of the South Bank Road bridge, is occupied by the Salmon River Golf Course. There is some limited low density residential development along South Bank Road east of the golf course (Subbasins 39 and 40.1). Gravel operations are located near the river (Subbasin 39) and near the South Bank Road (Subbasin 40.4). Subbasin 40.4 is almost entirely outside the UGB and, other than the gravel operation, undeveloped. Subbasin 40.2 is also outside the UGB; Subbasin 40.3 is, but for a few acres, also outside the UGB. The upper one-fourth, approximately, of Subbasin 40.5 is within the UGB and has been identified as having potential for residential development although it is currently zoned Forestry/Grazing.

Infrastructure in these subbasins is largely limited to crossings of South Bank Road and along Crown Terrace Road in Subbasin 44. Jack Creek itself crosses under a bridge on the South Bank Road. Subbasin 40.4 includes two sedimentation basins near the gravel operation above North Bank Road. There are no noted capacity or problem issues except reports of bypassed flows associated with construction in Subbasin 44.

6.5.12 Chetco River South Bank (Jack Creek to Highway 101)

This subsection includes subbasins numbered 41 through 45.

These subbasins define the study area along the south bank of the Chetco River from just below Jack Creek to, approximately, the Highway 101 bridge. Subbasins 41, 42, and 43 are dominated by undeveloped wooded hillsides. These three basins are zoned Forestry/Grazing and have nominal development potential. Subbasin 44 is largely undeveloped and wooded above the South Bank Road. There is some limited and scattered residential development. Zoning in this subbasin is largely residential and predominantly RR-5, a designation that would allow a density of one dwelling unit per two acres for otherwise developable acreage. Above the South Bank Road, Subbasin 45 is almost fully developed with (predominantly) residential units; the hillside between the South Bank Road and the Chetco River is predominantly

wooded and undeveloped. An application for a 60 unit development near the river has been filed with Curry County; nevertheless, access to the area is difficult and limited and development potential may also be limited. The subbasins bordering the river include multiple flow paths to the river.

Infrastructure in these subbasins is largely limited to crossings of South Bank Road and above South Bank Road in Subbasin 45. There are no noted capacity or problem issues.

6.5.13 Harbor East

This subsection includes subbasins numbered 47.1, 48.1, 49.1, 50.1, and 52.1.

The subbasins define an area of the Harbor Hills east of Highway 101, from Tuttle Creek north to Subbasins 44 and 45. Major drainages include Tuttle Creek, Delavan Creek, and Fish House Creek. The lower one-half of Subbasin 47.1 is fully developed (residential) except for riparian areas along the streams; the upper one-half has been largely cleared and is currently being developed (residential). There is currently a problem with providing electrical service to this area; nevertheless, Subbasin 47.1 appears to be on the path of more or less full development. Subbasin 48.1 is largely developed with commercial development along Highway 101 and residential development on the hills above; wooded areas are limited to riparian areas and the uppermost hillside. The lower one-third of Subbasin 49.1 includes a large mall development adjacent to Highway 101 and moderate density residential development above. The remaining area of Subbasin 49.1 is wooded; as are the riparian areas that extend down to the edge of the mall. The upper areas are zoned Forestry/Grazing and would have to be changed to allow for development. The lower one-half Subbasin 50.1 has moderately dense residential and commercial development; the upper one-half one-quarter has low density residential development; and the uppermost area (zoned Forestry/Grazing) is half wooded and half cleared. Subbasin 52.1 is largely undeveloped and wooded; lower density and limited residential and commercial development occurs on the lower hills above Highway 101. Most of Subbasin 52.1 is currently zoned Forestry/Grazing.

Infrastructure in these subbasins is generally limited to the area along or near Highway 101 and in the uphill developed areas on Subbasin 47.1 and 49.1.

Subbasin 47.1 discharges via a 48" (not verified) crossing of Highway 101 to Subbasin 47. A velocity of 16 fps would be necessary to accommodate the 25-year, 24-hour peak flow of 203 cfs. Mapping suggests surcharge potential, therefore

capacity may be adequate. No problems are noted for this subbasin.

In Subbasin 49.1, the 48" crossings of Highway 101, carrying Delavan Creek and discharging to Subbasin 48, extends east under the mall buildings where it branches to a 36" and 42" line and inlet on two branches of Delavan Creek. A velocity of 7.2 fps at the crossing is necessary to accommodate the 91 cfs (25-year, 24-hour) peak flow. This is probably achievable. There are no problems or capacity issues noted.

Subbasin 52.1 drains Tuttle Creek, via a 48" crossing of Highway 101, to Subbasin 52. A velocity of 13 fps is necessary to accommodate the 25-year, 24-hour peak flow of 163 cfs. Mapping suggests surcharge potential, therefore capacity may be adequate. There are no noted problems.

There are no problems or capacity issues noted for Subbasins 48.1 and 50.1

6.5.14 Harbor West

This subsection includes subbasins numbered 47, 48, 49, 50, and 52.

These subbasins define most of Harbor's core area and are continuations of subbasins and drainages discussed in Subsection 6.5.13. In general, tree cover is largely limited to riparian areas and hillsides. Residential development is extensive in both urban and suburban densities. Commercial development is also extensive along Highway 101; Shopping Center Avenue, along Benham Lane, and, to a lesser extent, along Lower Harbor Road. There are three undeveloped "field" areas of approximately three acres each zoned commercial in subbasins 4.7, 49, and 50. All streams and drainages, except Fish House Creek, which drains to the Chetco River, drain to the Harbor boat basins. The lower stretches of the drainages have been piped to facilitate development. Future growth is largely limited to development of the identified undeveloped commercial properties and redevelopment of existing properties.

In Subbasin 47, Fish House Creek drains via 36" and 42" lines across Subbasin 46 to bank discharges on the Chetco River. There is also an 18" line that drains across to the boat basin (Subbasin 46). No problems are noted, but capacities may not be adequate for the 25-year, 24-hour peak flow (12.1 fps, 224 cfs).

Infrastructure in Subbasin 48 collects flows along Highway 101 and Shopping Center Avenue. Capacity in the upper subbasin appears adequate. The subbasin drains via a 36" culvert across Subbasin 46 to the boat basin. A velocity of 10.7 fps is necessary to accommodate the 25-year, 24-hour peak flow of 76 cfs. Given the lack

of surcharge potential, this may not be achievable. There are no problems noted for this subbasin.

In Subbasin 49, developed infrastructure is largely concentrated in the eastern (uphill) part of the subbasin that drains to Delavan Creek. Delavan discharges from the subbasin via a 42" crossing of Lower Harbor Road and Subbasin 46 to its outlet in the boat basin. There is also an 18" crossing northwest of the 42" crossing. A velocity of 12.9 fps is necessary to accommodate the 25-year, 24-hour peak flow of 147 cfs. Given the lack of surcharge potential, this may not be achievable. There are no problems noted for this subbasin.

Infrastructure in Subbasin 50 is limited but appears to be adequately sized. The subbasins drains via an open creek to a 48" crossing of Lower Harbor Road. There are no problems or capacity issues noted.

Subbasin 52 includes Tuttle Creek which drains approximately one-half of the subbasin and enters a 54" line prior to crossing Lower Harbor Road. A long, 24" line running along Benham Lane drains the other one-half of the subbasin. The actual size of the crossing of Lower Harbor Road to the sedimentation basin is unclear, but the line from the sedimentation basin that discharges to the boat basin is an 84" line. Based on probable capacity the 84" line, which is of recent construction, capacities are adequate for the 25-year, 24-hour peak flow. There are no problems noted for this subbasin.

6.5.15 Boat Basin

This subsection includes subbasin 46.

Subbasin 46 is the area west of Lower Harbor Road and consists of fill, pavement, boat basins and associated commercial development. There are no vegetated areas of note other than some grass and/or weed covered areas. All drainages have been piped and discharge to the boat basins, except Fish House Creek which discharges directly to the Chetco, and part of the southwest area that drains toward the Pacific Ocean.

Infrastructure in the boat in discussed in Subbasin 6.5.14. There are no hydraulic problems of note associated with the pipeline crossings of the subbasin. Water quality and hydraulic problems associated with boat basins and river are discussed in Section 5.5.1.

6.5.16 Harbor Hills

This subsection includes subbasins number 53.1, 55.1, 58.1, 59.1, 61.1, 63.1, and 64.1.

These subbasins define the Harbor Hills which are east of Highway 101 and uphill from the Harbor Bench, and south of the Tuttle Creek basin. Residential and commercial development is extensive in the lower hills near Highway 101 and Benham Lane (Subbasin 53.1, 55.1, 58.1, and 59.1). Larger lot residential development also extends further uphill in Subbasins 58.1 and 59.1. Scattered low density residential and commercial development also occurs along Museum Road and McVay Lane (Subbasins 61.1, 63.1, and 65.1). There are some relatively small areas with agricultural fields near Highway 101 (Subbasins 53.1, 55.1, and 63.1). Most of the area consists of steep wooded hillsides with some cleared/lightly vegetated areas that are crisscrossed with rough access roads. Each subbasin includes the headwaters of creeks and drainages that drain across the Harbor Bench. All of the area, except the eastmost part of Subbasin 61.1 and 64.1, are within the UGB.

The undeveloped hillsides in this area are the site of the proposed Harbor Hills (or HW3) development. The proposed development involves approximately 632 acres and has an estimated (projected) population of 5,000 persons.

Subbasin 53.1 includes some developed (pipe and catchbasin) infrastructure; but the rest of the subbasins are largely limited to culvert crossings of Highway 101, roads, and driveways.

Subbasin 53.1 includes a 24" crossing of Highway 101 that transitions to a 30" line in Subbasin 53. A velocity of 17 fps would be required to accommodate the 25-year, 24-hour peak flow of 54 cfs; this is probably not achievable.

Subbasin 55.1 includes three crossings of Highway 101: one 24" line and two 48" lines. Capacities appear to be adequate for the 25-year, 24-hour peak flow of 138 cfs.

Subbasin 58.1 includes an 18" and 24" crossings of Highway 101. A velocity of 20.7 fps would be required to accommodate the 25-year, 24-hour peak flow of 102 cfs. Subbasin 59.1 includes a single 24" crossing of Highway 101. A velocity of 13.6 fps would be required to accommodate the 25-year, 24-hour peak flow of 43 cfs. Subbasin 61.1 includes an 18" and 36" crossing of Highway 101. A velocity of 15.6 fps would be required to accommodate the 25-year, 24-hour peak flow of 138 cfs. Capacities of the crossings in Subbasin 58.1, 59.1, and 61.1 are inadequate based on

the modelling; however, no specific infrastructure related problems are noted.

Subbasin 63.1 includes four crossings (18", 36", and two 30" lines) of Highway 101. A velocity of 5.3 fps is needed to accommodate the 25-year, 24-hour peak flow of 99 cfs. Capacity is adequate. No specific infrastructure problems are noted; however, back ups and diversions, passing through Subbasin 63.1, have impacted downstream (Subbasin 63) farm fields (PA24).

Subbasin 64.1 includes a 48" crossing of Highway 101 that conveys McVay Creek to Subbasin 64. Just upstream, there is a 36" crossing of McVay Lane. A velocity of 8.5 fps would be required to accommodate the 25-year, 24-hour peak flow of 106 cfs. This may be achievable; however, a velocity of 15 fps would be required on the 36" line just upstream - which is probably not achievable. Based on the mapping, excess flow or flows due to an obstruction at the 36" culvert may flow toward Subbasin 63.1 and exacerbate problems in Subbasin 63.

As noted above, subbasins in this subsection includes the hills that drain across Highway 101 and directly impact the Harbor Bench. Increased stream turbidities and sedimentation on the Harbor Bench have been associated with construction related erosion in the Harbor Hills[4]. Presumably, future construction will better address these impacts. Many of the stream channels and drainways on the bench have problems with downcutting and bank erosion. Any proposed line size increase under Highway 101 will need to take into account the potential hydraulic impacts of the project on the receiving stream or drainage.

6.5.17 Harbor Bench (Interior)

This subsection includes subbasins numbered 53, 55, 56, 58, 59, 61, 63, and 64.

These subbasins are located on the Harbor Bench west of Highway 101 and east of Ocean View Drive (with the exception of the drainage extensions of each subbasin to the Pacific Ocean). Remaining areas of the Harbor Bench are discussed in Subsection 6.5.18. Much of the area is agricultural and outside of, but surrounded by, the UGB. The west one-half of Subbasin 53 consists of a fairly dense residential development with ongoing development in the northeast part. It appears that Subbasin 53 will be fully developed (within the UGB) in the near future. Subbasin 55 includes a mix of agriculture and residential development, the latter of which generally follows Pedrioli Drive and Ocean View Drive. Subbasin 56 consists

4 *Winhabor Farms Monitoring Report, Winter of 2002-2003*, Gerald LaRue, 2003.

primarily of residential development. Subbasins 58, 59, and 64 are primarily agricultural. Subbasins 61 and 63 are also largely agricultural except for the UGB extension that includes relatively dense residential development along Camelia Drive. In general, creeks and drainways across the bench are highly modified, both in terms of routing and channelization. Future development on the bench should be nominal, based on zoning and the value of the agricultural resource; nevertheless, development pressures may occur, particularly in those areas already included in the UGB.

Infrastructure in the UGB part of Subbasin 53 is highly developed. The system includes a long 30" line that receives flow from Subbasin 53.1 and routes through new and ongoing development to a 67,000 cubic-foot sedimentation/detention pond off Olsen Lane. Flows from the pond drain open channel to a 48" crossing of Ocean View Drive. There is also a smaller, 24", line that drains across Ocean View Drive and across Subbasin 51 to the Pacific. The 48" line should have adequate capacity given the pond upstream; without the pond, a velocity of 9 fps would be needed for the crossings to accommodate the 25-year, 24-hour peak flow. Downstream off Toner Lane, is a noted problem area (PA21) where recent high flows have exceeded pipe and channel capacities on private property and resulted in excessive erosion. The 48" road crossing should not be enlarged without a more detailed evaluation of impacts and alternatives. The property owner is in the process of constructing private infrastructure consistent with the 48" road crossing.

Infrastructure in Subbasin 55 is developed along Pedrioli Drive and along Ocean View Drive. There are two drainways (creeks) that join and then flow west and south around a residential development. The edge of the development has experienced excessive erosion (PA22) associated with seasonal high flows. There is a 72" and an 18" x 30" parallel crossing of Ocean View Drive. A velocity of 6 fps is necessary to accommodate the 25-year, 24-hour peak flow of 189 cfs. Capacity is probably adequate.

Infrastructure in Subbasins 56, 58, 59, 61, 63, and 64 is largely limited to crossings of Ocean View Drive. Crossing capacities appear to be adequate with required velocities ranging from 3.5-7.2 fps to accommodate the 25-year, 24-hour peak flows. The exception is Subbasin 59 which has a single 36" crossing of Ocean View Drive. A velocity of 10.5 fps would be requred to accommodate the 25-year, 24-hour peak flow of 74 cfs. Flow from Subbasin 59.1 is limited by the 24" Highway 101 crossing; consequently, the full impact of potential higher flows is less likely to occur at the Ocean View Drive crossing unless upstream crossings are improved. Subbasin 61 includes a 24" crossing of Ocean View Drive that routes across the south edge of

Subbasin 61 and has caused erosion concerns for the property owner (PA23).

In general, capacities of Ocean View Drive crossings are adequate. Many of these culverts have been upgraded by the County. The creeks and open drainways in this area, however, have known problems (bed and bank erosion) associated with the higher seasonal flows and it is doubtful that they could accept higher flows from upstream subbasins such as could occur if higher capacity culverts were to be installed across Highway 101.

6.5.18 Harbor Bench (Coastal)

This subsection includes subbasins number 51, 54, 57, 60, and 62.

These subbasins occur primarily west of Ocean View Drive to the Pacific Ocean and include multiple drainage paths across each subbasin. Two subbasins (54 and 60) extend further up on to the Harbor Bench as defined by topographic boundaries, do not have any clearly delineated drainways east of Ocean View Drive. Development within the UGB is generally low to moderate density residential and largely built out. There are some larger lots that appear to be farmed, but further subdivision of these lots is limited under the current zoning (typically RR-5 in these areas). Subbasins 62 and 64 include McVay State Park.

Infrastructure in these subbasins are generally limited, although Subbasins 54 and 60 include infrastructure along, and across, Ocean View Drive. Problems along the coast are both manifest and potential. Much of the coastline consists of high bluffs and cliffs that drop to the beaches and ocean below. Natural erosion processes associated with streams, geological characteristics, and wave action are exacerbated by clearing and modification (development) of adjacent properties, and higher runoff flows in the streams and drainways associated with development upstream.

SECTION 7: RECOMMENDATIONS

7.1 POLICIES

7.1.1 Water Quality

Water quality issues are best addressed as close to the source as possible. A public education program is recommended as a means of disseminating information on the importance of correct storage, application, and disposal of potential chemical contaminants, and other materials, that may runoff and contaminate waterways.

For new development, or redevelopment, provision of water quality facilities should be provided and can be combined with detention/peak flow reduction facilities. Typical best management practices (BMPs) employed include vegetated swales or ponds. Sedimentation basins can also significantly improve water quality though they do not match vegetated facilities in ability to convert organic pollutants to less harmful chemical species. Water quality facilities generally have a modest design basis - Curry County's recently adopted rules require capture and treatment for all flows up to the 80th percentile storm event.

As a general policy, natural watercourses should not be adversely altered or impacted. In addition to benefits for wildlife, and riparian plant communities, watercourses can through aeration and biological action assist in improving water quality. This is especially true in areas that include adjacent wetlands. As a general rule, the process of piping a watercourse to facilitate development should not be allowed. Exceptions include the use of culverts under roads, driveways, and other limited applications that may be approvable by the City or County Engineer. The process of "opening up" piped watercourses should be encouraged; though the feasibility or practicability of doing so may be severely limited by the nature of the overlying development and its probable occurrence on private property. Stream restoration often requires individuals and organizations with both vision and commitment to negotiate with all the affected parties and agencies likely to be involved, and to research and secure funding needed to accomplish any particular project.

Protection of ground water, especially in areas likely to affect wells utilized for human consumption, is an essential goal. Use of infiltration facilities can reduce off-site flow and provide for groundwater recharge; however, any proposed facilities should address water quality impacts and mitigation measures.

Both the City and County have expressed a desire to not conduct ongoing monitoring with City and County resources. Additional monitoring may be required in the future after DEQ's TMDL study of the Chetco River is completed in 2007. Monitoring may be required of developers when the perceived impact of the development warrants monitoring of pre-development and post- development conditions in the potentially impacted areas. The City and County should be supportive of private efforts to monitor water quality in the UGB.

Potential sources of pollutants associated with storm water impacts on stream water quality are discussed in Section 5.5.2. Many pollutants bind with sediment and other solids; hence, effective erosion control and sediment management can significantly improve water quality associated with runoff. Erosion and sediment control are discussed in Section 7.1.2.

7.1.2 Erosion and Sediment Control

Erosion is a natural process that exists everywhere to some extent. Erosion from, or stemming from, human activities, if unmanaged, can impact downstream properties; generate sediments that bind and transport pollutants; increase receiving stream turbidities and impact fish; and prematurely fill ditches, pipelines, and catch basins with transported sediment and materials. Erosion can also compromise constructed infrastructure such as streets.

Sediment control refers to practices that trap sediment and particulates resulting from erosion. In general, it is best to focus most management efforts on reducing erosion where it is likely to occur.

DEQ recently developed an erosion and sediment control manual[1]. The 138 page manual provides considerable detail on both erosion control and sediment control in practices and could be an excellent resource for both the City and County public works departments. The manual is located on the internet at:

www.deq.state.or.us/wq/wqpermit/ESCManual/ESCManual.pdf

Basic principles of erosion and sediment control, reprinted from the manual, are listed below:

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[1] *Erosion and Sediment Control Manual,* GeoSyntec Consultant, San Diego, CA, April 2005.

- Fit the project to the existing topography, soils, and vegetation;
- Minimize disturbance and retain natural vegetation;
- Schedule construction to minimize soil exposure during rainy season;
- Vegetate and mulch denuded areas;
- Minimize concentrated flows and divert runoff away from slopes or critical areas;
- Minimize slope steepness and slope length by using benches, terraces, contour furrows, or diversion ditches;
- Utilize channel linings or temporary structures in drainage channels to slow runoff velocities;
- Keep sediment on site by using sediment basins, traps, or sediment barriers; and
- Monitor and inspect sites frequently and correct problems promptly.

Both the City and County have recently adopted erosion and sediment control requirements. In addition to City and County requirements, DEQ requires a Stormwater Permit (General Permit #1200-C) for development (or disturbance of soil) of more than one acre, in which an erosion plan must be provided to the agency for review and approval.

7.1.3 Hydraulics

To the extent practicable, the City and County should endeavor to maintain storm water discharges at current levels in order to minimize impacts on downstream infrastructure, watercourses, water bodies, and existing development. Exceptions could be made in areas where impacts are likely to be minimal such as: the downhill (river) side of North Bank Road and South Bank Road, the downhill (ocean) side of Ocean View Drive, the west side of Highway 101 from Subbasin 1 to Subbasin 17, and the remaining parts of Brookings within approximately 1000 feet of the coast. This is provided that adequate conveyance is available or constructed, and that adequate armoring and protection is available at the discharge; and that water quality facilities are provided consistent with Section 7.1.1 above.

In general, new or replacement facilities should be sized to accommodate peak flows from the 25-year, 24-hour event; however, the City or County Engineer may allow a lesser design basis, such as the 10-year, 24-hour event where potential exceedences are not deemed to be a significant threat. Culvert upgrades across Highway 101 will need to comply with ODOT requirements which generally entail a 50-year, 24-hour event basis. Highway 101 north of the Chetco River bridge was included in a major highway upgrade project last summer (2006); apparently, no new culvert upgrades

will be allowed across the highway for the next 10 years. (Presumably, bored crossings would be allowed; however, these are usually cost prohibitive.)

Flow control off developed sites is typically effected with detention basins. Whatever approach is used, capacity and flow control are the two critical components. Detention capacity should be sufficient to accommodate the post-development flow for release at the pre-development rate based on the 25-year, 24-hour event using conservative pre- and post-development runoff coefficients. Furthermore, off-site discharges should be controlled so that they match as closely as practicable pre-development rates for the "2-year", "5-year," and "10-year" rates in addition to the "25-year" rates.

Major developments above the Harbor Bench will need to evaluate and address impacts to receiving streams that cross the Harbor Bench to their discharge in the Pacific Ocean. These are particularly susceptible to erosion, and in some cases, flooding.

7.2 MAINTENANCE

Maintenance of the existing drainage system is necessary to maintain constructed flow capacity and reduce the incidence of backups (local flooding) due to obstructions.

Maintenance in the City of Brookings is conducted by Public Works staff. During the "wet-season", staff make daily (Monday-Friday) rounds of known problem areas and clear obstructions to maintain flows. More extensive maintenance operations are also conducted, based on perceived need and availability of manpower, equipment, and available funds. Staff also respond to citizen reports of existing or developing problems.

If additional resources can be provided by the City, City staff should regularly check the manholes along the Macklyn Creek line and along the South Fork Creek line, particularly at the 90° bends where obstructions can accumulate. Again, with sufficient resources, daily inspections of stormwater facilities can be expanded to include weekends during the wet-weather season.

County staff also perform maintenance operations outside the City of Brookings; however, they are more dependent on citizen reports because of the vast area which they service. Both County and City staff worked together to divide up responsibilities in areas where the City/County boundaries are complex.

Private developments, both inside the City of Brookings, and outside in Harbor and other areas of the UGB, are generally on their own with regard to maintenance of infrastructure and drainways.

Public Works staff do their best with the budgets they are provided. Additional funding would allow for expanded maintenance activities including repair or replacement of defective infrastructure. A potential source of additional funds is the establishment of a stormwater utility.

Constructed facilities such as detention basins require periodic maintenance. Responsibility for maintaining such facilities is often ambiguous and may result in improperly functioning facilities. The County has addressed this issue in the recent adopted rules (Appendix 4.1). The City of Brookings is currently working on an ordinance to address maintenance requirements on private property.

A critical consideration for any constructed infrastructure is access. New facilities should be constructed and located where readily accessible for maintenance and ultimate replacement.

7.3 DESIGN AND DEVELOPMENT STANDARDS

7.3.1 Design Criteria

The range of design possibilities for stormwater infrastructure are extensive and engineers will typically be able to select and utilize appropriate approaches for each specific project including approaches that may be innovative or uniquely applicable to the demands of the project. Nevertheless, many communities adopt design standards to ensure compliance with minimum standards and to provide a general guide for public works activities that may include construction of stormwater infrastructure according to the budget and capabilities of City of County staff. Both the City and County have developed design criteria and standards to a limited extent, with the County's recently adopted stormwater related design criteria being the most developed to date. Development of more detailed standards can be accomplished with the assistance of a qualified consultant and input from City and/or County staff; however, many communities decide to adopt, by reference, standards developed by others. Standards developed by others may include design criteria or other elements that are either not applicable or not desired; consequently, it is important to thoroughly review any referenced standard to determine which portions are acceptable and to either reference only the applicable sections or to provide supplementary guidance to ensure compatibility with local objectives. An example

of a highly developed design standard is *"Design and Construction Standards for Sanitary Sewer and Surface Water Management"*, Clean Water Services, March 2004. which can be viewed on the internet at:

http://www.cleanwaterservices.org/PermitCenter/DesignandConstruction/default.aspx

Many other examples are available on the internet and DEQ many also be able to provide assistance in recommending design standards for consideration. Regardless of what standards are developed or adopted, final say in interpreting the standards or in reviewing proposed projects should reside in the City or County Engineer.

7.3.2 Future Development

Future development will need to comply with provisions of Section 7.3.1 and other requirements as regulated or deemed appropriate by the City and/or County. In addition, mapping developed for this facilities plan can be useful in providing a context (subbasin or subbasins) for evaluating impacts of any proposed development. Current mapping is provisional and may omit detail or include erroneous detail depending on the ultimate reliability of the sources or the extent to which detail was verified or discovered. The purpose of the mapping in this context is to assist developers, and other interested parties, in locating relevant features, but it is not a substitute for field verification of the existence, precise location, and suitability of the infrastructure or drainages that bear on any proposed project. Both the City and County should be open to information provided by others that clarifies or modifies features, including subbasin boundaries indicated on the maps. Such information should be noted on map copies and included in a specific file to facilitate future updates of the mapping and/or facilities plan or other storm water related studies.

7.4 CONSTRUCTED IMPROVEMENTS

7.4.1 City of Brookings - Constructed Improvements

There were only two problems noted that require immediate or at least near-term attention: the 18" culvert in Subbasin 19.6 that backs up at times and directs flow toward Lucky Lane (PA6) and flooding next to City Hall in Subbasin 19.9 (PA13). Other noted problems generally result in ongoing maintenance needs and consequent attention by City Staff. These problems also need to be addressed; however, in most cases, the improvement could be deferred until the next street improvement project and included in the project as part of its scope of work.

Priority I Projects

Subbasin 19.6

Project #1 involves the replacement of the undersized 18" line (PA6) from the inlet to the manhole on east shoulder of Highway 101. Project sizing is 30" to accommodate the 25-year, 24-hour peak flow of 56 cfs and based on model results. Sizing will need to be reevaluated after surveying and selecting a route around the existing building. Currently the 18" line passes under the building. The Highway 101 crossing should also be evaluated. Some type of flow restriction or bypass may be needed at the inlet of the proposed 30" line to avoid overloading of downstream infrastructure until it is upgraded.

Table 7.1: Project #1 Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
30" Storm Drain Piping	250	LF	$125	$31,250
Manholes	4	EA	$4,000	$16,000
Headwall and Grate	1	LS	$6,000	$6,000
Misc. Resurfacing	1	LS	$5,000	$5,000
Construction Subtotal				**$58,250**
Contigencies				$5,825
Engineering				$11,650
Legal and Administration				$2,913
Permitting and Easements (allowance)				$5,000
Project Total (rounded)				**$84,000**

Related projects (Projects #3 and #4) will be needed to fully utilize the installed capacity associated with Project #1; however, Project #1, by itself, will significantly alleviate problems associated with the existing 18" line.

Subbasin 19.9

Project #2 involves an upgrade of the drainage along the north edge of the parking lot next to City Hall (PA13). It is recommended that the City televise the line (with City owned equipment) to determine if there are any obstructions or structural defects that may contribute to poor performance. If no defects are discovered, existing hydraulic capacity will need to be augmented. As part of the pre-design effort, the catchment tributary to the

24" line should be modelled to refine capacity requirements. Surveying will also be needed along the drainway preceding the 24" line and along the line to Macklyn Creek to determine existing capacity of the 24" line and to determine remaining capacity needed. A decision can then be made whether to: (a) reconstruct the 24" line, (b) supplement the 24" line with a parallel line, or (c) replace the 24" line with a single, larger diameter culvert.

A budget allowance of $30,000 should be sufficient for design and construction needs assuming a supplemental line of 24" diameter or less is needed. An opinion of probable cost can be prepared early in the project to apprise City officials of probable costs based on the actual scope of work.

In addition to this project, City staff should check downstream manholes on the Macklyn Creek line, especially where the 48" line makes a 90° bend in Subbasin 19.5, in order to monitor and clear any obstructions that could impair performance. Any observed surcharging of Macklyn Creek should be recorded with descriptions and photos. Manholes downstream should all be checked as soon as possible following any observed surcharging in Macklyn Creek. Modelling suggests inadequate capacity in the 36" line that carries Macklyn Creek. The 36" line runs approximately 500 feet under parking lots and a City street until it connects to a 48" line. Depths are described by City staff as approaching 25 feet for the 48" line near Highway 101. Replacement of the 36" line with a 48" line would be disruptive and costly. An order of magnitude OPC for the upgrade is $500,000. It is recommended that the City not construct the Macklyn Creek upgrade until the lower cost measures described above have been implemented and their effectiveness assessed. Any upgrade of the Macklyn Creek line should be preceded with a more detailed study of the Macklyn Creek drainage basin (see Section 7.5).

Priority II Projects

Subbasin 19.6

Project #3 is a continuation of Project #1 across Highway 101. The project crosses the ODOT ROW. Elevations are not known with sufficient accuracy to determine pipe size; a 36" line is estimated to be adequate. The manhole on the east side of Highway 101 is approximately 5 feet deep; consequently, the highway crossing is relatively shallow and will require open cutting to be constructed. Based on the recent 2006 highway project, it will be at least 2016 before such construction will be allowed by ODOT.

A budget allowance of $100,000 is recommended.

Subbasin 19.2

Project #4 is a continuation of Projects #1 and #3 and replaces defective and undersized 24" lines that run from Highway 101, south to and along Smith Drive to Rowland Lane, with 30" main; and replaces 30" and 36" lines with 42" down to and along Mill Beach Road to the 48" crossing in Subbasin 19.1.

Table 7.2: Project #4 Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
42" Storm Drain Pipes	500	LF	$180	$90,000
30" Storm Drain Piping	1300	LF	$125	$162,500
Manholes	7	EA	$4,000	$28,000
Misc. Resurfacing	1	LS	$18,000	$18,000
Construction Subtotal				**$298,500**
Contigencies				$29,850
Engineering				$59,700
Legal and Administration				$14,925
Project Total (rounded)				**$403,000**

This project could be broken into smaller components. The section between Highway 101 and Fifeld Street is in the worst condition and passes under a building. Replacement of this section would involve approximately 700 lineal feet of 30" main.

Final sizing should be based on surveyed elevation data and model modifications to include greater detail.

Subbasin 19.1

Project #5 involves replacement of the defective culvert across Alpine Street (PA7). Alpine is a gravel road that could easily be mistaken for a driveway. The existing culvert is highly degraded and an ongoing maintenance problem. A 12" culvert approximately 25 feet long is needed for a replacement of the existing 10" line. Replacement costs are nominal - approximately $1,000. Work could be accomplished by City staff assuming availability of needed resources.

Project #6 involves replacement of the defective 48" line crossing Mill Beach Road (PA9).

Table 7.3: Project #6 Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
48" Storm Drain Piping	75	LF	$200	$15,000
Manholes	1	EA	$4,000	$16,000
Headwall	1	LS	$10,000	$10,000
Misc. Resurfacing	1	LS	$1,000	$1,000
Construction Subtotal				**$42,000**
Contigencies				$4,200
Engineering				$8,400
Legal and Administration				$2,100
Project Total (rounded)				**$57,000**

Subbasin 27

Project #7 addresses problems (PA15) on Old County Road. The project was originally included in the City's 1985 Storm Drainage Study. The project originally included a new 36" line connecting the 24" line at Azalea Park Road with the existing 48" line at the base of Old County Road. There is an existing open drainway that drains into the 48" line. In keeping with the general policy of not piping drainways, the larger project as originally conceived is no longer recommended. Instead, an extension upstream of the existing catch basin at Fir Street and Old County Road, to the existing 24" line is recommended.

Table 7.4: Project #7 Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
36" Storm Drain Piping	150	LF	$140	$21,000
Manholes	5	EA	$4,000	$20,000
Misc. Resurfacing	1	LS	$5,000	$5,000
Construction Subtotal				**$46,000**
Contigencies				$4,600
Engineering				$9,200
Legal and Administration				$2,300
Project Total (rounded)				**$62,000**

Subbasin 23.1

Project #8 was included in the draft of this plan; it addressed problems along Railroad Street between Willow Street and Fern Avenue (PA16). Based on further review, this project (and Table 7.5) have been deleted; problems associated with this line should be addressed by construction of Project #9.

Project #9 involves replacing the 8" culvert at Willow Street and Railroad Street (PA17) with a 15" culvert.

Table 7.6: Project #9 Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
15" Storm Drain Piping	40	LF	$80	$3,200
Misc. Resurfacing	1	LS	$1,000	$1,000
Construction Subtotal				**$4,200**
Contigencies				$420
Engineering				$840
Legal and Administration				$210
Project Total (rounded)				**$6,000**

Project #10 involves replacement of the severely degraded 30" culvert that crosses Railroad Street at Oak Street.

Table 7.7: Project #10 Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
30" Storm Drain Piping	200	LF	$125	$25,000
Manholes	2	EA	$4,000	$8,000
Misc. Resurfacing	1	LS	$4,000	$4,000
Construction Subtotal				**$34,000**
Contingencies				$3,400
Engineering				$6,800
Legal and Administration				$1,700
Project Total (rounded)				**$46,000**

7.4.2 Curry County - Constructed Improvements

There are no specific recommendations for constructed improvements in the County portions of the UGB. Noted problem areas (PA21, 22, 23, 24, and 25) all occur on private property. Most of the noted problems are related to erosion associated with the highly modified nature of drainage on the Harbor Bench coupled with ongoing development activities on the Bench and in the Harbor Hills. One of the most important "projects" the County can undertake is the development of workable design and development policies and standards to minimize or alleviate potential impacts on stressed drainways and infrastructure. To a large extent, this has been accomplished with the recently adopted rules (Appendix 4.1).

The County has done an excellent job of upgrading key culverts along Ocean View Drive, North Bank Road, South Bank Road, and other areas in accordance with available manpower and budgets. Such work is anticipated to continue into the future in accordance with perceived need; the omission of specific projects in this study does not mean there is no need for additional culvert replacement or rehabilitation projects, rather it acknowledges that the recognition and correction of these deficiencies is ongoing and addressed in accordance with available resources.

From a broader perspective, watercourses on the Harbor Bench, in particular, the highly modified drainways located in Subbasins 55, 58, 59, and 63 could be restored (at least in part) to provide significant benefits in reducing erosion and in increasing groundwater levels on the Bench. Likely needs include: reconstruction of streambeds (possibly using log drops or stacked rock to create a series cascades which could be further backfilled with suitable materials to raise the streambed), shaping of the streambank to promote stability, and planting of riparian vegetation to reduce erosion and promote bank stability. There are approximately 14,000 lineal feet of watercourses in the above referenced subbasins. An order of magnitude OPC for reconstruction of these watercourses is $2,800,000. This OPC is a "guesstimate". To refine the costs would require a preliminary design effort to survey the watercourses and determine the needs for each reach. Cooperation of the property owners is essential and true reconstruction efforts are likely to impact, to varying extents, land currently under cultivation. These streams are more or less seasonal and do not have fish present. It is doubtful that funding sources are available for the improvements outside of the private resources of the property owners involved.

These improvements should increase the resiliency of the watercourses to accept the higher flows associated with recent increased development on the Bench and upstream in the Harbor Hills. Raising the streambeds should increase groundwater

levels, thereby providing a general benefit to well owners on the Bench. Given the magnitude of the proposed Harbor Hills development and concerns with impacts of the development on groundwater resources, it may be possible to mitigate groundwater losses associated with Harbor Hills development with increased groundwater storage capabilities on the Harbor Bench such as would be effected by the recommended improvements. Presumably, the developer would pay for most if not all of the improvements. Actual scope of the stream reconstruction may be significantly less than described above based on pre-design identification of need and willingness of the affected property owners to proceed.

7.5 STUDIES

Additional studies within the defined study area may be needed to address issues as they arise. In particular, DEQ is scheduled to complete its TMDL study of the Chetco River in 2007. Depending on the results of the TMDL study, the City and County could be required to undertake studies beyond what have been completed to date. In such a case, DEQ will provide guidance as to what is required; nevertheless both the City and County Engineers should be involved in evaluating and clarifying any requested actions.

Based on water quality and hydraulic studies completed on the boat basins to date, additional study is needed to combine concerns with water quality and wave dynamics into a single viable approach prior to any reconstruction of the basins. Probably costs are on the order of $50,000 - $100,000 depending on the extent of hydrographic surveying, additional water quality sampling, and the nature and complexity of the models involved.

Future updates of the Storm and Surface Water Facilities Plan should include extensive surveying of noted infrastructure (primarily major lines and crossings) to obtain accurate elevations for modelling and evaluating existing infrastructure. Updates of mapping should be conducted based on additions and corrections noted by staff and others. Additional problems noted by staff can also be investigated and more detailed capital improvement recommendations can be prepared consistent with the increased precision of the modelling. The Macklyn Creek drainage should be evaluated in greater depth with additional subbasin construction and more extensive, detailed, and accurate routing of flows through pipes and drainages in the basin. This should be completed prior to any major improvements involving the Macklyn Creek or South Fork Creek lines. An appropriate OPC for updating the facilities plan is $30,000 - $50,000 (in 2006 dollars) depending on the final scope of work. Scheduling will depend on perceived need by either the City or County. Consideration should also be given to an update approximately one to two years prior to a major ODOT project in order to incorporate recommendations for infrastructure modifications into the ODOT project.

SECTION 8: FINANCING AND IMPLEMENTATION

8.1 INTRODUCTION

Lack of adequate funding is a common frustration of all counties and municipalities in dealing with drainage problems. Funding for maintenance and capital improvements of storm drainage systems is basic to its successful operation as an efficient conveyance of stormwater runoff. If funds are not made available to address existing problems, the risk of stormwater related damage becomes greater. Adequate funding of the capital improvement projects and completion of the projects recommended in this plan will greatly reduce the risk of major storm water related damage.

Grant funding is generally not available for funding stormwater related improvements; consequently, the "need" for any particular capital improvement is shaped in large part by the cost of the project and the willingness of the governmental entity involved to devote the funds, or to incur the debt, necessary to complete the project. Priority is generally given to those projects that address existing or incipient problems that can be honestly characterized as urgent. Remaining projects are typically undertaken in accordance with prevailing perceptions of need and affordability.

8.2 FINANCING

8.2.1 Local Funding Sources

General Obligation Boards. Financing of improvements by General Obligation (G.O.) Bonds is accomplished by the following procedures:

1. The Consulting Engineer prepares a detailed cost estimate to determine the total monies required for construction.

2. An election is held.

3. When voter approval is granted (by a majority of the registered voters), bonds are offered for sale. The money for detailed planning and construction is obtained prior to preparation of final engineering plans and the start of project construction unless interim financing has been developed.

G.O. bonds are backed by the full credit of the issuer and authorize the issuer to levy

ad valorem taxes. The issuer can make the required payments on the bonds solely from the new tax levy or may instead use revenue from assessment, user charges, or some other source.

Oregon Revised Statutes limit the maximum term of G.O. bonds to 40 years for cities; a more common term is 15-20 years.

Revenue Bonds. A revenue bond is one that is payable solely from charges made for the services provided. Such bonds cannot be paid tax levies or special assessments, and their only security is the borrower's promise to operate in a way that will provide sufficient net revenue to meet the obligations of the bond issue. Revenue bonds are most commonly retired with revenue from user fees. To be applicable, the City would need to establish a storm water utility.

Successful issuance of revenue bonds depends on bond market evaluation of the dependability of the revenue pledged. Normally there are no legal limitations on the amount of revenue bonds to be issued, but excessive bond issue amounts are generally unattractive to bond buyers because they represent high investment risk. In rating revenue bonds, buyers consider the economic justification for the project, reputation of the borrower, methods for billing and collection, rate structures, and the degree to which forecasts of net revenues are realistic.

Improvement Bonds (Local Improvement District). Improvement bonds may be issued to assess certain portions of improvements directly against the parties being benefitted. An equitable means of distributing the assessed cost must be utilized so that all property, whether developed or undeveloped, receives the assessment on an equal basis. Cities are limited to improvement bonds not exceeding 3% of true cash value. For a particular improvement, all property within the assessment area is assessed on an equal basis, regardless of whether it is developed or undeveloped.

Improvement bond financing requires that an improvement district be formed, the boundaries be established, and the benefitted properties and property owners are determined. The engineer usually determines an approximate assessment based on a square-foot, a front-foot basis, or a combined basis. Property owners are then given an opportunity to remonstrate against the project. The assessment against the properties is usually not levied until the actual total cost of the project is determined. Since this determination is normally not possible until the project is completed, funds are not available from assessments for the purpose of making monthly payments to the contractor. Therefore, some method of interim financing must be arranged, or a pre-assessment program, based on the estimated total costs, must be adopted. It is

common practice to issue warrants, which are paid when the project is completed, to cover debts.

The primary disadvantages to this source of revenue (improvement bonds) are described below:

1. The property to be assessed must have a true cash valuation at least equal to 50% of the total assessments to be levied. This may require a substantial cash payment by owners of undeveloped property.

2. An assessment district is very cumbersome and expensive when facilities for an entire community are contemplated.

3. The project is impacted by tax limitations because the improvement bonds are backed or guaranteed by the city's authority to raise revenue via taxation.

Serial Levies. Under Oregon Revised Statutes, if approved by the voters, the City can levy taxes for a fixed period of time to construct new facilities and maintain existing facilities. Generally, when a serial levy is presented to the voters, it is based upon a specific program and listing of planned improvements.

Sinking Funds. Sinking funds can be established by budget for a particular capital improvement need. Budgeted amounts, from each annual budget, are carried in a sinking fund until sufficient revenue is available for the needed project. Funds can also be developed with revenue derived from system development charges or serial levies.

Assessments. Is some cases the beneficiary of a public works improvement can simply be assessed for the cost of the project. It is not uncommon for an industrial or commercial developer to provide up-front capital to pay for a community administered improvement which serves the development.

Storm Water Utility. See Section 8.2.2.

System Development Charges. See Section 8.2.3.

8.2.2 Storm Water Utility

A storm water utility, like a water or wastewater utility, provides a service through

the operation and maintenance of a public facility. Few communities currently have storm water utilities; however, they have increased in recent years as communities try to address storm water management needs on something other than a crisis basis. Revenue derived from user fees can be used for maintenance or capital improvements and associated debt service.

A storm water utility can be established by ordinance. A second ordinance is also needed to establish the rate structure. Rates are typically based on square footage of impermeable surface (roofs, paving, etc.) associated with each property. While equitable, the methodology requires measurements, often scaled off recent aerial photographs, and computations, as well as suitable billing software and data entry. Computations are also updated periodically. To reduce the administrative work, simplifications can be introduced - such as a flat rate for residential customers and a variable rate, based on impermeable square footage for other customers. For a small, predominantly residential community, the most cost-effective rate methodology may be that of a flat rate per water or sewer connection. A flat rate would allow the City to simply add a line item and cost to the water or sewer utility billing. This eliminates the need for computations, special billing software, or modifications, periodic updates, separate billings, and related administrative costs.

The political realities of establishing a storm water utility are such that revenues generated are not likely to truly meet all the storm water related needs. Recent literature indicates that a monthly fee of $3.00 per average residence appears to be an approximate limit of political palatability. For Brookings, a $3.00 per month storm water charge attached to the sewer billings (3,290 active connections[1]) would yield $118,440 per year. Monies could be used to supplement and expand current public works efforts devoted to stormwater management. Monies could also be used for debt service repayment.

Dedicated efforts by the City to inform and involve the public will be needed to obtain support for the establishment of a storm water utility. For areas outside the City of Brookings, establishment of a storm water utility would be more complex and may not be practicable for the monies involved. A possible exception would be creation of a stormwater utility within a defined service area, such as the Harbor Sanitary District. This would require a clear distinction of responsibilities be established between the District and County. Presumably the District would use the monies for routine maintenance of stormwater facilities within their boundaries, thereby providing an enhanced level of service. As an alternative for consideration,

1 Source: City of Brookings, November, 2006

the County could approach the District to see if they are interested and then explore the possibility further if interest is voiced.

8.2.3 System Development Charges (SDCs)

System Development Charges (SDCs) can be charged to all users of transportation, water, sewer, storm drainage, and parks and recreation facilities. The fee is usually charged as each piece of property is developed in the future and goes into a capital construction fund to pay for improvements required by growth in the community. The Oregon System Development Charges Act, House Bill 3224, became effective in 1991. Legislation requires that capital improvement plans be developed, and that methodology used to compute SDCs be documented and reviewed by the community before SDCs can be charged.

The Oregon System Development Charges Act permits two types of charges: 1) a reimbursable fee, and 2) an improvement charge. A reimbursable fee is a charge for unused capacity in existing capital improvements. An improvement charge is a fee associated with capital improvements to be constructed. Improvement fees are generally more popular than reimbursement fees, due to the complexity of computing reimbursable fees for infrastructure constructed sometime in the past.

8.2.4 Funding Programs

General. There are relatively few state or federal funding programs that provide financial assistance for municipal storm water related improvements. Those that do typically have conditions which limit the eligibility of any given project. Funding programs and policies are constantly evolving and funding priorities are often adjusted according to program budget allocations and prevailing economic policies. In general, most storm water improvement projects that address simple hydraulic conveyance (pipes, intakes, culverts, etc.) do not qualify for grant or low interest loan funding.

Specific Programs. This section is intended to provide a general overview of recently available programs. **Agency and program policies are continually evolving and specifics are likely to have changed since development of this section.**

<u>Rural Development</u>

The Water and Wastewater Disposal Grants and Loans program is under the

administration of the U.S. Department of Agriculture, Rural Development (RD), under the old guidelines of Farmers Home Administration (FmHA). The program is limited to rural communities which have a population of less than 10,000 people; community population must not be likely to decline in the foreseeable future. The City meets this criteria.

RD loans currently have a 4.5 % interest rate: The maximum term for all loans to cities is 40 years. However, no repayment period can exceed any local statutory limitation on obligations.

Funding for storm water improvements that only address hydraulic issues are likely to have a very low priority status with RD. Funding, if available, would likely be loan only. Projects related to municipal water or wastewater utilities, or projects that address water quality issues, could qualify for both grant and low interest loan funding. Actual grant percentage will be determined by the agency.

DEQ Clean Water State Revolving Fund

The State Revolving Fund (SRF) loan program provides low-interest rate loans to public agencies for the planning, design and construction of water pollution control facilities, as well as for some publicly-owned estuary management and non-point source control projects. This funding program is administered by DEQ. Recent interest rates for 20 year loans are approximately 2.92 % plus an annual fee of 0.5 % of the unpaid balance. These interest rates are subject to change, but will remain below market rates. Priority is given to projects addressing documented water-quality problems and health hazards. SRF funds can also be used for interim financing. Interim financing loans are paid when long-term financing is completed. The interest rate is 1.12 % for interim financing.

To be eligible, a stormwater project would need to either reduce inflow/infiltration to a sanitary sewer system or address issues directly related to water quality.

There were no projects identified for Brookings UGB that appear to meet the criteria.

Oregon Department of Transportation, Transportation Enhancement Program

The Oregon Department of Transportation (ODOT) through the Transportation Enhancement Program provides funds for twelve "transportation enhancement activities" that were identified in the Transportation Equity Act for the 21st Century

(TEA-21). Stormwater improvements are potentially covered under "landscaping and scenic beautification" or "environmental mitigation". Environmental mitigation refers to control of highway runoff or for purposes of wildlife protection only. The projects must also be directly related to surface transportation.

Potential projects are ranked and selected through a competitive process. Successful applicants contribute a minimum of 10.27% matching funds with the balance provided by the agency as a "reimbursement" rather than a grant.

There were no projects identified for the Brookings UGB that appear to meet the criteria.

Federal Emergency Management Agency

The Federal Emergency Management Agency (FEMA) has two programs that may be utilized for storm water projects that meet program criteria for eligibility. The two programs are:

Flood Mitigation Assistance (FMA) Grant Program. This program provides grant funding to States, Indian tribal governments, and communities for cost-effective approaches to reduce or eliminate the risk of flood damage to buildings insurable under the National Flood Insurance Program (NFIP). The FMA program includes three types of grants: Planning, Project, and Technical Assistance (TA). Current program priority is for flood mitigation activities that reduce the number of repetitive losses for structures currently insured by NFIP; however, the agency may also fund projects associated with properties covered by NFIP whether or not they have experienced repetitive losses. (Repetitive loss properties are those that have experienced at least two NFIP claim payments of over $1,000 each within any 10-year rolling period.)

To be eligible, a project must, at a minimum, be:

1. Cost effective.
2. Cost beneficial to the National Flood Insurance Fund
3. Technically feasible.
4. Physically located in a participating NFIP community or must

reduce future flood damages in an NFIP community.

A project must also conform with:

5. The minimum standards of the NFIP Floodplain Management Regulations.

6. The applicant's Flood Mitigation Plan.

7. All applicable laws and regulations, such as Federal and State environmental standards or local building codes.

FEMA may contribute up to 75 percent of the total eligible costs. At least 25 percent of the total eligible costs must be provided by a non-Federal source. Of this 25 percent, no more than half can be provided as in-kind contributions from third parties. There are limits on the frequency of grants and the amount of funding that can be allocated to a State or community in any 5-year period.

Since Project Grant funding requires the applicant to have a Flood Mitigation Plan, either a Planning Grant or a TA Grant may be a necessary pre-requisite to develop the Flood Mitigation Plan (or information needed to develop a viable FMA application or project).

Pre-Disaster Mitigation (PDM) Grant Program. This program provides grant funding to States, Indian tribal governments, and communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. The intent is to reduce the risk to populations and structures and to reduce the reliance on compensation or funding for actual disasters. Like the FMA program, the PDM program requires applicants to have a Flood Mitigation Plan. The program does provide funding for stormwater management projects to reduce or eliminate the long-term risk from flood hazards.

The program provides up to $3,000,000 of federal money. Grant funding contributes up to 75% of funds needed; at least 25% of the funds needed must be provided as matching funds (with no other federal monies included). Small, impoverished communities may be eligible for up to 90% federal cost-share.

There were no projects identified for the Brookings UGB that appear to

meet the criteria.

8.3 IMPLEMENTATION

<To be developed after the January 19, 2007 public meeting.>

8.4 PUBLIC INFORMATION

Dissemination of information to the public regarding storm water issues in general (as well as for specific projects, policies, ordinances, etc.) is essential for community support of needed actions by the City and County. With regard to improved water quality, it is probably the most important action the City or County can take. Understanding the impact and transport of household chemicals and pet wastes can make a real and favorable impact on how people manage their houses and yards. Public discussion can help stimulate interest in storm water related issues and water quality; this in turn can generate support for needed projects or programs. Both Planning meetings and City Council or County meetings can provide some information for projects and storm water related issues that have become sufficiently important for those bodies to discuss or consider.

Newspaper articles are a good way of getting general information to the public. Mailings may not be a good approach unless they are very well written, short (1 page), and formatted to catch someone's attention before its relegated to the "circular" file.

Public meetings, in general, are not well attended, even when advertised, unless people are responding to perceived direct impacts to their lives[2]. More targeted meetings, presentations, or discussions are likely to be better attended and received. Examples might include presentation to school classes, scouts, or various civic groups. Experts in various fields or representatives from various agencies may also be able to attend or even make the presentations themselves.

With regard to public information, the most difficult part is in determining who or how to implement it. One possibility is to form a committee within the governing bodies or a citizen's committee with close ties to the governing body. The committee should consist of people interested in the topic and capable of researching the needed information, making contacts, and implementing specific approaches.

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2 For example, the largest attendance at a Council meeting will likely be at the next meeting after a storm water utility billing is sent out, rather than at the meetings leading up to the formation of a storm water utility.

Appendix 2.1:

Supplementary Weather Data for Brookings
(Source: Oregon Climate Service)

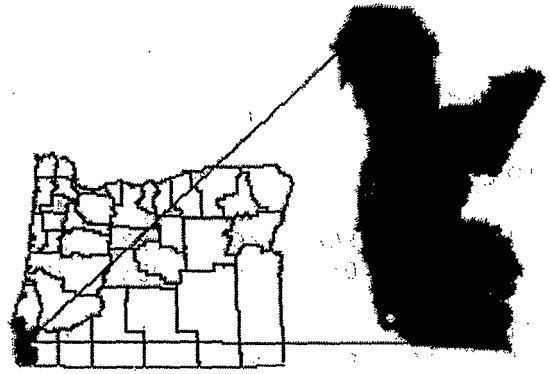
Monthly Means and Extremes
Brookings, Oregon Period: 1961-1990

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Temperature (F)													
Maximum	54.7	56.3	57.2	59.6	63.2	66.4	67.7	67.5	68.6	64.4	58.4	54.7	61.6
Minimum	40.9	42.0	41.8	42.5	46.0	49.5	51.2	52.0	51.2	47.9	44.6	41.2	45.9
Mean	47.8	49.1	49.5	51.0	54.6	57.9	59.4	59.8	59.9	56.2	51.5	47.9	53.7
Extreme Temperature (F)													
Maximum	73	83	80	85	94	101	102	101	103	94	81	79	103
Minimum	21	24	30	31	32	39	39	42	39	34	29	18	18
Precipitation (inches)													
Monthly mean	10.85	9.03	9.49	5.30	3.64	1.55	.53	1.31	2.15	5.84	11.89	12.23	74.78
Extreme 24 hour	4.00	4.20	5.00	3.05	5.97	2.92	1.40	3.61	2.97	5.45	4.58	4.55	5.97
Snowfall (inches)													
Monthly mean	.21	.30	.07	.00	.00	.00	.00	.00	.00	.00	.00	.07	.35
Average number of days													
Temperature													
Maximum 90 or more	.0	.0	.0	.0	.1	.3	.1	.2	.8	.1	.0	.0	1.8
Maximum 32 or less	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Minimum 32 or less	2.5	1.1	.5	.2	.0	.0	.0	.0	.0	.0	.3	2.0	5.6
Minimum 0 or less	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Precipitation													
.01 inches or more	16.6	15.7	18.1	12.7	8.7	5.8	3.9	5.3	5.8	10.8	17.5	17.8	140.6
.10 inches or more	13.6	12.7	14.5	9.4	5.6	3.0	1.2	1.9	3.4	7.6	14.6	15.1	103.0
.50 inches or more	7.6	7.0	7.3	3.8	2.4	1.1	.4	.8	1.5	4.4	8.5	9.1	54.6
1.00 inches or more	3.8	2.6	2.6	1.0	.9	.3	.1	.3	.6	1.9	4.1	4.1	22.7
Degree Days													
Heating days @ 65F	533	448	482	420	326	220	180	170	172	278	405	530	4156
Growing days @ 50F	30	39	43	66	148	237	292	303	296	194	78	28	1746

Oregon Climate Service

Climate Summary

Brookings, Oregon



station number: 351055

county: Curry

Monthly Means and Extremes **Period: 1971-2000**

Brookings, OR

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Temperature (F)													
Maximum	55.2	56.4	57.8	59.9	63.4	66.7	68.1	67.6	68.1	64.6	58.2	55.1	61.8
Minimum	41.7	42.5	42.4	43.7	46.8	49.8	52.0	52.6	51.4	48.2	44.6	41.4	46.4
Mean	48.5	49.5	50.1	51.8	55.1	58.3	60.1	60.1	59.8	56.4	51.4	48.3	54.1
Extreme Temperature (F)													
Maximum	73	83	83	85	93	101	102	101	103	94	79	79	103
Minimum	25	24	30	31	36	37	44	43	40	34	29	18	25
Precipitation (inches)													
Monthly mean	11.28	10.14	9.61	5.72	3.61	1.83	.51	1.04	1.95	5.22	10.58	11.99	73.48
Extreme 24 hr	4.80	4.01	5.00	2.80	2.68	2.92	1.81	3.61	2.67	5.45	5.15	5.56	5.56
Snowfall (inches)													
Monthly mean	.21	.30	.07	.00	.00	.00	.00	.00	.00	.00	.00	.07	.36
Average number of days													
Temperature													
Maximum 90 or more	.0	.0	.0	.0	.0	.4	.2	.1	.7	.2	.0	.0	1.7
Maximum 32 or less	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Minimum 32 or less	1.8	.9	.5	.1	.0	.0	.0	.0	.0	.0	.4	1.6	3.9

Minimum 0 or less	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Precipitation													
.01 inches or more	17.0	16.8	18.2	13.9	9.5	5.9	3.3	4.6	5.6	10.0	17.4	17.8	142.2
.10 inches or more	14.1	14.0	14.7	10.5	6.4	3.5	1.0	1.8	3.1	7.2	14.1	15.0	105.9
.50 inches or more	7.7	7.8	7.2	4.2	2.5	1.0	.3	.6	1.4	3.8	7.9	9.0	54.0
1.00 inches or more	3.9	3.2	2.8	1.4	1.0	.4	.1	.3	.6	1.8	3.8	4.3	24.1
Degree Days													
Heating days @ 65 (F)	511	439	465	400	310	212	163	159	172	276	415	520	3995
Growing days @ 50 (F)	33	42	53	77	161	245	310	313	292	198	70	30	1847

Appendix 4.1:

Curry County Zoning Ordinance
(Sections 3.280-3.450)

Section 3.280. Riparian Corridor Buffer Overlay Zone (RB).

Purpose of Classification: The purpose of the RB zone is to insure that riparian corridors identified in the County's Goal 5 water resources inventory (Comprehensive Plan Figure 5.8.A, Table 5.8.A, Table 5.8.C and Table 5.8.D) are protected as habitat for for fish, other aquatic life and wildlife, to control erosion and limit sedimentation, and to reduce the effects of flooding. The provisions of this section attempt to accomplish these goals by excluding structures from buffer areas around lakes, streams and associated wetlands, and by prohibiting vegetation removal or other alteration to those buffers.

Section 3.281. Riparian Corridors.

The riparian area is the area adjacent to a river, lake or stream, consisting of the area of transition from aquatic ecosystems to a terrestrial ecosystem. The riparian corridor to be protected by the provisions of this section is defined as the area:

1. Along all streams within a river drainage basin in which the principal river or creek has an average annual stream flow greater than 1,000 cubic feet per second (cfs), the riparian corridor boundary shall be seventy-five (75) feet from the top of each bank (Ref. Comp. Plan Figure 5.8.A).

2. Along all lakes, and streams within a river drainage basin in which the principal river or creek has an average annual stream flow less than 1000 cubic feet per second (cfs), the riparian corridor shall be fifty (50) feet from the top of each bank (Ref. Comp. Plan Figure 5.8.A).

3. Where the riparian corridor includes all or portions of a significant wetland as identified in the statewide wetland inventory (ref. ORS 196.674) and as adopted by the comprehensive plan, the standard distance to the riparian boundary shall be measured from, and include, the upland edge of the wetland.

4. Except as provided for in subsection 3. above, the measurement of distance to the riparian corridor boundary shall be from the top of the bank. The measurement shall be a slope distance. In areas where the top of each bank is not clearly defined, the riparian corridor boundary shall be measured from the ordinary high water level, or the line of non-aquatic vegetation, whichever is most landward. In areas where the predominant terrain consists of steep cliffs, the distance to the corridor shall be measured as a horizontal distance until the top of the cliff is reached, and as a slope distance on from that point.

Inventoried riparian corridors located on federal land are not subject to the provisions of this Section unless the riparian corridor identified in this subsection extends onto non-federal land.

Section 3.282. Uses Permitted in Riparian Corridors.

The following uses are allowed on lands located within a riparian corridor area as defined in subsection 1, above:

1. Uses permitted in the underlying zone(s) are permitted or conditionally permitted in the RB zone subject to the additional procedure and requirements of subsection 3.283, below.

2. The requirements of the RB zone does not regulate forest practices subject to ORS 527.610 to 527.770, 527.990(1) and 527.992 and the rules adopted pursuant thereto or to farm practices defined by ORS 30.930(2).

Section 3.283. Uses Prohibited or Limited within the Riparian Corridor.

The following uses are prohibited or limited within a riparian corridor area as defined in subsection 1, above:

1. The permanent alteration of the riparian corridor by placement of structures, by grading or the creation of impervious surfaces, except for the following uses provided they are designed to minimize intrusion into the riparian area, and no other options or locations are feasible:

   a) Streets, roads, and paths which are aligned to the greatest extent possible in a perpendicular direction relative to the bank of the body of water.

   b) Drainage facilities, utilities, and irrigation pumps.

   c) Water-related and water-dependent uses.

   d) Replacement of existing structures with structures in the same location that do not disturb additional riparian surface area.

   e) Structures or other non-conforming alterations existing fully or partially within the riparian area may be expanded provided the expansion does not occur within the riparian area. Substantial improvement of a non-conforming structure in the riparian area shall require compliance with the standards of this zone.

   f) Existing lawn within the riparian area may be maintained, but not expanded within the riparian area. Development activities on the property shall not justify replacement of riparian area with lawn.

   g) Existing shoreline stabilization and flood control structures may be maintained but not expanded to alter the riparian area.

2. Removal of vegetation in the riparian corridor area, except:

a) As necessary for restoration activities, such as replacement of non-native vegetation with native riparian species. The replacement vegetation shall cover, at a minimum, the area from which vegetation was removed, and shall maintain or exceed the density of the removed vegetation.

b) As necessary for the development of approved water-dependent or water-related uses. Vegetation removal shall be kept to the minimum necessary to allow the water-dependent or water-related use.

c) Trees in danger of falling and thereby posing a hazard to life or property may be removed, following consultation and approval from the Oregon Department of Fish & Wildlife. If no hazard will be created, the trees, once felled, may be required to be left in place in the riparian area.

d) Activities as necessary for uses involving forest practices subject to ORS 527.610 to 527.770, 527.990(1) and 527.992 and involving farming practices defined by ORS 30.930(2).

Section 3.284 Hardship Variances and Restoration Provisions.

1. Alteration Requiring Mitigation.

Permanent alteration of the riparian area by placement of structures or impervious surfaces under Section 3.283 (1) is allowable under the following procedures, subject to the mitigation requirements of 2. below.

a) A setback adjustment as allowed under subsection 3. below.

b) A variance to the riparian setback approved under subsection 4. below.

c) A setback reduction for streams described in Section 3.281 (1) as allowed under subsection 5. below.

2. Mitigation Requirements.

Proposals for development activities within the riparian area allowed under subsection 1 above, shall be reviewed by the Oregon Department of Fish & Wildlife (ODFW), as per OAR 635-415 "Fish and Wildlife Habitat Mitigation Policy". A mitigation recommendation shall be obtained from ODFW. For purposes of designing appropriate mitigation, sites should be considered at least in "Habitat Catagory 2" (OAR 635-415-0030), which strives for no net loss of habitat values.

Approval of the development proposal shall be as an administrative conditional use permit requiring compliance with the mitigation recommendations of ODFW.

3. Setback Adjustment.

a) Lots on which the riparian setback required by this zone exceeds any other setback required in the underlying zone results in a building area depth of 25 feet or less or a building footprint of 800 square feet or less will be qualified for a riparian setback adjustment.

b) A riparian setback adjustment shall be the minimum necessary to create a building footprint 25 feet deep or a building footprint of 800 square feet, whichever requires a lesser reduction of riparian setback. The yard setback opposite the riparian area may be reduced up to one-half of the standard setback, except in the case of the setback from a road or street where a traffic hazard would be created. If this does not create a sufficient building footprint area, the riparian setback may be reduced to one-half the required setback. Additional reductions of setbacks will require a variance. Removal of vegetation within the original riparian setback shall be the minimum necessary to allow development of the use, and shall otherwise conform with the relevant standards of Section 3.282(2).

4. Variance to Riparian Setback.

a) In cases where the provision for a setback adjustment under subsection 3 above is not sufficient, a property owner may request a variance to the riparian setback.

b) A variance to the riparian setback shall be applied for applied for and processed in accordance with Sections 8.010 and 8.020 of this ordinance.

c) Granting of a variance to riparian setback requires findings that:

i) the proposed development requires deviation from the riparian standards; and

ii) strict adherence to the riparian setback and other applicable standards would effectively preclude a use of the parcel that could be reasonably expected to occur in the underlying zone, and that the property owner would be precluded a substantial property right enjoyed by the majority of landowners in the vicinity; and

iii) the allowed setback adjustment in subsection 3 above is insufficient

to remedy the hardship.

5. Large River Setback Reduction.

On streams described in Section 3.281 (1) which have a large average annual flow structures and impervious surfaces may be placed within the riparian setback as follows:

a) The removal of vegetation shall be limited to the minimum amount necessary to accommodate the use. Any vegetation removed in excess of this standard shall be non-native species, and the proposal shall specify replacement of that vegetation with native species.

b) The applicant shall provide sufficient information regarding the proposed development and potential impacts to riparian resources to allow the Director, in consultation with the Oregon Department of Fish & Wildlife (ODFW), to determine whether the proposal will provide equal or better protection of riparian resources. This information shall include, but is not necessarily limited to:

i) a plot plan showing the top of the stream or waterbody bank;

ii) the extent of development within the riparian setback;

iii) uses that will occur within the riparian setback and potential impacts to riparian resources (e.g. chemical runoff, fire hazard, etc.);

iv) the extent of vegetation removal proposed;

v) characteristics of the existing vegetation (e.g. types, density, etc.);

vi) any proposed alterations of topography or drainage patterns; and

vii) existing uses on the property and any potential impacts they could have on riparian resources.

c) In no case shall such alterations occupy more than 50% of the width of the riparian area measured from the upland edge of the corridor.

Section 3.300 <u>Erosion Prevention and Sedimentation Control</u>

Purpose: The purpose of this provision, consistent with Goal 5 of the Curry County

Comprehensive Plan, is 1) to preserve or enhance the health, safety, welfare and quality of life of the inhabitants of Curry County by providing clean water, and by minimizing risk to inhabitants and property through control of erosion and management of storm water and 2) to maintain or improve water quality within Curry County consistent with the requirements of the State of Oregon and the United States government.

This provision seeks to accomplish these goals by requiring measures to prevent erosion, control sediment, and properly manage runoff from sites with disturbed soils and on structures and improvements that are associated with development activities. It is within this purpose to require measures that are both temporary and permanent in order to achieve these purposes for the long term.

Section 3.301 Areas of Applicability

This section is applicable to all lands within Curry County that are not within the limits of an incorporated city, or under federal ownership at the date of an application for approval of development activity, provided, however, that lands within areas that are subject to an approved comprehensive storm water management plan which has been adopted by Curry County are excluded from the provisions regulating the management of storm water drainage.

Section 3.310 Review by Director

1. The Director shall review all applications for development activity for conformance with the standards and criteria of this section.

2. The Director may retain decision-making authority over matters subject to review or may refer such matters to the Planning Commission consistent with the provisions of Article II of the Curry County Zoning Ordinance.

3. The Director or the Planning Commission, as the case may be, may approve, approve with conditions, require changes to or deny the application based upon the criteria or standards listed in Section 3.322. The decisions in such matters may be appealed consistent with the provisions of Article II of the Curry County Zoning Ordinance.

Section 3.320 Erosion Prevention and Sedimen~~tation~~ Control.

All development activity shall comply with the requirements for erosion prevention and sediment control. The intent of these provisions is to minimize the amount of sediment and pollutants that exit the site of development activity and, thereby, minimize the amount of such material that reaches waterways, wetlands, public improvements and the property of others. These provisions are intended to require that temporary and permanent measures be taken for all development activity that require or result in the disturbance of the surface of soil and/or vegetation.

Section 3.321 Development Affected

1. All development activity can result in altered or increased runoff, erosion and sedimen~~tation~~ both during and following vegetation removal, grading, construction of improvements, landscaping and other activities that disturb the surface of the soil. Measures must be taken to manage site hazards such as water runoff, soil erosion and sediment deposition. The requirements of this section must be met by all development activities that:

   a) Will result in the excavation of 800 square feet or more of soil surface or

   b) Will result in the construction of either 2,000 square feet of impervious surface on a site or will result in the coverage of 25% or more of the area of a site in impervious surfaces, whichever is less.

2. The activities of home gardening that disturb less than one half an acre of land and agricultural activities undertaken pursuant to ORS 215.203(2) are excluded from this requirement.

3. Activities undertaking to control invasive bush species for fire control purposes or for the preservation of pre-existing clearings or meadows are excluded from the requirements of Section 3.322.

4. Activities undertaking exploration activity such as backhoe pits and bore holes not requiring newly constructed road access are excluded from the requirements of Section 3.322.

Section 3.322 <u>Erosion Prevention and Sediment Control Plan</u>

1. Applications for authorization to undertake development and other activities described in Section 3.321 must be accompanied by an Erosion Prevention and Sediment Control Plan.

2. The provisions of an Erosion Prevention and Sediment Control Plan shall:

   a) demonstrate that the subject property will not be disturbed, excavated, filled or developed so as to cause movement of mud, soil, rock, vegetative material or any products of erosion or other depositional material onto, deposited upon or transported to the property of another;

   b) include specific interim and permanent measures that will prevent erosion and control sedimentation on the subject property and meet the requirements of Section 3.322(2)(a);

   c) include a strategy to minimize the removal of vegetation cover, particularly tree cover, necessary for access, building placement or to establish views for proposed structures or improvements. Nothing in this

requirement shall reduce the applicant's obligation to comply with the Fire Safety Areas required in Section 3.055.

d) in cases of development activity that will result in the division of land, include both interim and permanent measures and improvements that must be taken and installed during the development of each lot or parcel created.

3. Preparation of Erosion Prevention and Sediment Control Plans

a) On a single lot or parcel on which the development activity will occur on slopes of less than 15%, the plan may be prepared by the applicant utilizing best management practices. Plans for development activities that will result in the division of land may not be prepared pursuant to this subsection.

b) Development activities on properties that were created pursuant to an application and for which an Erosion Prevention and Sediment~~ation~~ Control Plan was approved shall comply with the provisions of that plan and may submit that plan in compliance with the requirements of Section 3.322(2).

c) On lands on which the development or other activity will occur on slopes of 15% or greater, the plan must be prepared by a geologist.

d) Plans prepared in Geologic Hazard Areas must also be prepared in consultation with, and be signed by, a geologist.

e) Final recorded plats and subdivision maps shall indicate that ~~the~~ all lots or parcels must be developed consistent with the approved Erosion Prevention and Sediment~~ation~~ Control Plan and that the measures and improvements specified in the plan must be maintained by the owner of each lot or parcel.

f) The applicant or owner of any lot or parcel on which an Erosion Prevention and Sedimentation Control Plan has been approved shall record on the title to the subject property a notification of the existence of the plan, of the fact that it can be reviewed in the Planning Division files and that also specifies the obligation of subsequent land owners to refrain from interfering with such measures or improvements and to maintain them.

Section 3.323 Review and Approval of an Erosion Prevention and Sediment Control Plan

1. The Director shall review the proposed Erosion Prevention and Sedimentation Control Plan for consistency with the requirements and purposes of these provisions and may approve, approve with conditions, require changes to or deny the application based and such review.

2. No activities may be conducted on the property that is the subject of such a plan prior to the Director's written approval thereof or prior to the installation of the approved erosion prevention and sedimentation control measures.

3. If prior to applying for a permit or other authorization vegetation removal is required to allow surveying and/ or site study, the applicant shall submit a plot plan to the Director describing the amount and location of vegetation removal. If the property has slopes greater than 15%, vegetation can only be cut off at or above ground level. Stumps and roots shall not be removed. The Director must approve this plan prior to any removal of vegetation.

Section 3.324. Installation and Certification of Erosion Prevention and Sediment Control Measures

1. The approved erosion prevention and sediment control measures shall be installed and maintained as required by the approved plan.

2. The installation of measures required in a plan prepared under Section 3.322(3)(c) may be certified by the applicant.

3. The installation of measures required in a plan prepared under Section 3.322(3)(d) shall be inspected by Curry County or may be certified by the engineer or by a geologist who prepared the plan.

Section 3.400. Storm and Surface Water Management Standards

Purpose: Detention of stormwater collected from impervious surfaces on a given property, or within public rights-of-way, is essential to the management of stormwater in Curry County. This ordinance includes standards for conveyance of surface water to streams, creeks, and channels. It also addresses pollution reduction and flow control for stormwater generated from new and redevelopment. For the purpose of this ordinance, "new" and "redevelopment" refers to any man-made change to improved or unimproved real estate including, but not limited to the placement of buildings or other structures, dredging, filling, grading, or paving. The ordinance provides standards for addressing infiltration, treatment, and detention of stormwater separately as well as an option for a combined approach to mitigating the water quality impacts of developments that fall below a certain size threshold.

Section 3.401 - Applicability: No permit for construction of new development or tenant improvements that results in impervious cover greater than 500 square feet for development activity on any land within Curry County that is not within the limits of an incorporated city, or under federal ownership, at the date of an application shall be issued until effects on stormwater management are evaluated. The level of review varies according to the affected area:

1. 500-1,999 square feet. No stormwater management measures beyond any mitigation measures for pollution reduction or flow control are required.

2. 2,000-4,999 square feet. Conceptual plans shall be submitted for approval.

3. 5,000+ square feet. A comprehensive stormwater **management plan** shall be submitted for approval.

4. Areas smaller than 500 square feet may require review, and a greater level of review for properties between 500 and 4,999 square feet may be necessary when the site is identified as having especially sensitive conditions, including but not limited to wetlands, steep slopes, and fish bearing streams.

Separate applicability thresholds for Pollution Reduction and Flow Control Standards are listed in Section 3.440 Pollution Reduction and Flow Control Standards. Development projects shall not be phased or segmented in such a manner to avoid the requirement of these Rules and Regulations.

The Oregon Department of Transportation (ODOT) shall require stormwater and water quality management plan coordination, design approval to state standards, and applicable permits for all development impacting state transportation drainage facilities.

Section 3.410. Stormwater Management Plan Submittal

1. Site plans shall included the following analyses and descriptions:

   a) A description of stormwater mitigation strategies to increase infiltration, promote evapotranspiration (use of water by plants), and reduce the amount of stormwater runoff generated from the site.

   b) Calculations of the amount of impervious surface before development and the amount of impervious surface after development. Impervious surface refers only to strictly impervious surfaces including roofs of buildings, impervious asphalt and concrete pavements, and other specifically impervious pavement materials such as mortared masonry and gravel.

   c) An analysis of vegetative and other treatment methods used to reduce pollutants.

   d) An analysis of flow reduction methods including infiltration, detention, and retention techniques.

   e) Statement of consistency with County stormwater management and, if applicable, the watershed management plan for the basin and/or

requirements of a pollutant load reduction plan for a water quality limited stream which may be affected by ground disturbance or increased or altered flow regime.

2. Post-construction plans shall include the following information:

   a) As-built plans, stamped an engineer or geologist indicating all stormwater mitigation and management strategies are installed per approved plans and approved changes.

   b) Maintenance plans for all stormwater treatment facilities installed to comply with this ordinance. The maintenance program shall be subject to a recorded agreement with the County that outlines the stormwater treatment facility responsibilities of property owners and the County.

Section 3.420. General Requirements

1. Intent and Purpose. All development shall be planned, designed, constructed and maintained to provide a system by which storm/surface water within the development will be managed without causing damage or harm to the natural environment, or to property or persons and to protect property from flood hazards.

2. Criteria. Plans shall be submitted to the Curry County Public Services Department for review. All plans and calculations for areas 5,000 square feet or larger must be stamped and signed by a hydrologist, civil engineer, or other qualified person recognized by the County. Plan approval will be based on the following criteria:

   a) Design, construction and maintenance of proposed stormwater management plan will result in limiting as much as possible the increase in post-development off-site stormwater flow over pre-development off-site stormwater flow.

   b) All in-stream culvert installations must allow fish passage in accordance with Division of State Lands (DSL) and the US Army Corps of Engineering (COE) and any other authorized federal, state, or local agency.

   c) Installation of culverts, spans, or stormwater outfalls along natural water features shall be designed to emphasize preservation of natural flow conditions and pursue stream enhancement opportunities.

   d) Stormwater mitigation strategies, such as retention of existing trees, and use of porous paving surfaces, as well as stormwater treatment and flow

control facilities used to meet the requirements of this code must be included in the plans.

e) Stormwater management plan shall be consistent with the County's most current Stormwater engineering practice.

f) In areas of high pollutant load, stormwater infiltration shall incorporate, or be preceded by treatment as necessary to prevent siltation of the infiltration facility, protect ground water, and prevent toxic accumulations of pollutants in the soil.

g) All storm conveyance pipes, vaults and stormwater infiltration, treatment and detention facilities shall be built to specifications of the County.

h) The plan shall demonstrate compliance with the standards of CCZO Section 3.430 - Surface Water Conveyance Standards.

i) The plan shall demonstrate compliance standards of CCZO Section 3.440 - Pollution Reduction and Flow Control Standards.

3. Infiltration Facilities. The County reserves the right to restrict the use of infiltration facilities in high risk areas including those in Natural Hazard Areas with steep slopes, unstable soils, high water tables, or sites known to be contaminated by hazardous substances.

a) Infiltration facilities which fall under the jurisdiction of DEQ's Underground Injection Control (UIC) Program must be registered with the state and meet the requirements of the UIC Program.

b) Security. Applicants shall provide cash or a letter of credit acceptable to the County to assure successful installation and initial maintenance of surface pollution reduction and flow control facilities.

c) Contingency for system failure. If the storm drainage system fails due to lack of maintenance or breakage, and there are impacts to downstream water quality or quantity as a result of the failure, the County may perform the maintenance or repair and has the authority to charge the owner of the facility.

Section 3.430. <u>Surface Water Conveyance Standards</u>

1. The following measures are designed to efficiently convey stormwater.

a) Culverts in and spans of streams, creeks, gulches, and other natural

drainage channels shall maintain a single channel conveyance system.

b) Culverts and/or spans are to be sized for the 24-hour post-developed tributary conditions of the 10-year storm on streams with an average flow less than 200 cfs.

c) Conveyance calculations shall use the following methods for analysis:

i) Projects smaller than 20 acres: The Rational Method, Santa Barbara Urban Hydrograph, SCS TR-55, HEC-1, or SWMM.

ii) Projects 20 acres or larger: Any of the methods except the Rational Method. Exceptions must be documented and approved by the County.

d) Credit will not be given for in-stream and in-line detention.

e) It shall be the responsibility of the owner that the new drainage system shall not negatively impact any natural water conditions. The owner is responsible for providing a drainage system for all surface water, springs, and groundwater on site and for water entering the property as well as management of springs and groundwater that surface during construction.

Section 3.440. Pollution Reduction and Flow Control Standards

1. Applicability. These standards shall apply to all subdivisions or site plan applications creating greater than 500 square feet of impervious surface or redevelopment footprint area, unless eligible for an exemption or granted a waiver by the County. Additionally, these standards apply to land development activities that are smaller than the minimum applicability criteria if such activities are part of a larger common plan of development that meets the applicability criteria, even though multiple separate and distinct land development activities may take place at different times and at different schedules.

2. Waivers. The County at its discretion can waive in whole or in part minimum requirements for stormwater management, provided the applicant can prove with submitted findings that at least one of the following conditions applies:

a) It can be demonstrated that the proposed development is not likely to impair attainment of the objectives or standards of this section, the County's Stormwater Plan, or the County's Stormwater Management Program.

b) Alternative minimum requirements for on-site management of stormwater

discharges have been established in a stormwater management plan that has been approved by the County.

c) Provisions are made to manage stormwater by an off-site facility. The off-site facility is required to be in place, to be designed and adequately sized to provide a level of stormwater control that is equal to or greater than that which would be afforded by onsite practices and there is a legally obligated entity responsible for long-term operation and maintenance of the stormwater practice.

d) The County finds that meeting the minimum on-site management requirements is not feasible due to the nature or existing physical characteristics of a site.

e) Non-structural practices will be used on the site that reduce: a) the generation of stormwater from the site, b) the size and cost of stormwater storage and c) the pollutants generated at the site. These non-structural practices are explained in detail in the current design manual and the amount of credit available for using such practices shall be determined by the County.

Section 3.443. Infiltration, Treatment, and Detention.

Proper management of stormwater includes a combination of infiltration, treatment, and detention. This Section establishes the review standards for each method.

1. Infiltration

a) Infiltration systems are to infiltrate a minimum of one-half inch of rainfall in 24 hours.

b) Stormwater treatment, in accordance with Section 3.443(2), shall occur prior to or concurrent with infiltration.

c) Infiltration systems shall be designed to overflow to conveyance systems.

d) Infiltration may be waived, or reduced, if it can be demonstrated by an engineer or geologist that infiltration will destabilize the soil, cause structural problems, or provide negative impacts to the environment, or because of site constraints such as high groundwater or soil contamination. In such cases, findings shall demonstrate that stormwater runoff will not adversely affect adjacent properties or substantially change the flow characteristics of receiving water ways, or if runoff is determined to occur, the developer shall be respsonsible for in-lieu-of fees for regional

treatment or off-site mitigation.

2. Treatment

   a) Water quality treatment facilities shall be designed to capture and treat runoff for all flows up to the 80th percentile storm event.

   b) The water quality system shall use vegetation for treatment. Alternative systems may be used with approval of the of the Director after consulting an engineer and shall be designed to provide equivalent treatment as is provided with a vegetated system.

   c) Systems treating stormwater from over 5,000 square feet of impervious area and all systems must be designed by a registered engineer and be approved by the County.

3. Detention. On-site storm quantity detention facilities shall be designed to capture and detain runoff as follows:

   a) 2-year, 24-hour, post-developed runoff rate to a 2-year, 24-hour pre-developed discharge rate;

   b) Sites with infiltration systems designed to handle storms in excess of that specified by Section 3.443(3)(a) (above) of this Section will be permitted to reduce on-site detention requirements by a volume equal to 100% of the infiltration capacity.

4. Conveyance. Infiltration, treatment, and detention facilities shall be constructed to convey excess stormwater. Conveyance systems shall be sized to meet the following conditions:

   a) Stormwater drainpipes draining less than 640 acres, 25-year 24-hour design storm.

   b) Stormwater drain pipes draining greater than 640 acres, 50-year 24-hour design storm.

Section 3.450. Review Process

The requirements of this Chapter must be approved by the Public Services Director.

Appendix 4.2:

Brookings Land Development Code
(Section 17.168.150)
(Section 100 (Updated 2006))
Brookings Municipal Code
(Section 8.10)

location, lengths and sizes as approved by the Department of Environmental Quality and the city engineer. Such design shall taken into account the capacity and grade to allow for needed extension beyond the proposed use or development. If required sewer facilities installed by the developer will directly benefit and serve property outside the development, whether immediate or future, the following arrangements will be made to equitably distribute the cost.

1. If the area outside the development to directly benefit from and be served by the sewer line has reached a state of development to justify immediate sewer installation and connection, the city manager will recommend that the city council establish a local improvement district and the project constructed under an assessment district, with such arrangement with the developer as is equitable to assure financing the developer's share of the construction project.

2. If the installation is not accomplished as an assessment project, the city will reimburse the developer an amount estimated to be a proportionate share of the cost for each connection made to the sewer by property owners outside of the development for a period of 10 years from the time of installation of the sewer. The amount of excess costs to the developer shall be as determined at the time of issuing the development permit, considering then current actual construction costs. [Ord. 89-O-446 § 1. Formerly 16.05.140.]

17.168.150 Storm drain system.

A. Storm drainage facilities shall be designed and installed by the developer to provide proper drainage for each new development and to connect the development to drainageways or storm sewers outside the development that have an adequate capacity to accept such stormwaters. If an upstream area discharges through the property proposed for development, the drainage system shall provide capacity to receive the flood water discharge from the upstream area.

B. If the proposed development, or the ultimate development that the proposed development will serve, will cause an increase in floodwater flow and the downstream drainage system is not sufficient to receive the increase, provisions shall be made to increase the downstream capacity.

C. Storm Drainage System Design. Design of the new drainage system within the development, as approved by the city engineer, shall take into account the capacity and grade necessary to maintain unrestricted flow from areas draining through the development and to allow extension of the system outside the development. The storm drainage system shall consist of mains of not less than 12 inches in diameter, together with such manholes, catch basins, laterals and other structures, and at such grades, as required by the city engineer to prevent standing or flooding stormwaters within and outside the development boundaries.

D. If the city engineer determines that oversizing drains, laterals or other facilities for storm drainage is necessary to be installed by the developer, which oversizing can or will benefit the immediate or future use of property outside the limits of the development, the developer shall install such facilities in excess of the requirements of his development alone, and the city shall reimburse the developer the excess of costs of the oversize or additional facilities to the extent available within the storm drain, systems development charge fund of the city. [Ord. 89-O-446 § 1. Formerly 16.05.150.]

17.168.160 Water system.

Water lines and fire hydrants serving each building site in the development shall be installed by the developer in public street rights-of-way, private streets or public easements. The lines shall be connected to existing mains, or the developer shall install additional mains as necessary to adequately serve such development.

A. Water System Design. Water system design shall take into account the need for extension beyond the development and to adequately grid the water system. All water facilities shall be installed to standards, location, lengths and sizes as approved by the city engineer. Actual capacity tests, if needed, shall be run by the city fire marshal at the expense of the developer.

B. If required water facilities installed by the developer will directly benefit and serve property outside the development, whether immediate or future, the city will reimburse the developer an amount estimated to be the proportionate share of the cost for each connection made to the water main by property owners outside the development for a period of 10 years from the time of installation of the main. The amount shall be determined at the time of issuing the development permit, considering then current construction costs. An alternative to this method of equitably distributing the cost of such water main extension outside the proposed development may be pursuant to BMC 17.168.140(A)(1). [Ord. 89-O-446 § 1. Formerly 16.05.160.]

Section 100
HAZARDOUS BUILDING SITE PROTECTION
HILLSIDE DEVELOPMENT STANDARDS

Sections:

100.010 Purpose.
100.020 Definitions
100.030 General Mitigation.
100.040 Decision Authority of City Manager or Planning Commission
100.050 Authority to Require Site Study
100.060 Geologic Report Required
100.070 Engineered Plans Required
100.080 Enforcement

100.010 Purpose.

A. The purpose of this section is to reduce the effects of flooding, erosion, landslides and siltation during all stages of development on all lots within the city and to reduce the hazards associated with construction on the steeper hillsides, beach fronts and/or wherever hazards are known or suspected. This section applies to all property within the city and the level of protection required is based on the steepness of slopes, relation to coastal bluffs and other known or suspected conditions. This section is intended to advance the above purpose:

1. By requiring the study of such areas, by a qualified person, as defined in 100.060 and 100.070, prior to development, as defined in Section 100.020 (C).

2. By requiring special construction techniques to control dust, mud, water runoff, soil erosion, rock or sediment deposition during construction.

3. By establishing mechanisms for enforcement to ensure compliance with this code.

B. The policies and standards of this section are based upon the data contained in the Comprehensive Plan document and other technical information.

C. This Section is not meant to regulate landscaping/ gardening activities on an existing, developed property unless there will be a disturbance of greater than acre in size, or involve terracing or similar activities. A property owner may apply to the Site Plan Committee for authorization to conduct more intense landscaping/ gardening activities if they exceed ½ acre in size.

100.020 Definitions. For the purposes of this section, the following definitions shall apply.

A. Average Slope – the overall increase/ decrease in elevation on the property proposed for development, expressed as a percentage based on the following formula: difference in elevation over horizontal distance.

B. Determination of 15% slopes – The applicant may be required to provide a topographic map prepared by a licensed engineer or surveyor. The topographic map shall contain a line drawn approximately perpendicular to the contours indicating the percent of slope. In some instances the City Engineer may accept a sketch and/ or certificate prepared by a licensed individual indicating the average slope of the property.

1. If the average slopes are less than 15%, but the proposed development is on area of 15% slopes, standards in Section 100.040 and 100.060 shall apply.

2. If the average slopes are greater than 15%, but the development is proposed on a level area away from the slopes, a site specific review of the proposal by the Site Plan Committee shall determine if standards in Section 100.040 and 100.060 apply.

C. Development – Any alteration of improved or unimproved land, including but not limited to a land division, buildings or other structures, grading, filling or removal of vegetation.

D. Geologic Report – A report prepared by a Geologist, Geotechnical Engineer or other qualified individual, licensed by the State of Oregon, and containing the following information:

1. The stability of the property and the suitability for the proposed type of construction in relation to the size of lot, including all existing and proposed new streets.

2. A statement of the need for engineered foundations or for site specific studi

to determine if engineered foundations are necessary.

3. A clear statement of all requirements or conditions on the proposed development that the geologist, geotechnical engineer or other qualified individual, licensed in the State of Oregon, has determined is necessary to mitigate the geological hazards that have been identified in the site investigation.

E. Grading – Any movement of earth for whatever reason including removal of the root systems for brush and trees.

F. Hazardous Sites– Areas containing or adjacent to a fault zone, sinkhole, unstable soils, steep slopes, high water table, or other geologic hazards as discussed in Section 100.010 (A) Purpose statement.

G. Vegetation Removal – Cutting of brush and trees but not removing root systems.

100.030 General Mitigation

Prior to development activity on **any** property, certain standards must be met to reduce building site hazards such as flooding, landslides, soil erosion, sediment deposition, etc. The following process is required:

A. When partitioning or subdividing any parcel, the requirements of Section 100.070, including a determination of seasonal high water table level impact on development of the property, and groundwater drainage mitigation design if necessary, must be submitted with the application.

B. Prior to any site preparation on all lots, the applicant must provide a plan demonstrating that no property shall be disturbed, graded, excavated, filled or developed within the City so as to cause slides of mud, soil, rock, vegetative material or any eroded or depositional material to be deposited on the property of another. The plan shall also include the strategy for the minimal removal of vegetation cover, particularly tree cover, necessary for building placement or access. This plan shall be submitted to the Site Plan Committee with a Permit Clearance Form, requesting a building permit, or a Land Use Permit Application.

C. If minimal brush removal is needed to allow surveying and/ or site study **prior to applying for a permit**, a plot plan and request must be submitted by the

applicant describing the amount and location of vegetation removal. Brush and trees can only be cut off at ground level and stumps and roots shall not removed. The City shall review and approve this plan prior to any removal of vegetation.

D. No grading can occur until a grading permit or building permit has been issued. Grading plans must show compliance with State of Oregon Structural Specialty Code.

100.040 Decision Authority of City Manager or Planning Commission.

A. The City Manager, or his or her designee, shall review and approve or deny requests for building permits or grading permits on lots within areas identified as having hazardous conditions.

B. The Planning Commission shall review and approve or deny land use applications proposed within areas identified as being a hazardous site and for all land divisions.

C. The Planning Commission may approve, approve with conditions or require changes or deny the proposal based upon the criteria or standards listed Sections 100.050, 100.060, and 100.070. Planning Commission decisions may be appealed to the City Council as provided in Section 156.

100.050 Authority to Require Site Study

A. The City Manager or his or her designee shall require a site study by a geologist, geotechnical engineer, or other qualified individual, licensed in the State of Oregon prior to any disturbance on property, or the approval of a land use application, in areas containing or adjacent to a fault zone, sinkhole, unstable soils, steep slopes, high water table, or other geologic hazard.

B. If the report in **A.** above indicates additional information is needed, site specific studies prepared by qualified person(s) shall be required by the City Manager or his or her designee, or the Planning Commission

100.060 Geologic Report Required. Except for the purpose of surveying pursuant to subsection 100.030 above, and prior to any vegetation removal and/or grading, a geologic report shall be required as follows:

A. When disturbing land within the City, the following provisions apply:

1. All parcels with slopes of less than 15% shall provide erosion control measures pursuant to subsection 100.030 above.

2. On all lots that contain slopes of 15% or greater but development is proposed on an area of less than 15% slope, only compliance with Section 100.030 above is required, unless other provisions of this Section are required at the discretion of the Site Plan Committee.

3. All lots with average slopes of 15% or greater, or other identified hazard, or on lots where the desired development is on a slope of 15% or greater, a geologic report and engineered plans in compliance with the provisions of subsection 100.070, below, is required prior to the removal of any vegetation or grading, on the property.

4. On lands that contain slopes of greater than 15%, all lots shall be of the minimum lot size allowed by underlying zone, except larger lots may be required if the geologic survey of the property requires a larger lot to avoid hazardous areas or other conditions.

B. Development on the ocean bluffs shall comply with the provisions of this section as follows:

1. A geologic report shall be provided prior to the following:

a) Partitioning or subdividing property.

b) Siting a new structure on a vacant lot.

c) Constructing an addition to an existing structure on the ocean side or the side yard area.

d) Constructing a second floor on an existing structure.

e) Siting an accessory structure (garage, shop etc) on the ocean side or side yard area of an existing dwelling.

2. The geologic report shall contain the following information:

a) The stability of the bluff and their suitability for the proposed type construction in relation to the size of lot proposed, including any required setback from the edge of the bluff.

b) The need for engineered foundations or for site specific studies to determine if engineered foundations are necessary.

c) A clear statement of all requirements or conditions on the proposed development that the geologist, geotechnical engineer, or other qualified individual has determined is necessary to mitigate the geological hazards that have been identified in the site investigation.

3. A geologic report (unless Site Plan Committee determines conditions dictate otherwise) is not required when:

a) Remodeling within an existing, intact structure or,

b) siting an addition or accessory structure on the upland (furthest from the ocean) side of the existing dwelling.

100.070 Engineered Plans Required

A. No property shall be disturbed, graded, excavated, filled or developed within the City so as to cause slides of mud, soil, rock, vegetative material or any eroded or depositional material to be deposited on the property of another.

B. Prior to any site preparation, including vegetation removal, except as allowed for survey purposes in subsection 100.030 above, on a lot with slopes greater than 15 %, or other hazardous condition including but not limited to ocean front property, or on any proposed partition or subdivision, the applicant shall submit plans prepared by an Oregon licensed civil engineer with the following information for approval by the City:

1. An erosion control plan showing the area to be denuded of vegetation, erosion control measures and implementation time table. Erosion and sedimentation caused by storm water runoff shall be minimized by employing the following measures, or substitute measures deemed acceptable by the City Manager or his or her qualified designee:

a. Only the removal of vegetation cover, particularly tree cover, necessary for building placement or access, shall be allowed. If any additional removal of vegetation is proposed by the applicant, a plot plan indicating the area and amount of removal must be submitted for review and approval by the Site Plan Committee.

b. Measures for controlling runoff, such as silt fencing, hay bales, berms, holding ponds, terraces, ditches, hydro seeding or permanent cover shall be used as required, particularly in areas having slopes of 15% or greater. The applicant shall contact Oregon Department of Environmental Quality (DEQ) concerning the possible need for a 1200C Storm Water General Permit.

2. Prior to any grading, a grading plan showing all cut and fill slopes associated with new or improved roads, driveways, building pads, and all utility grading including water, sewer, electrical, telephone, and television cables. The grading plan shall include associated erosion control measures and implementation time table for the grading operation.

3. A drainage plan to control groundwater and storm water runoff.

a. All storm drainage shall be designed by a Civil Engineer and approved by the City. The storm drain facilities shall be designed for storms having a 25-year recurrence frequency. Storm water shall be directed into drainage with capacity to be calculated in accordance with the City's Comprehensive Plan for Storm Drainage Development and Chapter 8.10 of the Brookings Municipal Code, and address on-site and off-site impacts, so as not to flood adjacent or downstream property.

b. In all areas of the city, the City Manager or his or her designee may require culverts or other drainage facilities, designed in accordance with the City's Comprehensive Plan for Storm Drainage Development and Chapter 8.10 of the Brookings Municipal Code, be installed as a condition of construction.

c. Plan must include a determination of seasonal high water table level impact on development of the property, and a groundwater drainage mitigation design if necessary.

C. Developments which abut the coastal bluffs or coastal shoreland boundary, or direct surface water runoff over the bluffs or boundary shall require special

impact mitigation measures.

D. Filling of lowlands shall be done only where it is determined that the fill shall not cause flooding or damage to adjacent properties and where adequate drainage facilities are installed. This provision does not apply to lowlands containing jurisdictional wetlands, where State wetland removal/fill permits would be required or areas regulated by the City Flood Damage Prevention Ordinance.

E. No work shall commence until the applicant has received written approval from the City and required permits have been issued.

100.080 Enforcement

A. The removal of vegetation, grading, construction, location, development or use of land or structures, contrary to the provisions of this section, ordinance or permit, or any conditions or limitations approved pursuant to this Code, is a violation.

B. In addition to other remedies set forth in Section 164, and other remedies provided by ordinance or under state law, the city may institute appropriate action or proceedings to prevent, restrain, correct, abate or remove the unlawful location, erection, construction, development, maintenance, repair, alteratio occupancy or use of land or structures.

C. If the City Manager determines that a violation of this section has occurred, the City shall notify the owner of the land and the developer, general agent, architect, builder, contractor or other person or entity who is known by the City to have participated in committing the violation, through a Stop Work Order, to cease all further development until such time as the violation has been remedied. If development continues in disregard of notice from the City, the City may seek an injunction to stop further development until the violation has been remedied.

D. If the City Manager determines that a violation has occurred, the City shall give written notice to the owner of the land, and the developer, general agent, architect, builder, contractor, or other person or entity who is known by the City to have participated in committing the violation, that a violation has occurred and that the violation must be remedied within a time specified. The amount of time to remedy the violation shall depend upon the nature of the violation, the circumstance then existing and whether an emergency exists. Noncompliance within the time set by the City shall cause the City to take remedial steps to cure the violation and charge the costs, fees and expenses of such remedial action to the owner of the land. This shall include any expenses, costs and fees paid by t

City to third persons for labor and materials to remedy the violation. Charges made under this subsection shall be a lien against the real property on which the violation arises and the City Recorder is authorized to enter the amount of such charges immediately in the docket of city liens.

E. The owner of the land, and the developer, general agent, architect, builder, contractor or other person or entity who takes part in any violation of this ordinance shall be guilty of a violation.

F. The remedies set forth in this section are cumulative and not exhaustive of all remedies the City may exercise to prevent, correct or abate a violation under this section.

[Section 100 as amended in its entirety by Ordinance No. .....

as may be warranted by the facts; or, if confirmed, the same may thereafter be enforced by notice issued by the city recorder to the police chief to sell said premises upon publishing a notice of such proceeding as is otherwise required on sale of real property for the satisfaction of city liens. [Ord. 59-O-134 § 13.]

8.05.090 Rules and regulations for the construction, installation and operation of incinerators.

No incinerator or other receptacle, container, or structure shall be used for the burning of refuse and other waste matter within the city of Brookings unless a permit for the use of such incinerator, container, or other structure shall have first been obtained from the fire marshal. No such incinerator or other structure shall be used for the burning of refuse or other waste matter unless it shall be so constructed as reasonably to contain the flame, cinders, and other debris resulting from the fire within the incinerator or other structure; and no such incinerator or other structure shall be operated in such a manner as to constitute a nuisance. The fire marshal is authorized to adopt such rules and regulations with regard to the construction, installation, and operation of such incinerators and other structures used for the burning of waste and other refuse as are necessary to bring said incinerators and other structures in compliance with the requirements of this chapter. [Ord. 59-O-134 § 14.]

8.05.100 Penalties.

Any violation of this chapter shall be deemed an offense and any person upon conviction thereof shall be punished by a fine of not less than $5.00 nor more than $100.00, or by imprisonment for not more than 30 days, or by both such fine and imprisonment, in the discretion of the court. [Ord. 59-O-134 § 15.]

Chapter 8.10

WATERCOURSES

Sections:

8.10.010	Alteration, change, restriction, or blockage of watercourses prohibited – Collection or concentration of surface waters prohibited.
8.10.020	Permit required.
8.10.030	Specification of damages.
8.10.040	Indemnification of city.
8.10.050	Responsibility of property owners.
8.10.060	Declaration of public nuisance and assessment of costs of abatement.
8.10.070	Penalties.
8.10.080	Continuing violations.

8.10.010 Alteration, change, restriction, or blockage of watercourses prohibited – Collection or concentration of surface waters prohibited.

No natural drainage course shall be altered, changed, restricted or blocked in any manner, nor shall diffused surface waters be collected or concentrated in any manner until or unless a drainage plan prepared by an Oregon registered professional engineer shall have been submitted to and approved by the city manager. [Ord. 88-O-429 § 1.]

8.10.020 Permit required.

The permit required herein may be terminated by order of the city manager for failure by the property owner to properly maintain the improved waterway and drainage appurtenances in a safe and workmanlike manner. [Ord. 88-O-429 § 2.]

8.10.030 Specification of damages.

Any person, firm or corporation which shall have altered or changed a watercourse, allowed restriction or blockage thereof in any manner whatsoever, or increased the drainage runoff flow so as to cause flooding or damage to other properties shall be liable in damages arising out of such alteration, change, restriction, blockage, flooding or damage, for such actions. [Ord. 88-O-429 § 3.]

8.10.040 Indemnification of city.

This chapter shall not be construed to hold the city responsible for any damage to persons or property by reason of the issuance of any permit for drainage improvements or development, the installation of any improvements, the collection or concentration of any diffused surface waters or the

alteration, change, restriction, blockage, flooding or damages to watercourses or to other properties resulting therefrom, all of the aforesaid being the responsibility of the private property owners of the properties affected or involved. [Ord. 88-O-429 § 4.]

8.10.050 Responsibility of property owners.

All property owners within the city of Brookings shall, within 10 days after they shall have actual notice that a natural watercourse on or adjacent to property owned by them is obstructed or constricted, remove such obstruction or constriction, and in the event such watercourse shall form the boundary between properties, it shall be the duty of each adjacent property owner to remove such obstruction or constriction. [Ord. 88-O-429 § 5.]

8.10.060 Declaration of public nuisance and assessment of costs of abatement.

It is hereby declared that any obstruction, constriction or blockage of a natural watercourse within the city of Brookings is a public nuisance and the city of Brookings shall have the right to abate such public nuisance, and to enter upon any private property within the city of Brookings for such purpose, and shall assess the cost of such abatement as a lien against the property through which such natural watercourse flows and upon which the obstruction or constriction occurs, and in the event such watercourse forms the boundary between two properties, shall assess the cost equally to the adjacent properties. Such assessment shall be levied by the filing of a statement of such costs together with the description of the properties to be assessed, together with the names of the owners thereof with the city recorder, whereupon the city recorder shall forthwith enter such assessment as a lien against such property in the city lien docket of the city of Brookings. An administration fee of $50.00 or 15 percent of the cost, whichever is greater, shall be charged and collected by the city. [Ord. 88-O-429 § 6.]

8.10.070 Penalties.

Any violation of the terms of this chapter shall be punishable, upon conviction thereof, by a fine of not more than $100.00, which fine shall be in addition to the costs of abatement and the liabilities enumerated herein. [Ord. 88-O-429 § 7.]

8.10.080 Continuing violations.

In the event of a continuing violation of this chapter, each day during which such violation exists shall be deemed a separate offense hereunder. [Ord. 88-O-429 § 8.]

Appendix 6.1:

Subbasin Data Sheets

Subbasin 1

Total Area:	239.3	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	107304	*Lineal Feet*
Hydraulic Length:	3875	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	0.9
D	0.1

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	112.17	0.4687	70.7
Woods with poor coverage (W2)	106.69	0.4458	77.6
Cultivated Land (F)	0.00	0.0000	78.3
Open Space with 50-70% cover (O)	0.00	0.0000	79.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	3.53	0.0148	94.1
Industrial (I)	0.00	0.0000	91.2
Paved (P)	15.60	0.0652	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.2
4 units/ acre (R4)	0.00	0.0000	83.4
3 units/ acre (R3)	0.00	0.0000	81.5
2 units/ acre (R2)	0.00	0.0000	80.5
1 unit/ acre (R1)	1.33	0.0056	79.5
		Subbasin Curve Number:	**75.9**

Subbasin 2

Total Area:	1260.75	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	770629	*Lineal Feet*
Hydraulic Length:	16130	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.15
C	0.7
D	0.15

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	727.82	0.5774	68.8
Woods with poor coverage (W2)	365.72	0.2901	76.3
Cultivated Land (F)	0.00	0.0000	77.4
Open Space with 50-70% cover (O)	32.43	0.0257	78.3
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.48	0.0004	93.9
Industrial (I)	0.00	0.0000	90.9
Paved (P)	1.14	0.0009	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.6
4 units/ acre (R4)	0.00	0.0000	82.4
3 units/ acre (R3)	0.00	0.0000	80.4
2 units/ acre (R2)	6.34	0.0050	79.3
1 unit/ acre (R1)	126.64	0.1005	78.1
		Subbasin Curve Number:	**72.2**

Subbasin 2.1

Total Area:	607.5	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	378315	*Lineal Feet*
Hydraulic Length:	13103	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.4
D	0.3

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	315.56	0.5145	67.6
Woods with poor coverage (W2)	215.56	0.3515	75.5
Cultivated Land (F)	0.00	0.0000	76.8
Open Space with 50-70% cover (O)	4.13	0.0067	77.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.7
Industrial (I)	0.00	0.0000	90.7
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.1
4 units/ acre (R4)	0.00	0.0000	81.8
3 units/ acre (R3)	0.00	0.0000	79.8
2 units/ acre (R2)	0.00	0.0000	78.5
1 unit/ acre (R1)	78.04	0.1272	77.2
		Subbasin Curve Number:	**71.7**

Subbasin 3

Total Area:	26.51	*Acres*
Contour Length (5' cont.):	35305	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1874	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.7
C	0.3
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	19.58	0.7397	59.5
Woods with poor coverage (W2)	6.00	0.2267	69.3
Cultivated Land (F)	0.00	0.0000	73.1
Open Space with 50-70% cover (O)	0.00	0.0000	72.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.6
Industrial (I)	0.00	0.0000	88.9
Paved (P)	0.89	0.0336	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.5
4 units/ acre (R4)	0.00	0.0000	77.4
3 units/ acre (R3)	0.00	0.0000	74.7
2 units/ acre (R2)	0.00	0.0000	73.0
1 unit/ acre (R1)	0.00	0.0000	71.3
		Subbasin Curve Number:	**63.0**

Subbasin 4

Total Area:	352.37	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	125771	*Lineal Feet*
Hydraulic Length:	10416	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.9
C	0.1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	284.58	0.8168	56.5
Woods with poor coverage (W2)	45.08	0.1294	67.1
Cultivated Land (F)	0.00	0.0000	71.7
Open Space with 50-70% cover (O)	0.00	0.0000	70.0
Waterbody (WB)	0.15	0.0004	100.0
Commercial (C)	0.00	0.0000	92.2
Industrial (I)	0.00	0.0000	88.3
Paved (P)	0.46	0.0013	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.5
4 units/ acre (R4)	0.00	0.0000	75.8
3 units/ acre (R3)	0.00	0.0000	72.9
2 units/ acre (R2)	0.00	0.0000	71.0
1 unit/ acre (R1)	18.15	0.0521	69.1
		Subbasin Curve Number:	**58.6**

Subbasin 4.1

Total Area:	7.91	*Acres*
Contour Length (5' cont.):	8342	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1333	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	7.40	0.9355	70.0
Woods with poor coverage (W2)	0.00	0.0000	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	0.00	0.0000	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.51	0.0645	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	0.00	0.0000	79.0
		Subbasin Curve Number:	71.8

Subbasin 4.A

Total Area:	16.47	*Acres*
Contour Length (5' cont.):	6909	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1217	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	16.39	0.9957	70.0
Woods with poor coverage (W2)	0.00	0.0000	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	0.00	0.0000	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.07	0.0043	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	0.00	0.0000	79.0
		Subbasin Curve Number:	**70.1**

Subbasin 5

Total Area:	67.03	*Acres*
Contour Length (5' cont.):	83626	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	3286	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.5
D	0.2

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	66.61	0.9931	66.9
Woods with poor coverage (W2)	0.00	0.0000	74.9
Cultivated Land (F)	0.00	0.0000	76.5
Open Space with 50-70% cover (O)	0.00	0.0000	77.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.6
Industrial (I)	0.00	0.0000	90.5
Paved (P)	0.46	0.0069	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.9
4 units/ acre (R4)	0.00	0.0000	81.4
3 units/ acre (R3)	0.00	0.0000	79.3
2 units/ acre (R2)	0.00	0.0000	78.0
1 unit/ acre (R1)	0.00	0.0000	76.7
		Subbasin Curve Number:	**67.1**

Subbasin 5.1

Total Area:	17.79	*Acres*
Contour Length (5' cont.):	10690	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1682	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	17.56	0.9838	70.0
Woods with poor coverage (W2)	0.00	0.0000	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	0.00	0.0000	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.29	0.0162	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	0.00	0.0000	79.0
Subbasin Curve Number:			**70.5**

Subbasin 6

Total Area:	7.38	*Acres*
Contour Length (5' cont.):	9490	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	774	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	0.8
D	0.2

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	5.01	0.6798	71.4
Woods with poor coverage (W2)	1.80	0.2442	78.2
Cultivated Land (F)	0.00	0.0000	78.6
Open Space with 50-70% cover (O)	0.00	0.0000	80.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.2
Industrial (I)	0.00	0.0000	91.4
Paved (P)	0.56	0.0760	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.4
4 units/ acre (R4)	0.00	0.0000	83.8
3 units/ acre (R3)	0.00	0.0000	82.0
2 units/ acre (R2)	0.00	0.0000	81.0
1 unit/ acre (R1)	0.00	0.0000	80.0
Subbasin Curve Number:			**75.1**

Subbasin 7

Total Area: 84.43 *Acres*
Contour Length (5' cont.): 105905 *Lineal Feet*
Contour Length (20' cont): *Lineal Feet*
Hydraulic Length: 2783 *Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.4
D	0.3

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	81.42	0.9653	67.6
Woods with poor coverage (W2)	1.82	0.0216	75.5
Cultivated Land (F)	0.00	0.0000	76.8
Open Space with 50-70% cover (O)	0.00	0.0000	77.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.7
Industrial (I)	0.00	0.0000	90.7
Paved (P)	1.11	0.0132	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.1
4 units/ acre (R4)	0.00	0.0000	81.8
3 units/ acre (R3)	0.00	0.0000	79.8
2 units/ acre (R2)	0.00	0.0000	78.5
1 unit/ acre (R1)	0.00	0.0000	77.2
		Subbasin Curve Number:	**68.2**

Subbasin 8

Total Area: 1374 *Acres*
Contour Length (5' cont.): *Lineal Feet*
Contour Length (20' cont): 791031 *Lineal Feet*
Hydraulic Length: 17819 *Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.9
C	0.1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	1037.18	0.7549	56.5
Woods with poor coverage (W2)	69.26	0.0504	67.1
Cultivated Land (F)	12.45	0.0091	71.7
Open Space with 50-70% cover (O)	89.85	0.0654	70.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.2
Industrial (I)	0.00	0.0000	88.3
Paved (P)	1.26	0.0009	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.5
4 units/ acre (R4)	0.00	0.0000	75.8
3 units/ acre (R3)	0.00	0.0000	72.9
2 units/ acre (R2)	3.29	0.0024	71.0
1 unit/ acre (R1)	160.62	0.1169	69.1
		Subbasin Curve Number:	**59.6**

Subbasin 9

Total Area:	11.53	*Acres*
Contour Length (5' cont.):	29373	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	696	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	0.3
D	0.7

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	74.9
Woods with poor coverage (W2)	9.14	0.7927	81.2
Cultivated Land (F)	0.00	0.0000	80.1
Open Space with 50-70% cover (O)	0.00	0.0000	82.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.7
Industrial (I)	0.00	0.0000	92.4
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	91.4
4 units/ acre (R4)	0.00	0.0000	85.8
3 units/ acre (R3)	0.00	0.0000	84.5
2 units/ acre (R2)	0.00	0.0000	83.5
1 unit/ acre (R1)	2.39	0.2073	82.5
		Subbasin Curve Number:	**81.5**

Subbasin 10

Total Area:	36.95	*Acres*
Contour Length (5' cont.):	79931	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2320	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.4
C	0.4
D	0.2

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	15.51	0.4182	65.4
Woods with poor coverage (W2)	1.42	0.0383	73.8
Cultivated Land (F)	0.00	0.0000	75.8
Open Space with 50-70% cover (O)	0.00	0.0000	76.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.4
Industrial (I)	0.00	0.0000	90.2
Paved (P)	1.25	0.0337	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.4
4 units/ acre (R4)	12.44	0.3354	80.6
3 units/ acre (R3)	0.00	0.0000	78.4
2 units/ acre (R2)	0.00	0.0000	77.0
1 unit/ acre (R1)	6.47	0.1744	75.6
		Subbasin Curve Number:	**73.7**

Subbasin 10.1

Total Area:	877.96	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	419343	*Lineal Feet*
Hydraulic Length:	12872	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.6
C	0.4
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	273.10	0.3111	61.0
Woods with poor coverage (W2)	231.92	0.2642	70.4
Cultivated Land (F)	3.35	0.0038	73.8
Open Space with 50-70% cover (O)	305.69	0.3483	73.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.8
Industrial (I)	24.61	0.0280	89.2
Paved (P)	0.75	0.0009	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.0
4 units/ acre (R4)	0.00	0.0000	78.2
3 units/ acre (R3)	0.00	0.0000	75.6
2 units/ acre (R2)	0.00	0.0000	74.0
1 unit/ acre (R1)	38.33	0.0437	72.4
	Subbasin Curve Number:		**69.0**

Subbasin 11

Total Area:	11.48	*Acres*
Contour Length (5' cont.):	23901	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	638	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	0.3
D	0.7

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	74.9
Woods with poor coverage (W2)	7.96	0.6934	81.2
Cultivated Land (F)	0.00	0.0000	80.1
Open Space with 50-70% cover (O)	0.00	0.0000	82.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.7
Industrial (I)	0.00	0.0000	92.4
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	91.4
4 units/ acre (R4)	3.52	0.3066	85.8
3 units/ acre (R3)	0.00	0.0000	84.5
2 units/ acre (R2)	0.00	0.0000	83.5
1 unit/ acre (R1)	0.00	0.0000	82.5
	Subbasin Curve Number:		**82.6**

Subbasin 12

Total Area:	50.57	*Acres*
Contour Length (5' cont.):	37852	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2648	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.1
C	0.9
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	68.5
Woods with poor coverage (W2)	8.18	0.1618	75.9
Cultivated Land (F)	0.00	0.0000	77.3
Open Space with 50-70% cover (O)	0.00	0.0000	78.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.8
Industrial (I)	0.00	0.0000	90.7
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.5
4 units/ acre (R4)	42.39	0.8382	82.2
3 units/ acre (R3)	0.00	0.0000	80.1
2 units/ acre (R2)	0.00	0.0000	79.0
1 unit/ acre (R1)	0.00	0.0000	77.9
		Subbasin Curve Number:	**81.2**

Subbasin 13

Total Area:	12.24	*Acres*
Contour Length (5' cont.):	12645	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1716	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.7
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.42	0.0343	65.5
Woods with poor coverage (W2)	0.00	0.0000	73.7
Cultivated Land (F)	0.00	0.0000	75.9
Open Space with 50-70% cover (O)	0.00	0.0000	76.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.4
Industrial (I)	0.00	0.0000	90.1
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.5
4 units/ acre (R4)	11.82	0.9657	80.6
3 units/ acre (R3)	0.00	0.0000	78.3
2 units/ acre (R2)	0.00	0.0000	77.0
1 unit/ acre (R1)	0.00	0.0000	75.7
		Subbasin Curve Number:	**80.1**

Subbasin 14

Total Area:	91.88	*Acres*
Contour Length (5' cont.):	124333	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	4290	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.7
C	0.3
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	59.76	0.6505	59.5
Woods with poor coverage (W2)	0.00	0.0000	69.3
Cultivated Land (F)	0.00	0.0000	73.1
Open Space with 50-70% cover (O)	0.19	0.0021	72.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.6
Industrial (I)	0.00	0.0000	88.9
Paved (P)	3.11	0.0339	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.5
4 units/ acre (R4)	22.97	0.2500	77.4
3 units/ acre (R3)	0.00	0.0000	74.7
2 units/ acre (R2)	0.00	0.0000	73.0
1 unit/ acre (R1)	5.84	0.0636	71.3
		Subbasin Curve Number:	**66.1**

Subbasin 14.1

Total Area:	983.81	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	502362	*Lineal Feet*
Hydraulic Length:	14474	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.5
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	408.45	0.4153	62.5
Woods with poor coverage (W2)	317.85	0.3232	71.5
Cultivated Land (F)	0.00	0.0000	74.5
Open Space with 50-70% cover (O)	53.54	0.0544	74.0
Waterbody (WB)	0.69	0.0007	100.0
Commercial (C)	0.00	0.0000	93.0
Industrial (I)	115.48	0.1174	89.5
Paved (P)	3.04	0.0031	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.5
4 units/ acre (R4)	24.40	0.0248	79.0
3 units/ acre (R3)	0.00	0.0000	76.5
2 units/ acre (R2)	25.17	0.0256	75.0
1 unit/ acre (R1)	34.90	0.0355	73.5
		Subbasin Curve Number:	**70.5**

Subbasin 15

Total Area:	80.25	*Acres*
Contour Length (5' cont.):	125141	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1257	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	50.54	0.6299	55.0
Woods with poor coverage (W2)	0.00	0.0000	66.0
Cultivated Land (F)	0.00	0.0000	71.0
Open Space with 50-70% cover (O)	1.97	0.0246	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.0
Industrial (I)	0.00	0.0000	88.0
Paved (P)	5.49	0.0684	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	0.00	0.0000	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	0.00	0.0000	70.0
1 unit/ acre (R1)	22.23	0.2771	68.0
		Subbasin Curve Number:	**61.9**

Subbasin 16

Total Area:	170.66	*Acres*
Contour Length (5' cont.):	164029	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	5509	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.7
C	0.3
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	77.48	0.4543	59.5
Woods with poor coverage (W2)	8.58	0.0503	69.3
Cultivated Land (F)	0.00	0.0000	73.1
Open Space with 50-70% cover (O)	0.00	0.0000	72.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.6
Industrial (I)	0.46	0.0027	88.9
Paved (P)	1.53	0.0090	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.5
4 units/ acre (R4)	0.00	0.0000	77.4
3 units/ acre (R3)	0.00	0.0000	74.7
2 units/ acre (R2)	11.27	0.0661	73.0
1 unit/ acre (R1)	71.23	0.4176	71.3
		Subbasin Curve Number:	**66.2**

Subbasin 17

Total Area:	45.19	*Acres*
Contour Length (5' cont.):	60410	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1315	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.8
C	0.2
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	5.25	0.1162	58.0
Woods with poor coverage (W2)	13.74	0.3042	68.2
Cultivated Land (F)	0.00	0.0000	72.4
Open Space with 50-70% cover (O)	0.00	0.0000	71.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	3.53	0.0781	92.4
Industrial (I)	0.00	0.0000	88.6
Paved (P)	0.79	0.0175	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.0
4 units/ acre (R4)	21.86	0.4839	76.6
3 units/ acre (R3)	0.00	0.0000	73.8
2 units/ acre (R2)	0.00	0.0000	72.0
1 unit/ acre (R1)	0.00	0.0000	70.2
		Subbasin Curve Number:	**73.5**

Subbasin 17.1

Total Area:	34.61	*Acres*
Contour Length (5' cont.):	19930	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	5230	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.6
C	0.4
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	61.0
Woods with poor coverage (W2)	0.00	0.0000	70.4
Cultivated Land (F)	0.00	0.0000	73.8
Open Space with 50-70% cover (O)	4.75	0.1373	73.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	3.96	0.1145	92.8
Industrial (I)	0.00	0.0000	89.2
Paved (P)	2.72	0.0786	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.0
4 units/ acre (R4)	23.17	0.6697	78.2
3 units/ acre (R3)	0.00	0.0000	75.6
2 units/ acre (R2)	0.00	0.0000	74.0
1 unit/ acre (R1)	0.00	0.0000	72.4
		Subbasin Curve Number:	**80.7**

Subbasin 18

Total Area:	593.74	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	266910	*Lineal Feet*
Hydraulic Length:	10803	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.6
C	0.4
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	359.95	0.6014	61.0
Woods with poor coverage (W2)	48.45	0.0810	70.4
Cultivated Land (F)	0.00	0.0000	73.8
Open Space with 50-70% cover (O)	16.32	0.0273	73.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	2.73	0.0046	92.8
Industrial (I)	23.87	0.0399	89.2
Paved (P)	0.97	0.0016	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.39	0.0007	87.0
4 units/ acre (R4)	38.49	0.0643	78.2
3 units/ acre (R3)	0.00	0.0000	75.6
2 units/ acre (R2)	46.69	0.0780	74.0
1 unit/ acre (R1)	60.64	0.1013	72.4
		Subbasin Curve Number:	**66.7**

Subbasin 18A

Total Area:	30.66	*Acres*
Contour Length (5' cont.):	22486	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1044	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.5
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	62.5
Woods with poor coverage (W2)	5.51	0.1797	71.5
Cultivated Land (F)	0.00	0.0000	74.5
Open Space with 50-70% cover (O)	0.00	0.0000	74.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.0
Industrial (I)	0.00	0.0000	89.5
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.99	0.0323	87.5
4 units/ acre (R4)	24.16	0.7880	79.0
3 units/ acre (R3)	0.00	0.0000	76.5
2 units/ acre (R2)	0.00	0.0000	75.0
1 unit/ acre (R1)	0.00	0.0000	73.5
		Subbasin Curve Number:	**77.9**

Subbasin 19

Total Area:	49.76	*Acres*
Contour Length (5' cont.):	32576	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2416	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.1
D	0.4

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	11.38	0.2302	65.3
Woods with poor coverage (W2)	0.00	0.0000	73.9
Cultivated Land (F)	0.00	0.0000	75.7
Open Space with 50-70% cover (O)	4.02	0.0813	76.0
Waterbody (WB)	2.11	0.0427	100.0
Commercial (C)	5.06	0.1024	93.4
Industrial (I)	21.39	0.4327	90.3
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.3
4 units/ acre (R4)	2.91	0.0589	80.6
3 units/ acre (R3)	0.00	0.0000	78.5
2 units/ acre (R2)	0.00	0.0000	77.0
1 unit/ acre (R1)	2.56	0.0518	75.5
		Subbasin Curve Number:	**82.8**

Subbasin 19.1

Total Area:	18.25	*Acres*
Contour Length (5' cont.):	4977	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2570	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.8
C	0.2
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.27	0.0148	58.0
Woods with poor coverage (W2)	0.00	0.0000	68.2
Cultivated Land (F)	0.00	0.0000	72.4
Open Space with 50-70% cover (O)	0.00	0.0000	71.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.62	0.0340	92.4
Industrial (I)	0.50	0.0274	88.6
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.0
4 units/ acre (R4)	16.85	0.9238	76.6
3 units/ acre (R3)	0.00	0.0000	73.8
2 units/ acre (R2)	0.00	0.0000	72.0
1 unit/ acre (R1)	0.00	0.0000	70.2
		Subbasin Curve Number:	**77.2**

Subbasin 19.2

Total Area:	17.48	*Acres*
Contour Length (5' cont.):	5078	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1507	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.6
C	0.4
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	3.34	0.1911	61.0
Woods with poor coverage (W2)	0.00	0.0000	70.4
Cultivated Land (F)	0.00	0.0000	73.8
Open Space with 50-70% cover (O)	0.00	0.0000	73.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	4.91	0.2809	92.8
Industrial (I)	0.43	0.0246	89.2
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.0
4 units/ acre (R4)	8.80	0.5034	78.2
3 units/ acre (R3)	0.00	0.0000	75.6
2 units/ acre (R2)	0.00	0.0000	74.0
1 unit/ acre (R1)	0.00	0.0000	72.4
		Subbasin Curve Number:	**79.3**

Subbasin 19.3

Total Area:	11.27	*Acres*
Contour Length (5' cont.):	3483	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1778	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.25
D	0.25

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.11	0.0098	64.3
Woods with poor coverage (W2)	0.00	0.0000	73.0
Cultivated Land (F)	0.00	0.0000	75.3
Open Space with 50-70% cover (O)	0.00	0.0000	75.3
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	8.31	0.7380	93.3
Industrial (I)	0.00	0.0000	90.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.0
4 units/ acre (R4)	2.84	0.2522	80.0
3 units/ acre (R3)	0.00	0.0000	77.8
2 units/ acre (R2)	0.00	0.0000	76.3
1 unit/ acre (R1)	0.00	0.0000	74.8
		Subbasin Curve Number:	**89.6**

Subbasin 19.4

Total Area:	9.33	*Acres*
Contour Length (5' cont.):	2572	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	870	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	0
D	1

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	77.0
Woods with poor coverage (W2)	0.00	0.0000	83.0
Cultivated Land (F)	0.00	0.0000	81.0
Open Space with 50-70% cover (O)	0.00	0.0000	84.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	9.19	0.9861	95.0
Industrial (I)	0.00	0.0000	93.0
Paved (P)	0.13	0.0139	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	92.0
4 units/ acre (R4)	0.00	0.0000	87.0
3 units/ acre (R3)	0.00	0.0000	86.0
2 units/ acre (R2)	0.00	0.0000	85.0
1 unit/ acre (R1)	0.00	0.0000	84.0
		Subbasin Curve Number:	**95.0**

Subbasin 19.5

Total Area:	25.5	*Acres*
Contour Length (5' cont.):	7724	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1874	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.1
D	0.4

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.05	0.0020	65.3
Woods with poor coverage (W2)	0.00	0.0000	73.9
Cultivated Land (F)	0.00	0.0000	75.7
Open Space with 50-70% cover (O)	0.00	0.0000	76.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	25.00	0.9804	93.4
Industrial (I)	0.00	0.0000	90.3
Paved (P)	0.45	0.0176	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.3
4 units/ acre (R4)	0.00	0.0000	80.6
3 units/ acre (R3)	0.00	0.0000	78.5
2 units/ acre (R2)	0.00	0.0000	77.0
1 unit/ acre (R1)	0.00	0.0000	75.5
		Subbasin Curve Number:	**93.4**

Subbasin 19.6

Total Area:	58.21	*Acres*
Contour Length (5' cont.):	27124	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	3247	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.5
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	62.5
Woods with poor coverage (W2)	3.09	0.0522	71.5
Cultivated Land (F)	4.32	0.0730	74.5
Open Space with 50-70% cover (O)	1.00	0.0169	74.0
Waterbody (WB)	3.63	0.0613	100.0
Commercial (C)	0.00	0.0000	93.0
Industrial (I)	0.00	0.0000	89.5
Paved (P)	0.84	0.0142	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.5
4 units/ acre (R4)	46.32	0.7824	79.0
3 units/ acre (R3)	0.00	0.0000	76.5
2 units/ acre (R2)	0.00	0.0000	75.0
1 unit/ acre (R1)	0.00	0.0000	73.5
		Subbasin Curve Number:	**79.8**

Subbasin 19.7

Total Area:	12.7	*Acres*
Contour Length (5' cont.):	7920	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1682	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.8
C	0.2
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	58.0
Woods with poor coverage (W2)	5.75	0.4531	68.2
Cultivated Land (F)	0.00	0.0000	72.4
Open Space with 50-70% cover (O)	0.00	0.0000	71.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	5.41	0.4263	92.4
Industrial (I)	0.00	0.0000	88.6
Paved (P)	1.43	0.1127	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.0
4 units/ acre (R4)	0.10	0.0079	76.6
3 units/ acre (R3)	0.00	0.0000	73.8
2 units/ acre (R2)	0.00	0.0000	72.0
1 unit/ acre (R1)	0.00	0.0000	70.2
		Subbasin Curve Number:	**81.9**

Subbasin 19.8

Total Area: 22.53 *Acres*
Contour Length (5' cont.): 13632 *Lineal Feet*
Contour Length (20' cont): *Lineal Feet*
Hydraulic Length: 1798 *Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.2
C	0.6
D	0.2

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	68.4
Woods with poor coverage (W2)	3.44	0.1519	76.0
Cultivated Land (F)	0.00	0.0000	77.2
Open Space with 50-70% cover (O)	0.00	0.0000	78.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	14.41	0.6362	93.8
Industrial (I)	0.00	0.0000	90.8
Paved (P)	0.77	0.0340	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.4
4 units/ acre (R4)	4.03	0.1779	82.2
3 units/ acre (R3)	0.00	0.0000	80.2
2 units/ acre (R2)	0.00	0.0000	79.0
1 unit/ acre (R1)	0.00	0.0000	77.8
		Subbasin Curve Number:	**89.2**

Subbasin 19.9

Total Area: 224.62 *Acres*
Contour Length (5' cont.): 164,024 *Lineal Feet*
Contour Length (20' cont): *Lineal Feet*
Hydraulic Length: 6764 *Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.7
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	37.31	0.1661	65.5
Woods with poor coverage (W2)	2.31	0.0103	73.7
Cultivated Land (F)	0.00	0.0000	75.9
Open Space with 50-70% cover (O)	11.06	0.0492	76.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	18.99	0.0845	93.4
Industrial (I)	0.00	0.0000	90.1
Paved (P)	0.34	0.0015	98.0
Residential (approx. density)			
8 units/ acre (R8)	9.14	0.0407	88.5
4 units/ acre (R4)	93.89	0.4180	80.6
3 units/ acre (R3)	0.00	0.0000	78.3
2 units/ acre (R2)	18.44	0.0821	77.0
1 unit/ acre (R1)	33.14	0.1475	75.7
		Subbasin Curve Number:	**78.2**

Subbasin 19.10

Total Area:	123.81	*Acres*
Contour Length (5' cont.):	193529	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	5876	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.1
C	0.9
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	4.50	0.0364	68.5
Woods with poor coverage (W2)	0.00	0.0000	75.9
Cultivated Land (F)	0.00	0.0000	77.3
Open Space with 50-70% cover (O)	14.59	0.1179	78.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	46.07	0.3722	93.8
Industrial (I)	0.00	0.0000	90.7
Paved (P)	1.97	0.0159	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.5
4 units/ acre (R4)	32.29	0.2609	82.2
3 units/ acre (R3)	0.00	0.0000	80.1
2 units/ acre (R2)	10.49	0.0847	79.0
1 unit/ acre (R1)	13.87	0.1121	77.9
		Subbasin Curve Number:	**85.0**

Subbasin 20

Total Area:	36.38	*Acres*
Contour Length (5' cont.):	33753	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1894	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.7
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	6.71	0.1845	65.5
Woods with poor coverage (W2)	5.07	0.1394	73.7
Cultivated Land (F)	0.00	0.0000	75.9
Open Space with 50-70% cover (O)	0.00	0.0000	76.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.38	0.0104	93.4
Industrial (I)	13.10	0.3602	90.1
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	4.85	0.1334	88.5
4 units/ acre (R4)	0.00	0.0000	80.6
3 units/ acre (R3)	0.00	0.0000	78.3
2 units/ acre (R2)	6.26	0.1721	77.0
1 unit/ acre (R1)	0.00	0.0000	75.7
		Subbasin Curve Number:	**80.8**

Subbasin 21

Total Area:	16.25	*Acres*
Contour Length (5' cont.):	27085	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	832	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	3.79	0.2334	70.0
Woods with poor coverage (W2)	0.00	0.0000	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	0.00	0.0000	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	4.34	0.2672	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	8.11	0.4994	80.0
1 unit/ acre (R1)	0.00	0.0000	79.0
		Subbasin Curve Number:	**78.5**

Subbasin 22

Total Area:	65.98	*Acres*
Contour Length (5' cont.):	20968	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	3093	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.5
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	62.5
Woods with poor coverage (W2)	2.93	0.0444	71.5
Cultivated Land (F)	0.00	0.0000	74.5
Open Space with 50-70% cover (O)	0.00	0.0000	74.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	32.57	0.4938	93.0
Industrial (I)	0.00	0.0000	89.5
Paved (P)	0.53	0.0080	98.0
Residential (approx. density)			
8 units/ acre (R8)	11.12	0.1686	87.5
4 units/ acre (R4)	14.52	0.2201	79.0
3 units/ acre (R3)	0.00	0.0000	76.5
2 units/ acre (R2)	4.29	0.0650	75.0
1 unit/ acre (R1)	0.00	0.0000	73.5
		Subbasin Curve Number:	**86.9**

Subbasin 23

Total Area:	39.31	*Acres*
Contour Length (5' cont.):	9938	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2203	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	0.6
D	0.4

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	72.8
Woods with poor coverage (W2)	0.78	0.0198	79.4
Cultivated Land (F)	0.00	0.0000	79.2
Open Space with 50-70% cover (O)	0.00	0.0000	81.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.4
Industrial (I)	0.00	0.0000	91.8
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.8
4 units/ acre (R4)	29.37	0.7473	84.6
3 units/ acre (R3)	0.00	0.0000	83.0
2 units/ acre (R2)	9.15	0.2328	82.0
1 unit/ acre (R1)	0.00	0.0000	81.0
Subbasin Curve Number:			**83.9**

Subbasin 23.1

Total Area:	36.37	*Acres*
Contour Length (5' cont.):	14633	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1991	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.25
D	0.25

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	64.3
Woods with poor coverage (W2)	0.00	0.0000	73.0
Cultivated Land (F)	0.00	0.0000	75.3
Open Space with 50-70% cover (O)	0.00	0.0000	75.3
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	13.27	0.3654	93.3
Industrial (I)	0.00	0.0000	90.0
Paved (P)	0.32	0.0088	98.0
Residential (approx. density)			
8 units/ acre (R8)	6.73	0.1853	88.0
4 units/ acre (R4)	16.00	0.4405	80.0
3 units/ acre (R3)	0.00	0.0000	77.8
2 units/ acre (R2)	0.00	0.0000	76.3
1 unit/ acre (R1)	0.00	0.0000	74.8
Subbasin Curve Number:			**86.5**

Subbasin 24

Total Area:	12.17	*Acres*
Contour Length (5' cont.):	15733	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	792	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	70.0
Woods with poor coverage (W2)	2.67	0.2190	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	0.00	0.0000	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	2.77	0.2272	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	6.75	0.5537	80.0
1 unit/ acre (R1)	0.00	0.0000	79.0
		Subbasin Curve Number:	**80.0**

Subbasin 25

Total Area:	32.46	*Acres*
Contour Length (5' cont.):	39728	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2241	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.1
C	0.9
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	4.19	0.1293	68.5
Woods with poor coverage (W2)	0.00	0.0000	75.9
Cultivated Land (F)	0.00	0.0000	77.3
Open Space with 50-70% cover (O)	0.00	0.0000	78.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.8
Industrial (I)	0.00	0.0000	90.7
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.5
4 units/ acre (R4)	17.24	0.5319	82.2
3 units/ acre (R3)	0.00	0.0000	80.1
2 units/ acre (R2)	10.98	0.3388	79.0
1 unit/ acre (R1)	0.00	0.0000	77.9
		Subbasin Curve Number:	**79.3**

Subbasin 26

Total Area:	21.25	*Acres*
Contour Length (5' cont.):	16266	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	1816	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.9
C	0.1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	4.98	0.2348	56.5
Woods with poor coverage (W2)	0.00	0.0000	67.1
Cultivated Land (F)	0.00	0.0000	71.7
Open Space with 50-70% cover (O)	0.00	0.0000	70.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	1.45	0.0684	92.2
Industrial (I)	0.00	0.0000	88.3
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.5
4 units/ acre (R4)	12.05	0.5681	75.8
3 units/ acre (R3)	0.00	0.0000	72.9
2 units/ acre (R2)	2.73	0.1287	71.0
1 unit/ acre (R1)	0.00	0.0000	69.1
		Subbasin Curve Number:	**71.8**

Subbasin 27

Total Area:	125.26	*Acres*
Contour Length (5' cont.):	106723	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	4619	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.1
C	0.9
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	18.96	0.1528	68.5
Woods with poor coverage (W2)	23.60	0.1902	75.9
Cultivated Land (F)	0.00	0.0000	77.3
Open Space with 50-70% cover (O)	4.48	0.0361	78.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	14.73	0.1187	93.8
Industrial (I)	0.00	0.0000	90.7
Paved (P)	6.49	0.0523	98.0
Residential (approx. density)			
8 units/ acre (R8)	4.53	0.0365	89.5
4 units/ acre (R4)	30.79	0.2481	82.2
3 units/ acre (R3)	0.00	0.0000	80.1
2 units/ acre (R2)	6.31	0.0509	79.0
1 unit/ acre (R1)	14.19	0.1144	77.9
		Subbasin Curve Number:	**80.6**

Subbasin 28

Total Area:	44.16	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	14581	*Lineal Feet*
Hydraulic Length:	774	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.6
C	0.4
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	6.41	0.1453	61.0
Woods with poor coverage (W2)	0.17	0.0039	70.4
Cultivated Land (F)	0.00	0.0000	73.8
Open Space with 50-70% cover (O)	10.43	0.2363	73.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.8
Industrial (I)	12.14	0.2751	89.2
Paved (P)	0.57	0.0129	98.0
Residential (approx. density)			
8 units/ acre (R8)	8.95	0.2028	87.0
4 units/ acre (R4)	0.00	0.0000	78.2
3 units/ acre (R3)	0.00	0.0000	75.6
2 units/ acre (R2)	4.64	0.1051	74.0
1 unit/ acre (R1)	0.82	0.0186	72.4
		Subbasin Curve Number:	**79.0**

Subbasin 29

Total Area:	32.37	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	12478	*Lineal Feet*
Hydraulic Length:	1566	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	15.71	0.4852	70.0
Woods with poor coverage (W2)	0.00	0.0000	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	11.75	0.3629	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.54	0.0167	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.13	0.0040	80.0
1 unit/ acre (R1)	4.25	0.1313	79.0
		Subbasin Curve Number:	**74.8**

Subbasin 30

Total Area:	69.7	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	37827	*Lineal Feet*
Hydraulic Length:	3711	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	13.49	0.1937	70.0
Woods with poor coverage (W2)	0.00	0.0000	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	0.00	0.0000	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.39	0.0056	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.46	0.0066	80.0
1 unit/ acre (R1)	55.31	0.7941	79.0
		Subbasin Curve Number:	**77.3**

Subbasin 31

Total Area:	51.11	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	31332	*Lineal Feet*
Hydraulic Length:	2183	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	20.01	0.3926	70.0
Woods with poor coverage (W2)	0.00	0.0000	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	0.00	0.0000	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.16	0.0031	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	30.80	0.6043	79.0
		Subbasin Curve Number:	**75.5**

Subbasin 32

Total Area:	510.99	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	386957	*Lineal Feet*
Hydraulic Length:	9469	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.15
C	0.85
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	185.06	0.3624	67.8
Woods with poor coverage (W2)	254.51	0.4984	75.4
Cultivated Land (F)	0.00	0.0000	77.0
Open Space with 50-70% cover (O)	1.36	0.0027	77.5
Waterbody (WB)	4.01	0.0079	100.0
Commercial (C)	0.00	0.0000	93.7
Industrial (I)	0.00	0.0000	90.6
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.3
4 units/ acre (R4)	0.00	0.0000	81.8
3 units/ acre (R3)	0.00	0.0000	79.7
2 units/ acre (R2)	0.00	0.0000	78.5
1 unit/ acre (R1)	65.68	0.1286	77.4
		Subbasin Curve Number:	**73.1**

Subbasin 33

Total Area:	136.33	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	79852	*Lineal Feet*
Hydraulic Length:	3247	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	40.70	0.2986	70.0
Woods with poor coverage (W2)	42.18	0.3094	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	4.30	0.0315	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	49.14	0.3605	79.0
		Subbasin Curve Number:	**75.7**

Subbasin 34

Total Area:	1225.98	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	1054663	*Lineal Feet*
Hydraulic Length:	11402	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.4
C	0.6
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	246.91	0.2014	64.0
Woods with poor coverage (W2)	886.61	0.7232	72.6
Cultivated Land (F)	0.00	0.0000	75.2
Open Space with 50-70% cover (O)	64.43	0.0526	75.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.2
Industrial (I)	0.00	0.0000	89.8
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.0
4 units/ acre (R4)	0.00	0.0000	79.8
3 units/ acre (R3)	0.00	0.0000	77.4
2 units/ acre (R2)	0.00	0.0000	76.0
1 unit/ acre (R1)	27.92	0.0228	74.6
		Subbasin Curve Number:	**71.0**

Subbasin 35

Total Area:	519.36	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	399699	*Lineal Feet*
Hydraulic Length:	6551	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.1
C	0.9
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	242.62	0.4672	68.5
Woods with poor coverage (W2)	51.88	0.0999	75.9
Cultivated Land (F)	0.00	0.0000	77.3
Open Space with 50-70% cover (O)	111.10	0.2139	78.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.8
Industrial (I)	0.00	0.0000	90.7
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.5
4 units/ acre (R4)	0.00	0.0000	82.2
3 units/ acre (R3)	0.00	0.0000	80.1
2 units/ acre (R2)	28.64	0.0551	79.0
1 unit/ acre (R1)	85.09	0.1638	77.9
		Subbasin Curve Number:	73.4

Subbasin 36

Total Area:	197.75	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	101939	*Lineal Feet*
Hydraulic Length:	4947	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.05
C	0.95
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	122.35	0.6187	69.3
Woods with poor coverage (W2)	12.80	0.0647	76.5
Cultivated Land (F)	0.00	0.0000	77.7
Open Space with 50-70% cover (O)	0.20	0.0010	78.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.9
Industrial (I)	0.00	0.0000	90.9
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.8
4 units/ acre (R4)	0.00	0.0000	82.6
3 units/ acre (R3)	0.00	0.0000	80.6
2 units/ acre (R2)	17.30	0.0875	79.5
1 unit/ acre (R1)	45.11	0.2281	78.5
		Subbasin Curve Number:	**72.7**

Subbasin 37

Total Area:	195.22	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	120990	*Lineal Feet*
Hydraulic Length:	7499	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.7
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	97.63	0.5001	65.5
Woods with poor coverage (W2)	28.27	0.1448	73.7
Cultivated Land (F)	0.00	0.0000	75.9
Open Space with 50-70% cover (O)	64.71	0.3315	76.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.4
Industrial (I)	0.00	0.0000	90.1
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.5
4 units/ acre (R4)	0.00	0.0000	80.6
3 units/ acre (R3)	0.00	0.0000	78.3
2 units/ acre (R2)	1.51	0.0077	77.0
1 unit/ acre (R1)	3.09	0.0158	75.7
		Subbasin Curve Number:	70.4

Subbasin 38

Total Area:	138.1	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	98453.8	*Lineal Feet*
Hydraulic Length:	2899	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.45
C	0.55
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	126.19	0.9140	63.3
Woods with poor coverage (W2)	0.00	0.0000	72.1
Cultivated Land (F)	0.00	0.0000	74.9
Open Space with 50-70% cover (O)	1.44	0.0104	74.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.1
Industrial (I)	0.00	0.0000	89.7
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.8
4 units/ acre (R4)	0.00	0.0000	79.4
3 units/ acre (R3)	0.00	0.0000	77.0
2 units/ acre (R2)	0.00	0.0000	75.5
1 unit/ acre (R1)	10.44	0.0756	74.1
		Subbasin Curve Number:	**64.2**

Subbasin 39

Total Area:	200.22	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	527103	*Lineal Feet*
Hydraulic Length:	3749	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.05
C	0.85
D	0.1

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	115.89	0.5788	70.0
Woods with poor coverage (W2)	11.53	0.0576	77.1
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	53.25	0.2659	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.1
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.1
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	19.56	0.0977	79.0
		Subbasin Curve Number:	**73.6**

Subbasin 40

Total Area:	3520.04	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	2249930	*Lineal Feet*
Hydraulic Length:	34149	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.05
C	0.95
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	3213.83	0.9130	69.3
Woods with poor coverage (W2)	56.42	0.0160	76.5
Cultivated Land (F)	0.00	0.0000	77.7
Open Space with 50-70% cover (O)	239.16	0.0679	78.5
Waterbody (WB)	3.97	0.0011	100.0
Commercial (C)	0.00	0.0000	93.9
Industrial (I)	0.00	0.0000	90.9
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.8
4 units/ acre (R4)	0.00	0.0000	82.6
3 units/ acre (R3)	0.00	0.0000	80.6
2 units/ acre (R2)	0.00	0.0000	79.5
1 unit/ acre (R1)	6.54	0.0019	78.5
	Subbasin Curve Number:		**70.0**

Subbasin 40.1

Total Area:	46.4	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	17778.2	*Lineal Feet*
Hydraulic Length:	2416	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	2.63	0.0567	70.0
Woods with poor coverage (W2)	2.87	0.0618	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	33.15	0.7143	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	7.76	0.1672	79.0
	Subbasin Curve Number:		**78.4**

Subbasin 40.2

Total Area:	83.37	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	37004.7	*Lineal Feet*
Hydraulic Length:	3846	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	32.28	0.3872	70.0
Woods with poor coverage (W2)	35.89	0.4305	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	15.20	0.1823	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	0.00	0.0000	79.0
		Subbasin Curve Number:	**74.7**

Subbasin 40.3

Total Area:	977.86	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	507216	*Lineal Feet*
Hydraulic Length:	11460	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.05
C	0.95
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	722.18	0.7386	69.3
Woods with poor coverage (W2)	92.85	0.0950	76.5
Cultivated Land (F)	0.00	0.0000	77.7
Open Space with 50-70% cover (O)	162.80	0.1665	78.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.9
Industrial (I)	0.00	0.0000	90.9
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.8
4 units/ acre (R4)	0.00	0.0000	82.6
3 units/ acre (R3)	0.00	0.0000	80.6
2 units/ acre (R2)	0.00	0.0000	79.5
1 unit/ acre (R1)	0.00	0.0000	78.5
		Subbasin Curve Number:	**71.5**

Subbasin 40.4

Total Area:	304.84	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	209258	*Lineal Feet*
Hydraulic Length:	3943	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	259.04	0.8499	70.0
Woods with poor coverage (W2)	11.24	0.0369	77.0
Cultivated Land (F)	0.00	0.0000	78.0
Open Space with 50-70% cover (O)	34.51	0.1132	79.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.0
Industrial (I)	0.00	0.0000	91.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	90.0
4 units/ acre (R4)	0.00	0.0000	83.0
3 units/ acre (R3)	0.00	0.0000	81.0
2 units/ acre (R2)	0.00	0.0000	80.0
1 unit/ acre (R1)	0.00	0.0000	79.0
		Subbasin Curve Number:	**71.3**

Subbasin 40.5

Total Area:	726.28	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	461048	*Lineal Feet*
Hydraulic Length:	8774	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.1
C	0.9
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	641.27	0.8830	68.5
Woods with poor coverage (W2)	64.37	0.0886	75.9
Cultivated Land (F)	0.00	0.0000	77.3
Open Space with 50-70% cover (O)	20.15	0.0277	78.0
Waterbody (WB)	0.49	0.0007	100.0
Commercial (C)	0.00	0.0000	93.8
Industrial (I)	0.00	0.0000	90.7
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.5
4 units/ acre (R4)	0.00	0.0000	82.2
3 units/ acre (R3)	0.00	0.0000	80.1
2 units/ acre (R2)	0.00	0.0000	79.0
1 unit/ acre (R1)	0.00	0.0000	77.9
		Subbasin Curve Number:	**69.4**

Subbasin 41

Total Area:	180.76	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	162833	*Lineal Feet*
Hydraulic Length:	4638	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.7
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	178.09	0.9858	65.5
Woods with poor coverage (W2)	2.57	0.0142	73.7
Cultivated Land (F)	0.00	0.0000	75.9
Open Space with 50-70% cover (O)	0.00	0.0000	76.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.4
Industrial (I)	0.00	0.0000	90.1
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.5
4 units/ acre (R4)	0.00	0.0000	80.6
3 units/ acre (R3)	0.00	0.0000	78.3
2 units/ acre (R2)	0.00	0.0000	77.0
1 unit/ acre (R1)	0.00	0.0000	75.7
		Subbasin Curve Number:	**65.6**

Subbasin 42

Total Area:	31.75	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	31805.3	*Lineal Feet*
Hydraulic Length:	2879	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.4
C	0.6
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	31.75	1.0000	64.0
Woods with poor coverage (W2)	0.00	0.0000	72.6
Cultivated Land (F)	0.00	0.0000	75.2
Open Space with 50-70% cover (O)	0.00	0.0000	75.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.2
Industrial (I)	0.00	0.0000	89.8
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.0
4 units/ acre (R4)	0.00	0.0000	79.8
3 units/ acre (R3)	0.00	0.0000	77.4
2 units/ acre (R2)	0.00	0.0000	76.0
1 unit/ acre (R1)	0.00	0.0000	74.6
		Subbasin Curve Number:	**64.0**

Subbasin 43

Total Area:	196.08	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	152357	*Lineal Feet*
Hydraulic Length:	4175	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.2
C	0.8
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	187.28	0.9551	67.0
Woods with poor coverage (W2)	7.97	0.0406	74.8
Cultivated Land (F)	0.00	0.0000	76.6
Open Space with 50-70% cover (O)	0.00	0.0000	77.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.6
Industrial (I)	0.00	0.0000	90.4
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.0
4 units/ acre (R4)	0.00	0.0000	81.4
3 units/ acre (R3)	0.00	0.0000	79.2
2 units/ acre (R2)	0.00	0.0000	78.0
1 unit/ acre (R1)	0.84	0.0043	76.8
		Subbasin Curve Number:	**67.4**

Subbasin 44

Total Area:	349.02	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	249890	*Lineal Feet*
Hydraulic Length:	3614	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.05
C	0.95
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	143.74	0.4119	69.3
Woods with poor coverage (W2)	115.31	0.3304	76.5
Cultivated Land (F)	0.00	0.0000	77.7
Open Space with 50-70% cover (O)	14.05	0.0403	78.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	12.48	0.0358	93.9
Industrial (I)	14.95	0.0428	90.9
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.8
4 units/ acre (R4)	0.00	0.0000	82.6
3 units/ acre (R3)	0.00	0.0000	80.6
2 units/ acre (R2)	1.29	0.0037	79.5
1 unit/ acre (R1)	47.19	0.1352	78.5
		Subbasin Curve Number:	**75.1**

Subbasin 45

Total Area:	45.7	*Acres*
Contour Length (5' cont.):	78163.7	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2396	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.25
C	0.5
D	0.25

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	17.75	0.3890	68.0
Woods with poor coverage (W2)	5.92	0.1297	75.8
Cultivated Land (F)	0.00	0.0000	77.0
Open Space with 50-70% cover (O)	0.00	0.0000	77.8
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	4.96	0.1087	93.8
Industrial (I)	0.40	0.0088	90.8
Paved (P)	0.86	0.0188	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	89.3
4 units/ acre (R4)	5.61	0.1229	82.0
3 units/ acre (R3)	0.00	0.0000	80.0
2 units/ acre (R2)	10.13	0.2220	78.8
1 unit/ acre (R1)	0.00	0.0000	77.5
		Subbasin Curve Number:	**76.7**

Subbasin 46

Total Area:	62.75	*Acres*
Contour Length (5' cont.):	17507.3	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	754	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0
C	0
D	1

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	77.0
Woods with poor coverage (W2)	0.00	0.0000	83.0
Cultivated Land (F)	0.00	0.0000	81.0
Open Space with 50-70% cover (O)	0.00	0.0000	84.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	9.28	0.1479	95.0
Industrial (I)	53.46	0.8521	93.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	92.0
4 units/ acre (R4)	0.00	0.0000	87.0
3 units/ acre (R3)	0.00	0.0000	86.0
2 units/ acre (R2)	0.00	0.0000	85.0
1 unit/ acre (R1)	0.00	0.0000	84.0
		Subbasin Curve Number:	**93.3**

Subbasin 47

Total Area:	28.87	*Acres*
Contour Length (5' cont.):	37137.9	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2532	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	14.10	0.4887	55.0
Woods with poor coverage (W2)	0.00	0.0000	66.0
Cultivated Land (F)	0.00	0.0000	71.0
Open Space with 50-70% cover (O)	2.36	0.0818	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.0
Industrial (I)	4.88	0.1692	88.0
Paved (P)	1.16	0.0402	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	6.35	0.2201	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	0.00	0.0000	70.0
1 unit/ acre (R1)	0.00	0.0000	68.0
		Subbasin Curve Number:	**67.9**

Subbasin 47.1

Total Area:	206.46	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	136256	*Lineal Feet*
Hydraulic Length:	5314	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.1
C	0.9
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	68.01	0.3294	68.5
Woods with poor coverage (W2)	2.72	0.0132	75.9
Cultivated Land (F)	0.00	0.0000	77.3
Open Space with 50-70% cover (O)	0.00	0.0000	78.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	4.45	0.0216	93.8
Industrial (I)	0.00	0.0000	90.7
Paved (P)	2.23	0.0108	98.0
Residential (approx. density)			
8 units/ acre (R8)	4.97	0.0241	89.5
4 units/ acre (R4)	27.95	0.1354	82.2
3 units/ acre (R3)	0.00	0.0000	80.1
2 units/ acre (R2)	14.11	0.0683	79.0
1 unit/ acre (R1)	82.02	0.3973	77.9
		Subbasin Curve Number:	**76.3**

Subbasin 48

Total Area:	25.24	*Acres*
Contour Length (5' cont.):	22926	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2203	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	3.62	0.1434	55.0
Woods with poor coverage (W2)	0.00	0.0000	66.0
Cultivated Land (F)	0.00	0.0000	71.0
Open Space with 50-70% cover (O)	0.00	0.0000	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	10.38	0.4113	92.0
Industrial (I)	1.42	0.0563	88.0
Paved (P)	0.74	0.0293	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	9.08	0.3597	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	0.00	0.0000	70.0
1 unit/ acre (R1)	0.00	0.0000	68.0
		Subbasin Curve Number:	**80.5**

Subbasin 48.1

Total Area:	40.3	*Acres*
Contour Length (5' cont.):	57423.3	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2899	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.5
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	12.27	0.3044	62.5
Woods with poor coverage (W2)	0.00	0.0000	71.5
Cultivated Land (F)	0.00	0.0000	74.5
Open Space with 50-70% cover (O)	0.00	0.0000	74.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	7.41	0.1838	93.0
Industrial (I)	0.00	0.0000	89.5
Paved (P)	1.30	0.0323	98.0
Residential (approx. density)			
8 units/ acre (R8)	5.45	0.1352	87.5
4 units/ acre (R4)	9.97	0.2473	79.0
3 units/ acre (R3)	0.00	0.0000	76.5
2 units/ acre (R2)	3.91	0.0970	75.0
1 unit/ acre (R1)	0.00	0.0000	73.5
		Subbasin Curve Number:	**77.9**

Subbasin 49

Total Area:	50.45	*Acres*
Contour Length (5' cont.):	67741.8	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2377	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.8
C	0.2
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	9.81	0.1944	58.0
Woods with poor coverage (W2)	0.00	0.0000	68.2
Cultivated Land (F)	0.00	0.0000	72.4
Open Space with 50-70% cover (O)	2.74	0.0543	71.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	13.61	0.2697	92.4
Industrial (I)	1.30	0.0258	88.6
Paved (P)	0.76	0.0151	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.0
4 units/ acre (R4)	22.24	0.4407	76.6
3 units/ acre (R3)	0.00	0.0000	73.8
2 units/ acre (R2)	0.00	0.0000	72.0
1 unit/ acre (R1)	0.00	0.0000	70.2
	Subbasin Curve Number:		**77.6**

Subbasin 49.1

Total Area:	114.19	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	87054.4	*Lineal Feet*
Hydraulic Length:	4252	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.5
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	77.49	0.6785	62.5
Woods with poor coverage (W2)	0.28	0.0025	71.5
Cultivated Land (F)	0.00	0.0000	74.5
Open Space with 50-70% cover (O)	0.00	0.0000	74.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	11.48	0.1005	93.0
Industrial (I)	0.00	0.0000	89.5
Paved (P)	1.12	0.0098	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.5
4 units/ acre (R4)	18.74	0.1641	79.0
3 units/ acre (R3)	0.00	0.0000	76.5
2 units/ acre (R2)	5.09	0.0446	75.0
1 unit/ acre (R1)	0.00	0.0000	73.5
	Subbasin Curve Number:		**69.2**

Subbasin 50

Total Area:	57.46	*Acres*
Contour Length (5' cont.):	45770.6	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2977	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	10.53	0.1832	55.0
Woods with poor coverage (W2)	0.00	0.0000	66.0
Cultivated Land (F)	6.36	0.1107	71.0
Open Space with 50-70% cover (O)	0.00	0.0000	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	11.28	0.1963	92.0
Industrial (I)	0.22	0.0038	88.0
Paved (P)	1.04	0.0181	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	26.53	0.4616	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	1.51	0.0263	70.0
1 unit/ acre (R1)	0.00	0.0000	68.0
		Subbasin Curve Number:	**74.6**

Subbasin 50.1

Total Area:	45.55	*Acres*
Contour Length (5' cont.):	84368.3	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2744	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.4
C	0.6
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	6.33	0.1392	64.0
Woods with poor coverage (W2)	0.00	0.0000	72.6
Cultivated Land (F)	0.00	0.0000	75.2
Open Space with 50-70% cover (O)	0.00	0.0000	75.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	12.16	0.2675	93.2
Industrial (I)	0.00	0.0000	89.8
Paved (P)	1.56	0.0343	98.0
Residential (approx. density)			
8 units/ acre (R8)	1.82	0.0400	88.0
4 units/ acre (R4)	11.34	0.2495	79.8
3 units/ acre (R3)	0.00	0.0000	77.4
2 units/ acre (R2)	0.00	0.0000	76.0
1 unit/ acre (R1)	12.25	0.2695	74.6
		Subbasin Curve Number:	**80.7**

Subbasin 51

Total Area:	27.69	*Acres*
Contour Length (5' cont.):	23777.2	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	561	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.8
C	0.2
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	5.42	0.1957	58.0
Woods with poor coverage (W2)	0.00	0.0000	68.2
Cultivated Land (F)	0.00	0.0000	72.4
Open Space with 50-70% cover (O)	0.00	0.0000	71.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	1.28	0.0462	92.4
Industrial (I)	0.00	0.0000	88.6
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.0
4 units/ acre (R4)	14.30	0.5164	76.6
3 units/ acre (R3)	0.00	0.0000	73.8
2 units/ acre (R2)	6.69	0.2416	72.0
1 unit/ acre (R1)	0.00	0.0000	70.2
		Subbasin Curve Number:	**72.6**

Subbasin 52

Total Area:	95.81	*Acres*
Contour Length (5' cont.):	87248.4	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	3652	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.65
C	0.3
D	0.05

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	17.00	0.1774	60.6
Woods with poor coverage (W2)	0.00	0.0000	70.2
Cultivated Land (F)	0.03	0.0003	73.6
Open Space with 50-70% cover (O)	0.00	0.0000	72.8
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	21.55	0.2249	92.8
Industrial (I)	0.00	0.0000	89.2
Paved (P)	1.21	0.0126	98.0
Residential (approx. density)			
8 units/ acre (R8)	6.22	0.0649	86.9
4 units/ acre (R4)	46.87	0.4891	78.0
3 units/ acre (R3)	0.00	0.0000	75.4
2 units/ acre (R2)	2.94	0.0307	73.8
1 unit/ acre (R1)	0.00	0.0000	72.1
		Subbasin Curve Number:	**78.9**

Subbasin 52.1

Total Area:	278.61	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	273725	*Lineal Feet*
Hydraulic Length:	5759	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.5
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	238.65	0.8566	62.5
Woods with poor coverage (W2)	12.37	0.0444	71.5
Cultivated Land (F)	0.00	0.0000	74.5
Open Space with 50-70% cover (O)	0.00	0.0000	74.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	1.51	0.0054	93.0
Industrial (I)	0.00	0.0000	89.5
Paved (P)	1.10	0.0039	98.0
Residential (approx. density)			
8 units/ acre (R8)	3.66	0.0131	87.5
4 units/ acre (R4)	1.56	0.0056	79.0
3 units/ acre (R3)	0.00	0.0000	76.5
2 units/ acre (R2)	3.49	0.0125	75.0
1 unit/ acre (R1)	16.27	0.0584	73.5
		Subbasin Curve Number:	**64.4**

Subbasin 53

Total Area:	131.09	*Acres*
Contour Length (5' cont.):	43859.4	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	4735	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.5
C	0.5
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	3.07	0.0235	62.5
Woods with poor coverage (W2)	0.00	0.0000	71.5
Cultivated Land (F)	70.45	0.5388	74.5
Open Space with 50-70% cover (O)	0.00	0.0000	74.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.68	0.0052	93.0
Industrial (I)	0.00	0.0000	89.5
Paved (P)	1.34	0.0102	98.0
Residential (approx. density)			
8 units/ acre (R8)	12.18	0.0931	87.5
4 units/ acre (R4)	36.50	0.2791	79.0
3 units/ acre (R3)	0.00	0.0000	76.5
2 units/ acre (R2)	6.54	0.0500	75.0
1 unit/ acre (R1)	0.00	0.0000	73.5
		Subbasin Curve Number:	**77.0**

Subbasin 53.1

Total Area:	49.01	*Acres*
Contour Length (5' cont.):	103055	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2087	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.4
C	0.6
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	16.12	0.3287	64.0
Woods with poor coverage (W2)	0.00	0.0000	72.6
Cultivated Land (F)	6.29	0.1283	75.2
Open Space with 50-70% cover (O)	0.00	0.0000	75.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	3.73	0.0761	93.2
Industrial (I)	0.00	0.0000	89.8
Paved (P)	1.77	0.0361	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.0
4 units/ acre (R4)	0.00	0.0000	79.8
3 units/ acre (R3)	0.00	0.0000	77.4
2 units/ acre (R2)	0.28	0.0057	76.0
1 unit/ acre (R1)	20.85	0.4252	74.6
		Subbasin Curve Number:	**73.5**

Subbasin 54

Total Area:	98.88	*Acres*
Contour Length (5' cont.):	42696.7	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2241	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.6
C	0.35
D	0.05

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	11.65	0.1178	61.4
Woods with poor coverage (W2)	0.00	0.0000	70.7
Cultivated Land (F)	41.39	0.4186	74.0
Open Space with 50-70% cover (O)	0.00	0.0000	73.3
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.9
Industrial (I)	0.00	0.0000	89.3
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.1
4 units/ acre (R4)	0.03	0.0003	78.4
3 units/ acre (R3)	0.00	0.0000	75.9
2 units/ acre (R2)	45.81	0.4633	74.3
1 unit/ acre (R1)	0.00	0.0000	72.7
		Subbasin Curve Number:	**72.6**

Subbasin 55

Total Area:	97.95	*Acres*
Contour Length (5' cont.):	33167.6	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	5527	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.7
C	0.1
D	0.2

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	6.02	0.0615	60.9
Woods with poor coverage (W2)	0.00	0.0000	70.5
Cultivated Land (F)	45.11	0.4605	73.7
Open Space with 50-70% cover (O)	0.00	0.0000	73.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	2.27	0.0232	92.8
Industrial (I)	0.00	0.0000	89.3
Paved (P)	1.85	0.0189	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.9
4 units/ acre (R4)	9.54	0.0974	78.2
3 units/ acre (R3)	0.00	0.0000	75.7
2 units/ acre (R2)	31.06	0.3171	74.0
1 unit/ acre (R1)	2.10	0.0214	72.3
		Subbasin Curve Number:	**74.3**

Subbasin 55.1

Total Area:	232.61	*Acres*
Contour Length (5' cont.):	652772	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	4542	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.9
C	0.1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	107.45	0.4620	56.5
Woods with poor coverage (W2)	23.92	0.1028	67.1
Cultivated Land (F)	4.33	0.0186	71.7
Open Space with 50-70% cover (O)	58.21	0.2503	70.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	5.80	0.0249	92.2
Industrial (I)	0.00	0.0000	88.3
Paved (P)	1.91	0.0082	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.5
4 units/ acre (R4)	0.00	0.0000	75.8
3 units/ acre (R3)	0.00	0.0000	72.9
2 units/ acre (R2)	5.01	0.0215	71.0
1 unit/ acre (R1)	25.97	0.1117	69.1
		Subbasin Curve Number:	**64.2**

Subbasin 56

Total Area:	21.39	*Acres*
Contour Length (5' cont.):	6089.94	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2241	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.1
C	0.1
D	0.8

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	2.34	0.1094	74.1
Woods with poor coverage (W2)	0.00	0.0000	80.7
Cultivated Land (F)	3.18	0.1487	79.7
Open Space with 50-70% cover (O)	0.00	0.0000	82.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	94.6
Industrial (I)	0.00	0.0000	92.3
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	91.1
4 units/ acre (R4)	7.40	0.3460	85.4
3 units/ acre (R3)	0.00	0.0000	84.1
2 units/ acre (R2)	6.76	0.3160	83.0
1 unit/ acre (R1)	1.71	0.0799	81.9
		Subbasin Curve Number:	**82.3**

Subbasin 57

Total Area:	7.45	*Acres*
Contour Length (5' cont.):	4324.93	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	696	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.4
C	0.6
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	2.82	0.3785	64.0
Woods with poor coverage (W2)	0.00	0.0000	72.6
Cultivated Land (F)	2.84	0.3812	75.2
Open Space with 50-70% cover (O)	0.00	0.0000	75.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	93.2
Industrial (I)	0.00	0.0000	89.8
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.0
4 units/ acre (R4)	0.00	0.0000	79.8
3 units/ acre (R3)	0.00	0.0000	77.4
2 units/ acre (R2)	1.79	0.2403	76.0
1 unit/ acre (R1)	0.00	0.0000	74.6
		Subbasin Curve Number:	**71.2**

Subbasin 58

Total Area:	113.82	*Acres*
Contour Length (5' cont.):	36719.7	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	3827	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.3
C	0.5
D	0.2

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.24	0.0021	66.9
Woods with poor coverage (W2)	0.00	0.0000	74.9
Cultivated Land (F)	85.68	0.7463	76.5
Open Space with 50-70% cover (O)	0.00	0.0000	77.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	1.64	0.0143	93.6
Industrial (I)	8.12	0.0707	90.5
Paved (P)	2.30	0.0200	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	88.9
4 units/ acre (R4)	0.94	0.0082	81.4
3 units/ acre (R3)	0.00	0.0000	79.3
2 units/ acre (R2)	14.88	0.1296	78.0
1 unit/ acre (R1)	1.00	0.0087	76.7
		Subbasin Curve Number:	**78.4**

Subbasin 58.1

Total Area:	146.06	*Acres*
Contour Length (5' cont.):	336944	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	4697	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.95
C	0.05
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	20.70	0.1419	55.8
Woods with poor coverage (W2)	54.39	0.3730	66.6
Cultivated Land (F)	0.00	0.0000	71.4
Open Space with 50-70% cover (O)	19.05	0.1306	69.5
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	7.42	0.0509	92.1
Industrial (I)	0.00	0.0000	88.2
Paved (P)	1.87	0.0128	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.3
4 units/ acre (R4)	0.00	0.0000	75.4
3 units/ acre (R3)	9.84	0.0675	72.5
2 units/ acre (R2)	0.00	0.0000	70.5
1 unit/ acre (R1)	32.56	0.2233	68.6
		Subbasin Curve Number:	**68.0**

Subbasin 59

Total Area:	48.22	*Acres*
Contour Length (5' cont.):	15154.7	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	3208	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.6
C	0.4
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.90	0.0187	61.0
Woods with poor coverage (W2)	0.00	0.0000	70.4
Cultivated Land (F)	39.85	0.8268	73.8
Open Space with 50-70% cover (O)	0.00	0.0000	73.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.8
Industrial (I)	0.03	0.0006	89.2
Paved (P)	0.54	0.0112	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.0
4 units/ acre (R4)	4.26	0.0884	78.2
3 units/ acre (R3)	0.00	0.0000	75.6
2 units/ acre (R2)	2.62	0.0544	74.0
1 unit/ acre (R1)	0.00	0.0000	72.4
		Subbasin Curve Number:	**74.2**

Subbasin 59.1

Total Area:	67.18	*Acres*
Contour Length (5' cont.):	180835	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	4155	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	18.77	0.2805	55.0
Woods with poor coverage (W2)	15.68	0.2343	66.0
Cultivated Land (F)	0.00	0.0000	71.0
Open Space with 50-70% cover (O)	24.71	0.3692	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	2.03	0.0303	92.0
Industrial (I)	0.00	0.0000	88.0
Paved (P)	0.35	0.0052	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	0.00	0.0000	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	0.00	0.0000	70.0
1 unit/ acre (R1)	5.38	0.0804	68.0
		Subbasin Curve Number:	**65.1**

Subbasin 60

Total Area:	41.45	*Acres*
Contour Length (5' cont.):	25142.6	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	2029	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	3.12	0.0753	55.0
Woods with poor coverage (W2)	0.00	0.0000	66.0
Cultivated Land (F)	27.90	0.6729	71.0
Open Space with 50-70% cover (O)	0.00	0.0000	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.0
Industrial (I)	0.00	0.0000	88.0
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	0.00	0.0000	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	10.44	0.2518	70.0
1 unit/ acre (R1)	0.00	0.0000	68.0
		Subbasin Curve Number:	**69.5**

Subbasin 61

Total Area:	71.57	*Acres*
Contour Length (5' cont.):	36836.9	*Lineal Feet*
Contour Length (20' cont):		*Lineal Feet*
Hydraulic Length:	3168	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.9
C	0.1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	6.26	0.0875	56.5
Woods with poor coverage (W2)	0.00	0.0000	67.1
Cultivated Land (F)	40.15	0.5611	71.7
Open Space with 50-70% cover (O)	0.00	0.0000	70.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.2
Industrial (I)	0.00	0.0000	88.3
Paved (P)	1.27	0.0177	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.5
4 units/ acre (R4)	21.90	0.3060	75.8
3 units/ acre (R3)	0.00	0.0000	72.9
2 units/ acre (R2)	0.80	0.0112	71.0
1 unit/ acre (R1)	1.18	0.0165	69.1
		Subbasin Curve Number:	**72.0**

Subbasin 61.1

Total Area:	255.83	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	170000	*Lineal Feet*
Hydraulic Length:	5663	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	78.77	0.3080	55.0
Woods with poor coverage (W2)	68.11	0.2663	66.0
Cultivated Land (F)	0.84	0.0033	71.0
Open Space with 50-70% cover (O)	93.32	0.3649	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.0
Industrial (I)	0.00	0.0000	88.0
Paved (P)	2.70	0.0106	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	0.16	0.0006	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	0.00	0.0000	70.0
1 unit/ acre (R1)	11.83	0.0463	68.0
		Subbasin Curve Number:	**64.2**

Subbasin 62

Total Area:	10.27	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	1886	*Lineal Feet*
Hydraulic Length:	754	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.7
C	0.1
D	0.2

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.00	0.0000	60.9
Woods with poor coverage (W2)	0.00	0.0000	70.5
Cultivated Land (F)	0.97	0.0944	73.7
Open Space with 50-70% cover (O)	4.25	0.4138	73.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.8
Industrial (I)	0.00	0.0000	89.3
Paved (P)	0.00	0.0000	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	86.9
4 units/ acre (R4)	0.00	0.0000	78.2
3 units/ acre (R3)	0.00	0.0000	75.7
2 units/ acre (R2)	0.00	0.0000	74.0
1 unit/ acre (R1)	5.05	0.4917	72.3
		Subbasin Curve Number:	**72.7**

Subbasin 63

Total Area:	67.89	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	8445.46	*Lineal Feet*
Hydraulic Length:	3730	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.6
C	0.4
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	0.68	0.0100	61.0
Woods with poor coverage (W2)	0.00	0.0000	70.4
Cultivated Land (F)	39.82	0.5866	73.8
Open Space with 50-70% cover (O)	6.68	0.0984	73.0
Waterbody (WB)	0.37	0.0055	100.0
Commercial (C)	0.00	0.0000	92.8
Industrial (I)	7.75	0.1142	89.2
Paved (P)	1.85	0.0273	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	87.0
4 units/ acre (R4)	10.30	0.1517	78.2
3 units/ acre (R3)	0.00	0.0000	75.6
2 units/ acre (R2)	0.43	0.0063	74.0
1 unit/ acre (R1)	0.00	0.0000	72.4
		Subbasin Curve Number:	**76.8**

Subbasin 63.1

Total Area:	152.4	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	116195	*Lineal Feet*
Hydraulic Length:	4232	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use.Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	22.36	0.1467	55.0
Woods with poor coverage (W2)	101.26	0.6644	66.0
Cultivated Land (F)	2.61	0.0171	71.0
Open Space with 50-70% cover (O)	9.67	0.0635	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.0
Industrial (I)	0.00	0.0000	88.0
Paved (P)	2.62	0.0172	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	0.00	0.0000	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	0.00	0.0000	70.0
1 unit/ acre (R1)	13.88	0.0911	68.0
		Subbasin Curve Number:	**65.4**

Subbasin 64

Total Area:	54.08	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	4419.2	*Lineal Feet*
Hydraulic Length:	3923	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

Soil Group	*Decimal Fraction*
A	0
B	0.9
C	0.1
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	3.66	0.0677	56.5
Woods with poor coverage (W2)	0.00	0.0000	67.1
Cultivated Land (F)	37.20	0.6879	71.7
Open Space with 50-70% cover (O)	5.24	0.0969	70.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.2
Industrial (I)	1.86	0.0344	88.3
Paved (P)	0.63	0.0116	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.5
4 units/ acre (R4)	0.00	0.0000	75.8
3 units/ acre (R3)	0.00	0.0000	72.9
2 units/ acre (R2)	5.49	0.1015	71.0
1 unit/ acre (R1)	0.00	0.0000	69.1
		Subbasin Curve Number:	**71.3**

Subbasin 64.1

Total Area:	220.69	*Acres*
Contour Length (5' cont.):		*Lineal Feet*
Contour Length (20' cont):	151275	*Lineal Feet*
Hydraulic Length:	6783	*Lineal Feet*

Subbasin Soils (approx. decimal fractions of hydrologic soil groups):

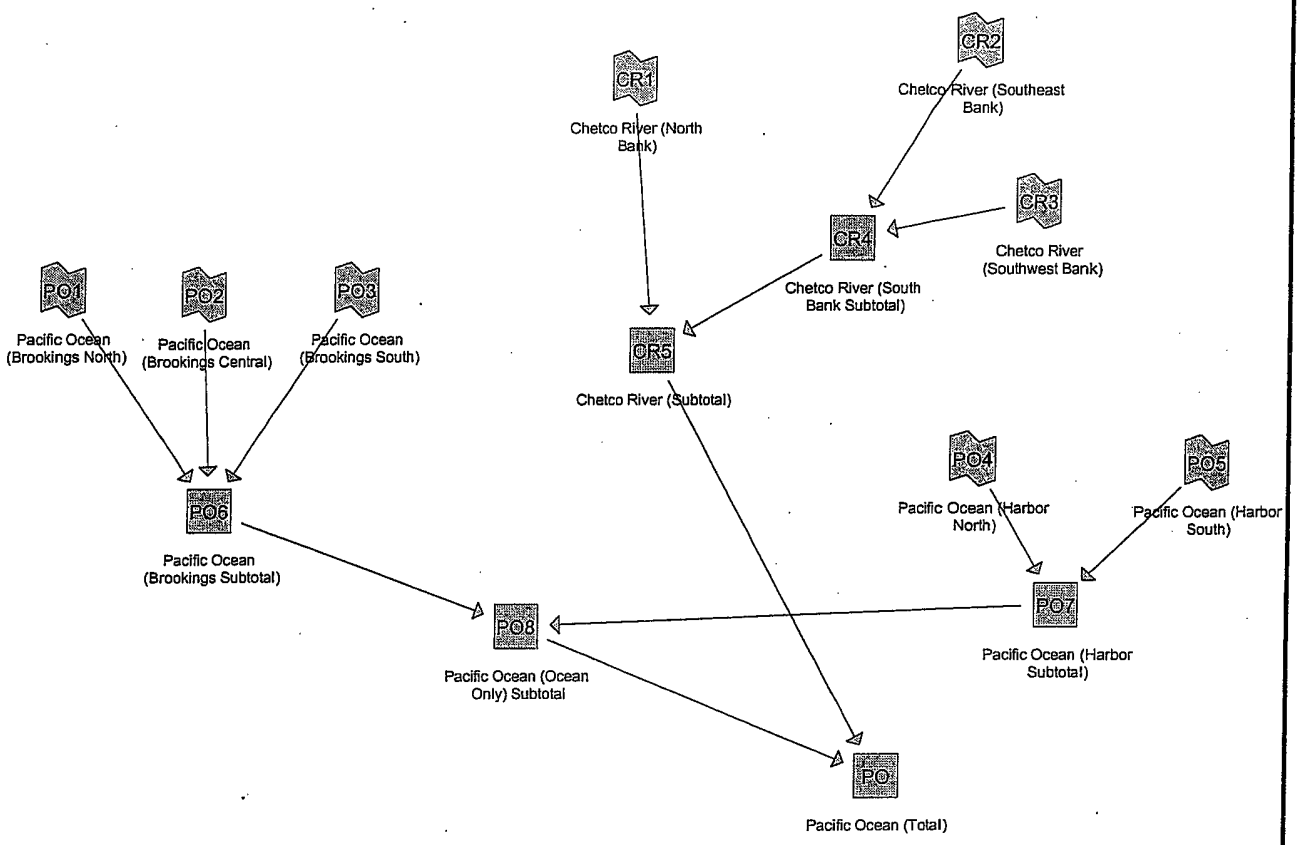
Soil Group	*Decimal Fraction*
A	0
B	1
C	0
D	0

Subbasin Existing Land Use:

Land Use Category	*Subtotal Acres*	*Decimal Fraction*	*Average Curve Number*
Woods with good coverage (W1)	78.18	0.3543	55.0
Woods with poor coverage (W2)	97.06	0.4398	66.0
Cultivated Land (F)	1.84	0.0083	71.0
Open Space with 50-70% cover (O)	38.38	0.1739	69.0
Waterbody (WB)	0.00	0.0000	100.0
Commercial (C)	0.00	0.0000	92.0
Industrial (I)	0.00	0.0000	88.0
Paved (P)	0.35	0.0016	98.0
Residential (approx. density)			
8 units/ acre (R8)	0.00	0.0000	85.0
4 units/ acre (R4)	0.00	0.0000	75.0
3 units/ acre (R3)	0.00	0.0000	72.0
2 units/ acre (R2)	0.00	0.0000	70.0
1 unit/ acre (R1)	4.88	0.0221	68.0
		Subbasin Curve Number:	**62.8**

Appendix 6.2:

HydroCAD Model Results Summary
(25-Year, 24-hour Event Basis)



Drainage Diagram for Brookings-Harbor Model Totals
Prepared by HGE, Inc.
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Reach CR4: Chetco River (South Bank Subtotal)

Inflow Area = 7,668.010 ac, Inflow Depth > 3.73"
Inflow = 4,358.24 cfs @ 8.07 hrs, Volume= 2,383.075 af
Outflow = 4,358.24 cfs @ 8.07 hrs, Volume= 2,383.075 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach CR5: Chetco River (Subtotal)

Inflow Area = 10,968.050 ac, Inflow Depth > 3.82"
Inflow = 6,901.33 cfs @ 8.07 hrs, Volume= 3,490.765 af
Outflow = 6,901.33 cfs @ 8.07 hrs, Volume= 3,490.765 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO: Pacific Ocean (Total)

Inflow Area = 20,756.470 ac, Inflow Depth > 3.74"
Inflow = 11,012.38 cfs @ 8.12 hrs, Volume= 6,473.776 af
Outflow = 11,012.38 cfs @ 8.12 hrs, Volume= 6,473.776 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO6: Pacific Ocean (Brookings Subtotal)

Inflow Area = 7,872.890 ac, Inflow Depth > 3.66"
Inflow = 4,281.33 cfs @ 10.05 hrs, Volume= 2,402.808 af
Outflow = 4,281.33 cfs @ 10.05 hrs, Volume= 2,402.808 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO7: Pacific Ocean (Harbor Subtotal)

Inflow Area = 1,915.530 ac, Inflow Depth > 3.63"
Inflow = 1,218.70 cfs @ 8.24 hrs, Volume= 580.203 af
Outflow = 1,218.70 cfs @ 8.24 hrs, Volume= 580.203 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO8: Pacific Ocean (Ocean Only) Subtotal

Inflow Area = 9,788.420 ac, Inflow Depth > 3.66"
Inflow = 4,950.69 cfs @ 10.04 hrs, Volume= 2,983.011 af
Outflow = 4,950.69 cfs @ 10.04 hrs, Volume= 2,983.011 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link CR1: Chetco River (North Bank)

Inflow Area = 3,300.040 ac, Inflow Depth > 4.03"
Inflow = 2,544.42 cfs @ 8.06 hrs, Volume= 1,107.691 af
Primary = 2,544.42 cfs @ 8.06 hrs, Volume= 1,107.691 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (North Bank)~Reach CR1

Link CR2: Chetco River (Southeast Bank)

Inflow Area = 6,960.400 ac, Inflow Depth > 3.71"
Inflow = 3,791.30 cfs @ 8.07 hrs, Volume= 2,151.860 af
Primary = 3,791.30 cfs @ 8.07 hrs, Volume= 2,151.860 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (Southeast Bank)~Reach CR2

Link CR3: Chetco River (Southwest Bank)

Inflow Area = 707.610 ac, Inflow Depth > 3.92"
Inflow = 572.43 cfs @ 8.13 hrs, Volume= 231.214 af
Primary = 572.43 cfs @ 8.13 hrs, Volume= 231.214 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (Southwest Bank)~Reach CR3

Link PO1: Pacific Ocean (Brookings North)

Inflow Area = 4,976.350 ac, Inflow Depth > 3.37"
Inflow = 2,299.26 cfs @ 8.25 hrs, Volume= 1,397.872 af
Primary = 2,299.26 cfs @ 8.25 hrs, Volume= 1,397.872 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Brookings (North)~Reach PO1

Link PO2: Pacific Ocean (Brookings Central)

Inflow Area = 2,169.250 ac, Inflow Depth > 3.83"
Inflow = 2,237.64 cfs @ 10.06 hrs, Volume= 692.286 af
Primary = 2,237.64 cfs @ 10.06 hrs, Volume= 692.286 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Brookings (Central)~Reach PO2

Link PO3: Pacific Ocean (Brookings South)

Inflow Area = 727.290 ac, Inflow Depth > 5.16"
Inflow = 606.14 cfs @ 8.02 hrs, Volume= 312.650 af
Primary = 606.14 cfs @ 8.02 hrs, Volume= 312.650 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Brookings (South)~Reach PO3

Link PO4: Pacific Ocean (Harbor North)

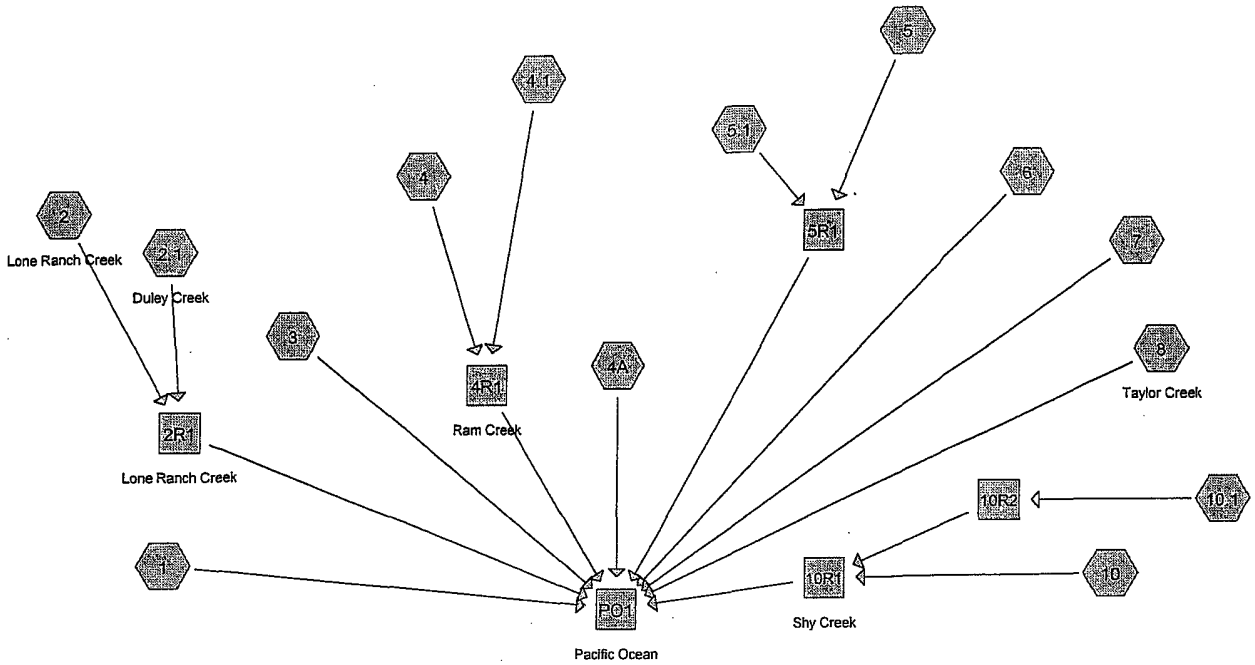
Inflow Area = 925.950 ac, Inflow Depth > 3.89"
Inflow = 634.95 cfs @ 8.23 hrs, Volume= 300.452 af
Primary = 634.95 cfs @ 8.23 hrs, Volume= 300.452 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Harbor (North)~Reach PO4

Link PO5: Pacific Ocean (Harbor South)

Inflow Area = 989.580 ac, Inflow Depth > 3.39"
Inflow = 583.97 cfs @ 8.25 hrs, Volume= 279.751 af
Primary = 583.97 cfs @ 8.25 hrs, Volume= 279.751 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Harbor (South)~Reach PO5



Drainage Diagram for Brookings (North)
Prepared by HGE, Inc.
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Subcatchment 1:

Runoff = 240.09 cfs @ 8.04 hrs, Volume= 88.851 af, Depth> 4.46"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
239.300	76	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	3,875	0.2059	2.8		**Lag/CN Method,** Contour Length= 107,304' Interval= 20'

Subcatchment 2: Lone Ranch Creek

Runoff = 695.10 cfs @ 8.31 hrs, Volume= 407.056 af, Depth> 3.87"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
1,260.750	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
70.1	16,130	0.2806	3.8		**Lag/CN Method,** Contour Length= 770,629' Interval= 20'

Subcatchment 2.1: Duley Creek

Runoff = 364.39 cfs @ 8.24 hrs, Volume= 197.960 af, Depth> 3.91"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
607.500	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
58.8	13,103	0.2859	3.7		**Lag/CN Method,** Contour Length= 378,315' Interval= 20'

Subcatchment 3:

Runoff = 16.83 cfs @ 8.05 hrs, Volume= 6.788 af, Depth> 3.07"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
26.510	63	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	1,874	0.1529	1.4		**Lag/CN Method,** Contour Length= 35,305' Interval= 5'

Subcatchment 4:

Runoff = 97.20 cfs @ 8.98 hrs, Volume= 73.102 af, Depth> 2.49"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
352.370	59	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
90.9	10,416	0.1639	1.9		**Lag/CN Method,** Contour Length= 125,771' Interval= 20'

Subcatchment 4.1:

Runoff = 8.03 cfs @ 8.01 hrs, Volume= 2.666 af, Depth> 4.04"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
7.910	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.5	1,333	0.1211	1.5		**Lag/CN Method,** Contour Length= 8,342' Interval= 5'

Subcatchment 4A:

Runoff = 13.71 cfs @ 8.04 hrs, Volume= 5.223 af, Depth> 3.81"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
16.470	70	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.6	1,217	0.0482	0.9		**Lag/CN Method,** Contour Length= 6,909' Interval= 5'

Subcatchment 5:

Runoff = 43.88 cfs @ 8.07 hrs, Volume= 19.340 af, Depth> 3.46"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
67.030	67	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
31.4	3,286	0.1432	1.7		**Lag/CN Method,** Contour Length= 83,626' Interval= 5'

Subcatchment 5.1:

Runoff = 15.08 cfs @ 8.05 hrs, Volume= 5.796 af, Depth> 3.91"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
17.790	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	1,682	0.0690	1.2		**Lag/CN Method,** Contour Length= 10,690' Interval= 5'

Subcatchment 6:

Runoff = 9.11 cfs @ 7.98 hrs, Volume= 2.701 af, Depth> 4.39"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
7.380	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	774	0.1476	1.6		**Lag/CN Method,** Contour Length= 9,490' Interval= 5'

Subcatchment 7:

Runoff = 61.40 cfs @ 8.06 hrs, Volume= 25.196 af, Depth> 3.58"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
84.430	68	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.7	2,783	0.1440	1.7		**Lag/CN Method,** Contour Length= 105,905' Interval= 5'

Subcatchment 8: Taylor Creek

Runoff = 370.18 cfs @ 9.08 hrs, Volume= 291.058 af, Depth> 2.54"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
1,374.000	60	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
107.2	17,819	0.2643	2.8		**Lag/CN Method,** Contour Length= 791,031' Interval= 20'

Subcatchment 10:

Runoff = 39.71 cfs @ 8.01 hrs, Volume= 13.122 af, Depth> 4.26"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
36.950	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.9	2,320	0.2483	2.6		**Lag/CN Method,** Contour Length= 79,931' Interval= 5'

Subcatchment 10.1:

Runoff = 427.00 cfs @ 8.34 hrs, Volume= 259.921 af, Depth> 3.55"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
877.960	69	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.8	12,872	0.2193	3.0		**Lag/CN Method,** Contour Length= 419,343' Interval= 20'

Reach 2R1: Lone Ranch Creek

Inflow Area = 1,868.250 ac, Inflow Depth > 3.89"
Inflow = 1,058.83 cfs @ 8.28 hrs, Volume= 605.016 af
Outflow = 1,058.83 cfs @ 8.28 hrs, Volume= 605.016 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 4R1: Ram Creek

Inflow Area = 360.280 ac, Inflow Depth > 2.52"
Inflow = 100.95 cfs @ 8.91 hrs, Volume= 75.769 af
Outflow = 100.95 cfs @ 8.91 hrs, Volume= 75.769 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 5R1:

Inflow Area = 84.820 ac, Inflow Depth > 3.56"
Inflow = 58.92 cfs @ 8.07 hrs, Volume= 25.136 af
Outflow = 58.92 cfs @ 8.07 hrs, Volume= 25.136 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 10R1: Shy Creek

Inflow Area = 914.910 ac, Inflow Depth > 3.57"
Inflow = 454.93 cfs @ 8.33 hrs, Volume= 272.134 af
Outflow = 454.93 cfs @ 8.33 hrs, Volume= 272.134 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 10R2:

Inflow Area = 877.960 ac, Inflow Depth > 3.55"
Inflow = 427.00 cfs @ 8.34 hrs, Volume= 259.921 af
Outflow = 426.78 cfs @ 8.40 hrs, Volume= 259.011 af, Atten= 0%, Lag= 3.3 min

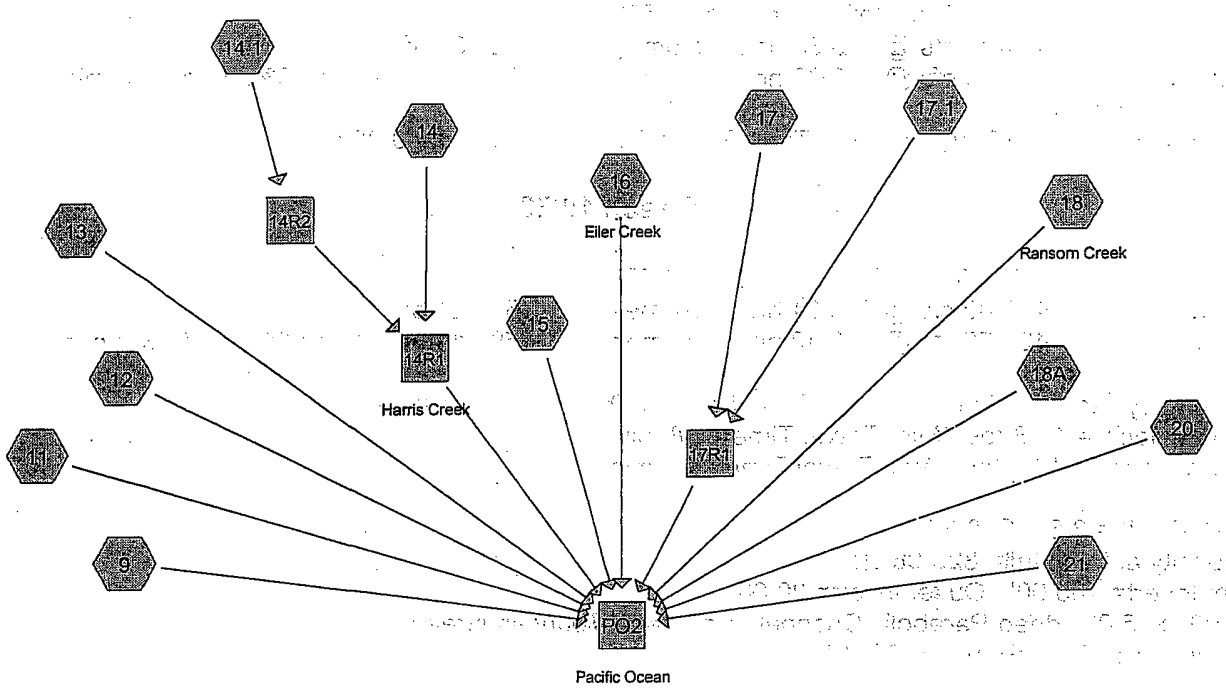
Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.8 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 10.4 fps, Avg. Travel Time= 2.4 min

Peak Depth= 3.63' @ 8.37 hrs
Capacity at bank full= 825.06 cfs
Inlet Invert= 100.00', Outlet Invert= 20.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Mountain streams
Length= 1,507.0' Slope= 0.0531 '/'

Reach PO1: Pacific Ocean

Inflow Area = 4,976.350 ac, Inflow Depth > 3.37"
Inflow = 2,299.26 cfs @ 8.25 hrs, Volume= 1,397.872 af
Outflow = 2,299.26 cfs @ 8.25 hrs, Volume= 1,397.872 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs



Subcat Reach Pond Link

Drainage Diagram for Brookings (Central)
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Subcatchment 9:

Runoff = 52.11 cfs @ 9.95 hrs, Volume= 5.082 af, Depth> 5.29"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
11.530	82	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	696	0.2924	2.8		**Lag/CN Method,** Contour Length= 29,373' Interval= 5'

Subcatchment 11:

Runoff = 52.87 cfs @ 9.95 hrs, Volume= 5.159 af, Depth> 5.39"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
11.480	83	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	638	0.2390	2.6		**Lag/CN Method,** Contour Length= 23,901' Interval= 5'

Subcatchment 12:

Runoff = 120.70 cfs @ 10.01 hrs, Volume= 21.675 af, Depth> 5.14"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
50.570	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.9	2,648	0.0859	1.9		**Lag/CN Method,** Contour Length= 37,852' Interval= 5'

Subcatchment 13:

Runoff = 35.96 cfs @ 9.99 hrs, Volume= 5.158 af, Depth> 5.06"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
12.240	80	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.2	1,716	0.1186	2.0		**Lag/CN Method,** Contour Length= 12,645' Interval= 5'

Subcatchment 14:

Runoff = 103.61 cfs @ 10.05 hrs, Volume= 26.610 af, Depth> 3.48"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
91.880	66	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
38.4	4,290	0.1553	1.9		**Lag/CN Method,** Contour Length= 124,333' Interval= 5'

Subcatchment 14.1:

Runoff = 868.67 cfs @ 10.17 hrs, Volume= 321.246 af, Depth> 3.92"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
983.810	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
72.3	14,474	0.2344	3.3		**Lag/CN Method,** Contour Length= 502,362' Interval= 20'

Subcatchment 15:

Runoff = 132.95 cfs @ 10.00 hrs, Volume= 20.789 af, Depth> 3.11"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
80.250	62	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.8	1,257	0.1790	1.4		**Lag/CN Method,** Contour Length= 125,141' Interval= 5'

Subcatchment 16: Eiler Creek

Runoff = 150.03 cfs @ 10.05 hrs, Volume= 48.804 af, Depth> 3.43"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
170.660	66	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
55.6	5,509	0.1103	1.7		**Lag/CN Method,** Contour Length= 164,029' Interval= 5'

Subcatchment 17:

Runoff = 122.70 cfs @ 9.99 hrs, Volume= 16.610 af, Depth> 4.41"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
45.190	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	1,315	0.1534	1.8		**Lag/CN Method,** Contour Length= 60,410' Interval= 5'

Subcatchment 17.1:

Runoff = 55.67 cfs @ 10.05 hrs, Volume= 14.670 af, Depth> 5.09"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
34.610	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
45.0	5,230	0.0661	1.9		**Lag/CN Method,** Contour Length= 19,930' Interval= 5'

Subcatchment 18: Ransom Creek

Runoff = 473.60 cfs @ 10.18 hrs, Volume= 173.388 af, Depth> 3.50"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
593.740	67	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.9	10,803	0.2064	2.7		**Lag/CN Method,** Contour Length= 266,910' Interval= 20'

Subcatchment 18A:

Runoff = 92.08 cfs @ 9.99 hrs, Volume= 12.384 af, Depth> 4.85"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
30.660	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	1,044	0.0842	1.4		**Lag/CN Method,** Contour Length= 22,486' Interval= 5'

Subcatchment 20:

Runoff = 104.46 cfs @ 10.00 hrs, Volume= 15.643 af, Depth> 5.16"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
36.380	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.7	1,894	0.1065	2.0		**Lag/CN Method,** Contour Length= 33,753' Interval= 5'

Subcatchment 21:

Runoff = 61.91 cfs @ 9.96 hrs, Volume= 6.726 af, Depth> 4.97"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=8.00"

Area (ac)	CN	Description
16.250	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	832	0.1913	2.1		**Lag/CN Method,** Contour Length= 27,085' Interval= 5'

Reach 14R1: Harris Creek

Inflow Area = 1,075.690 ac, Inflow Depth > 3.86"
Inflow = 964.34 cfs @ 10.22 hrs, Volume= 346.199 af
Outflow = 964.34 cfs @ 10.22 hrs, Volume= 346.199 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 14R2:

Inflow Area = 983.810 ac, Inflow Depth > 3.92"
Inflow = 868.67 cfs @ 10.17 hrs, Volume= 321.246 af
Outflow = 868.14 cfs @ 10.26 hrs, Volume= 319.588 af, Atten= 0%, Lag= 5.3 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.7 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 8.6 fps, Avg. Travel Time= 4.6 min

Peak Depth= 4.84' @ 10.21 hrs
Capacity at bank full= 928.58 cfs
Inlet Invert= 80.00', Outlet Invert= 0.00'
20.00' x 5.00' deep Parabolic Channel, n= 0.040 Mountain streams
Length= 2,358.0' Slope= 0.0339 '/'

Reach 17R1:

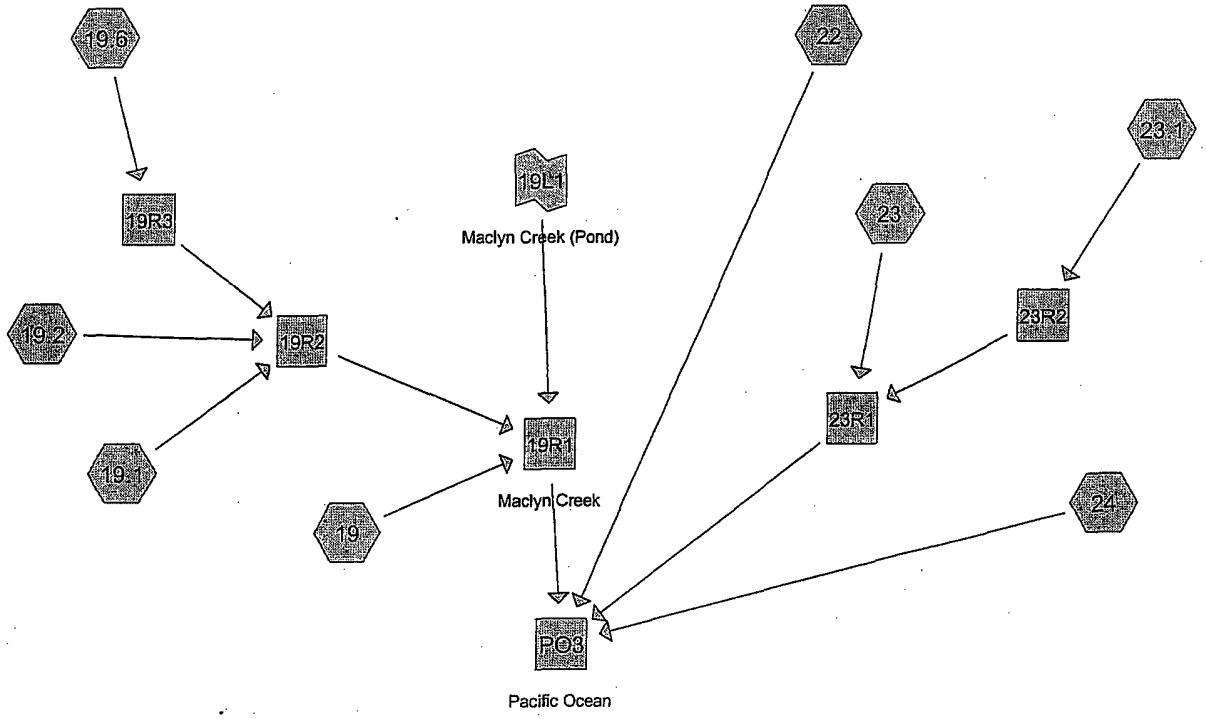
Inflow Area = 79.800 ac, Inflow Depth > 4.70"
Inflow = 177.37 cfs @ 10.00 hrs, Volume= 31.280 af
Outflow = 177.37 cfs @ 10.00 hrs, Volume= 31.280 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach PO2: Pacific Ocean

Inflow Area = 2,169.250 ac, Inflow Depth > 3.83"
Inflow = 2,237.64 cfs @ 10.06 hrs, Volume= 692.286 af
Outflow = 2,237.64 cfs @ 10.06 hrs, Volume= 692.286 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs



Drainage Diagram for Brookings (South)
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Subcatchment 19:

Runoff = 61.69 cfs @ 8.03 hrs, Volume= 21.746 af, Depth> 5.24"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
49.760	83	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.3	2,416	0.0751	1.9		**Lag/CN Method,** Contour Length= 32,576' Interval= 5'

Subcatchment 19.1:

Runoff = 14.99 cfs @ 8.11 hrs, Volume= 6.854 af, Depth> 4.51"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
18.250	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
41.9	2,570	0.0313	1.0		**Lag/CN Method,** Contour Length= 4,977' Interval= 5'

Subcatchment 19.2:

Runoff = 18.66 cfs @ 8.04 hrs, Volume= 6.967 af, Depth> 4.78"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
17.480	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.9	1,507	0.0333	1.0		**Lag/CN Method,** Contour Length= 5,078' Interval= 5'

Subcatchment 19.6:

Runoff = 56.05 cfs @ 8.07 hrs, Volume= 23.579 af, Depth> 4.86"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
58.210	80	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.3	3,247	0.0535	1.5		**Lag/CN Method,** Contour Length= 27,124' Interval= 5'

Subcatchment 22:

Runoff = 77.30 cfs @ 8.05 hrs, Volume= 31.139 af, Depth> 5.66"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
65.980	87	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
32.4	3,093	0.0365	1.6		**Lag/CN Method,** Contour Length= 20,968' Interval= 5'

Subcatchment 23:

Runoff = 44.03 cfs @ 8.05 hrs, Volume= 17.448 af, Depth> 5.33"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
39.310	84	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.8	2,203	0.0290	1.2		**Lag/CN Method,** Contour Length= 9,938' Interval= 5'

Subcatchment 23.1:

Runoff = 49.82 cfs @ 8.02 hrs, Volume= 17.290 af, Depth> 5.70"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
36.370	87	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	1,991	0.0462	1.6		**Lag/CN Method,** Contour Length= 14,633' Interval= 5'

Subcatchment 24:

Runoff = 17.25 cfs @ 7.97 hrs, Volume= 5.022 af, Depth> 4.95"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
12.170	80	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	792	0.1484	1.9		**Lag/CN Method,** Contour Length= 15,733' Interval= 5'

Reach 19R1: Maclyn Creek

Inflow Area = 573.460 ac, Inflow Depth > 5.06"
Inflow = 420.37 cfs @ 7.99 hrs, Volume= 241.798 af
Outflow = 420.37 cfs @ 7.99 hrs, Volume= 241.798 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 19R2:

Inflow Area = 93.940 ac, Inflow Depth > 4.77"
Inflow = 73.32 cfs @ 8.06 hrs, Volume= 37.332 af
Outflow = 70.43 cfs @ 7.94 hrs, Volume= 37.287 af, Atten= 4%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 10.7 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 8.1 fps, Avg. Travel Time= 1.0 min

Peak Depth= 3.00' @ 8.00 hrs
Capacity at bank full= 66.70 cfs
Inlet Invert= 105.00', Outlet Invert= 100.00'
36.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0100 '/'

Reach 19R3:

Inflow Area =	58.210 ac,	Inflow Depth > 4.86"		
Inflow =	56.05 cfs @	8.07 hrs, Volume=	23.579 af	
Outflow =	40.84 cfs @	9.99 hrs, Volume=	23.511 af,	Atten= 27%, Lag= 115.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.4 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 10.9 fps, Avg. Travel Time= 2.5 min

Peak Depth= 2.00' @ 7.85 hrs
Capacity at bank full= 39.71 cfs
Inlet Invert= 155.00', Outlet Invert= 105.00'
24.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,623.0' Slope= 0.0308 '/'

Reach 23R1:

Inflow Area =	75.680 ac,	Inflow Depth > 5.50"		
Inflow =	93.45 cfs @	8.06 hrs, Volume=	34.691 af	
Outflow =	93.45 cfs @	8.06 hrs, Volume=	34.691 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 23R2:

Inflow Area =	36.370 ac,	Inflow Depth > 5.70"		
Inflow =	49.82 cfs @	8.02 hrs, Volume=	17.290 af	
Outflow =	49.45 cfs @	8.07 hrs, Volume=	17.243 af,	Atten= 1%, Lag= 3.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.7 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 8.4 fps, Avg. Travel Time= 2.8 min

Peak Depth= 1.32' @ 8.04 hrs
Capacity at bank full= 210.27 cfs
Inlet Invert= 105.00', Outlet Invert= 75.00'
48.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,400.0' Slope= 0.0214 '/'

Reach PO3: Pacific Ocean

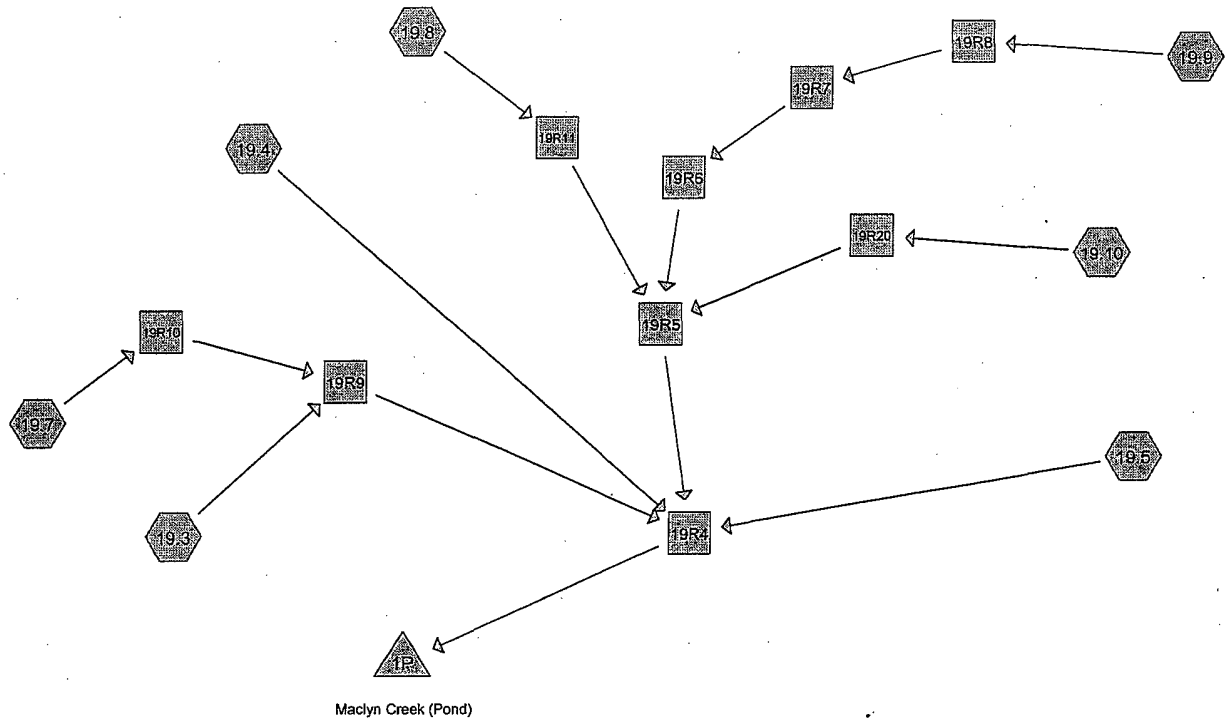
Inflow Area = 727.290 ac, Inflow Depth > 5.16"
Inflow = 606.14 cfs @ 8.02 hrs, Volume= 312.650 af
Outflow = 606.14 cfs @ 8.02 hrs, Volume= 312.650 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 19L1: Maclyn Creek (Pond)

Inflow Area = 429.760 ac, Inflow Depth > 5.10"
Inflow = 291.15 cfs @ 8.00 hrs, Volume= 182.765 af
Primary = 291.15 cfs @ 8.00 hrs, Volume= 182.765 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Primary Outflow Imported from Brookings (Maclyn Creek)~Pond 1P



Drainage Diagram for Brookings (Maclyn Creek)
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Subcatchment 19.10:

Runoff = 150.12 cfs @ 8.04 hrs, Volume= 56.286 af, Depth> 5.46"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
123.810	85	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.2	5,876	0.1794	3.7		**Lag/CN Method,** Contour Length= 193,529' Interval= 5'

Subcatchment 19.3:

Runoff = 16.59 cfs @ 8.01 hrs, Volume= 5.688 af, Depth> 6.06"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
11.270	90	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.8	1,778	0.0355	1.6		**Lag/CN Method,** Contour Length= 3,483' Interval= 5'

Subcatchment 19.4:

Runoff = 16.70 cfs @ 7.97 hrs, Volume= 5.190 af, Depth> 6.68"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
9.330	95	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	870	0.0316	1.6		**Lag/CN Method,** Contour Length= 2,572' Interval= 5'

Subcatchment 19.5:

Runoff = 39.93 cfs @ 8.01 hrs, Volume= 13.624 af, Depth> 6.41"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
25.500	93	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	1,874	0.0348	1.8		**Lag/CN Method,** Contour Length= 7,724' Interval= 5'

Subcatchment 19.7:

Runoff = 16.42 cfs @ 8.01 hrs, Volume= 5.445 af, Depth> 5.15"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
12.700	82	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.9	1,682	0.0716	1.7		**Lag/CN Method,** Contour Length= 7,920' Interval= 5'

Subcatchment 19.8:

Runoff = 34.95 cfs @ 8.00 hrs, Volume= 11.182 af, Depth> 5.96"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
22.530	89	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	1,798	0.0695	2.1		**Lag/CN Method,** Contour Length= 13,632' Interval= 5'

Subcatchment 19.9:

Runoff = 170.26 cfs @ 8.18 hrs, Volume= 85.681 af, Depth> 4.58"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
224.620	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
53.9	6,764	0.0838	2.1		**Lag/CN Method,** Contour Length= 164,024' Interval= 5'

Reach 19R10:

Inflow Area = 12.700 ac, Inflow Depth > 5.15"
Inflow = 16.42 cfs @ 8.01 hrs, Volume= 5.445 af
Outflow = 9.89 cfs @ 7.76 hrs, Volume= 5.423 af, Atten= 40%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.6 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 6.6 fps, Avg. Travel Time= 3.7 min

Peak Depth= 1.25' @ 7.75 hrs
Capacity at bank full= 9.29 cfs
Inlet Invert= 135.00', Outlet Invert= 105.00'
15.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,450.0' Slope= 0.0207 '/'

Reach 19R11:

Inflow Area = 22.530 ac, Inflow Depth > 5.96"
Inflow = 34.95 cfs @ 8.00 hrs, Volume= 11.182 af
Outflow = 34.83 cfs @ 8.01 hrs, Volume= 11.175 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 16.5 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 9.9 fps, Avg. Travel Time= 0.7 min

Peak Depth= 0.99' @ 8.00 hrs
Capacity at bank full= 163.43 cfs
Inlet Invert= 135.00', Outlet Invert= 117.00'
38.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 400.0' Slope= 0.0450 '/'

Reach 19R20:

Inflow Area = 123.810 ac, Inflow Depth > 5.46"
Inflow = 150.12 cfs @ 8.04 hrs, Volume= 56.286 af
Outflow = 82.91 cfs @ 7.67 hrs, Volume= 56.216 af, Atten= 45%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 12.8 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 10.1 fps, Avg. Travel Time= 1.2 min

Peak Depth= 3.00' @ 7.70 hrs
Capacity at bank full= 79.72 cfs
Inlet Invert= 127.00', Outlet Invert= 117.00'
36.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 700.0' Slope= 0.0143 '/'

Reach 19R4:

Inflow Area = 429.760 ac, Inflow Depth > 5.10"
Inflow = 291.15 cfs @ 8.00 hrs, Volume= 182.769 af
Outflow = 291.15 cfs @ 8.00 hrs, Volume= 182.765 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 41.6 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 29.5 fps, Avg. Travel Time= 0.0 min

Peak Depth= 1.93' @ 8.00 hrs
Capacity at bank full= 920.80 cfs
Inlet Invert= 105.00', Outlet Invert= 100.00'
60.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 40.0' Slope= 0.1250 '/'

Reach 19R5:

Inflow Area = 370.960 ac, Inflow Depth > 4.95"
Inflow = 208.88 cfs @ 8.01 hrs, Volume= 152.937 af
Outflow = 208.77 cfs @ 8.02 hrs, Volume= 152.844 af, Atten= 0%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 20.7 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 15.8 fps, Avg. Travel Time= 0.5 min

Peak Depth= 2.55' @ 8.01 hrs
Capacity at bank full= 403.48 cfs
Inlet Invert= 117.00', Outlet Invert= 105.00'
60.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0240 '/'

Reach 19R6:

Inflow Area = 224.620 ac, Inflow Depth > 4.57"
Inflow = 99.34 cfs @ 14.33 hrs, Volume= 85.562 af
Outflow = 98.84 cfs @ 14.33 hrs, Volume= 85.546 af, Atten= 1%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 25.4 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 20.8 fps, Avg. Travel Time= 0.1 min

Peak Depth= 1.26' @ 14.33 hrs
Capacity at bank full= 709.85 cfs
Inlet Invert= 130.00', Outlet Invert= 117.00'
60.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 175.0' Slope= 0.0743 '/'

Reach 19R7:

Inflow Area = 224.620 ac, Inflow Depth > 4.57"
Inflow = 101.34 cfs @ 14.33 hrs, Volume= 85.611 af
Outflow = 99.34 cfs @ 14.33 hrs, Volume= 85.562 af, Atten= 2%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.6 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 12.1 fps, Avg. Travel Time= 0.4 min

Peak Depth= 2.14' @ 14.33 hrs
Capacity at bank full= 179.55 cfs
Inlet Invert= 135.00', Outlet Invert= 130.00'
48.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 320.0' Slope= 0.0156 '/'

Reach 19R8:

Inflow Area = 224.620 ac, Inflow Depth > 4.58"
Inflow = 170.26 cfs @ 8.18 hrs, Volume= 85.681 af
Outflow = 101.34 cfs @ 14.33 hrs, Volume= 85.611 af, Atten= 40%, Lag= 369.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 15.2 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 12.4 fps, Avg. Travel Time= 0.7 min

Peak Depth= 3.00' @ 7.70 hrs
Capacity at bank full= 94.33 cfs
Inlet Invert= 145.00', Outlet Invert= 135.00'
36.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0200 '/'

Reach 19R9:

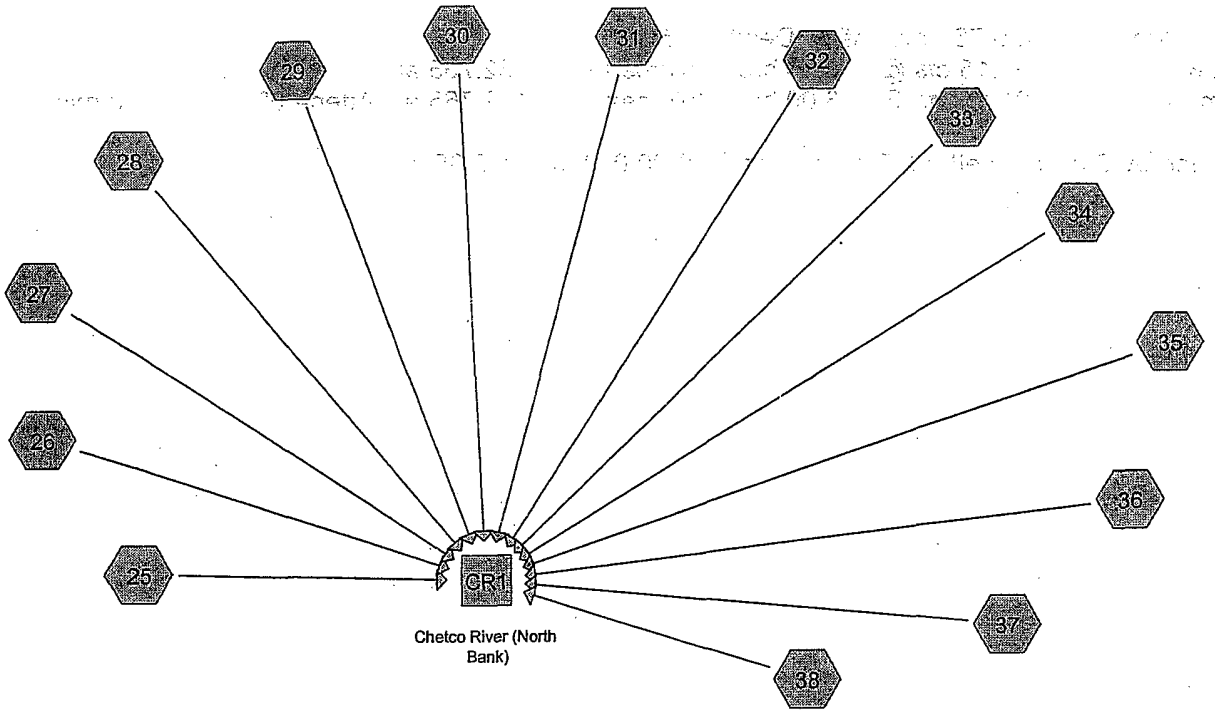
Inflow Area =	23.970 ac,	Inflow Depth >	5.56"		
Inflow =	25.88 cfs @	8.01 hrs,	Volume=	11.111 af	
Outflow =	25.88 cfs @	8.01 hrs,	Volume=	11.111 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Pond 1P: Maclyn Creek (Pond)

Inflow Area =	429.760 ac,	Inflow Depth >	5.10"		
Inflow =	291.15 cfs @	8.00 hrs,	Volume=	182.765 af	
Primary =	291.15 cfs @	8.00 hrs,	Volume=	182.765 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs



Drainage Diagram for Chetco River (North Bank)
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Subcatchment 25:

Runoff = 39.09 cfs @ 8.01 hrs, Volume= 13.008 af, Depth> 4.81"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
32.460	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.7	2,241	0.1405	2.2		**Lag/CN Method,** Contour Length= 39,728' Interval= 5'

Subcatchment 26:

Runoff = 19.20 cfs @ 8.04 hrs, Volume= 7.125 af, Depth> 4.02"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
21.250	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.8	1,816	0.0879	1.4		**Lag/CN Method,** Contour Length= 16,266' Interval= 5'

Subcatchment 27:

Runoff = 126.42 cfs @ 8.06 hrs, Volume= 51.968 af, Depth> 4.98"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
125.260	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.5	4,619	0.0978	2.3		**Lag/CN Method,** Contour Length= 106,723' Interval= 5'

Subcatchment 28:

Runoff = 61.00 cfs @ 7.97 hrs, Volume= 17.810 af, Depth> 4.84"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
44.160	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	774	0.1516	1.9		**Lag/CN Method,** Contour Length= 14,581' Interval= 20'

Subcatchment 29:

Runoff = 37.21 cfs @ 8.00 hrs, Volume= 11.810 af, Depth> 4.38"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
32.370	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	1,566	0.1770	2.1		**Lag/CN Method,** Contour Length= 12,478' Interval= 20'

Subcatchment 30:

Runoff = 75.66 cfs @ 8.03 hrs, Volume= 26.582 af, Depth> 4.58"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
69.700	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.9	3,711	0.2492	3.1		**Lag/CN Method,** Contour Length= 37,827' Interval= 20'

Subcatchment 31:

Runoff = 60.48 cfs @ 8.00 hrs, Volume= 19.117 af, Depth> 4.49"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
51.110	76	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	2,183	0.2815	2.9		**Lag/CN Method,** Contour Length= 31,332' Interval= 20'

Subcatchment 32:

Runoff = 376.95 cfs @ 8.11 hrs, Volume= 173.586 af, Depth> 4.08"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
510.990	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.0	9,469	0.3477	3.9		**Lag/CN Method,** Contour Length= 386,957' Interval= 20'

Subcatchment 33:

Runoff = 148.79 cfs @ 8.02 hrs, Volume= 50.815 af, Depth> 4.47"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
136.330	76	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.7	3,247	0.2689	3.1		**Lag/CN Method,** Contour Length= 79,852' Interval= 20'

Subcatchment 34:

Runoff = 793.21 cfs @ 8.17 hrs, Volume= 392.637 af, Depth> 3.84"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
1,225.980	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
46.0	11,402	0.3950	4.1		**Lag/CN Method,** Contour Length= 1,054,663' Interval= 20'

Subcatchment 35:

Runoff = 435.01 cfs @ 8.06 hrs, Volume= 177.809 af, Depth> 4.11"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
519.360	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.6	6,551	0.3534	3.7		**Lag/CN Method,** Contour Length= 399,699' Interval= 20'

Subcatchment 36:

Runoff = 167.39 cfs @ 8.06 hrs, Volume= 67.742 af, Depth> 4.11"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
197.750	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.8	4,947	0.2367	2.9		**Lag/CN Method,** Contour Length= 101,939' Interval= 20'

Subcatchment 37:

Runoff = 129.68 cfs @ 8.12 hrs, Volume= 61.091 af, Depth> 3.76"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
195.220	70	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.8	7,499	0.2846	3.1		**Lag/CN Method,** Contour Length= 120,990' Interval= 20'

Subcatchment 38:

Runoff = 93.58 cfs @ 8.04 hrs, Volume= 36.589 af, Depth> 3.18"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

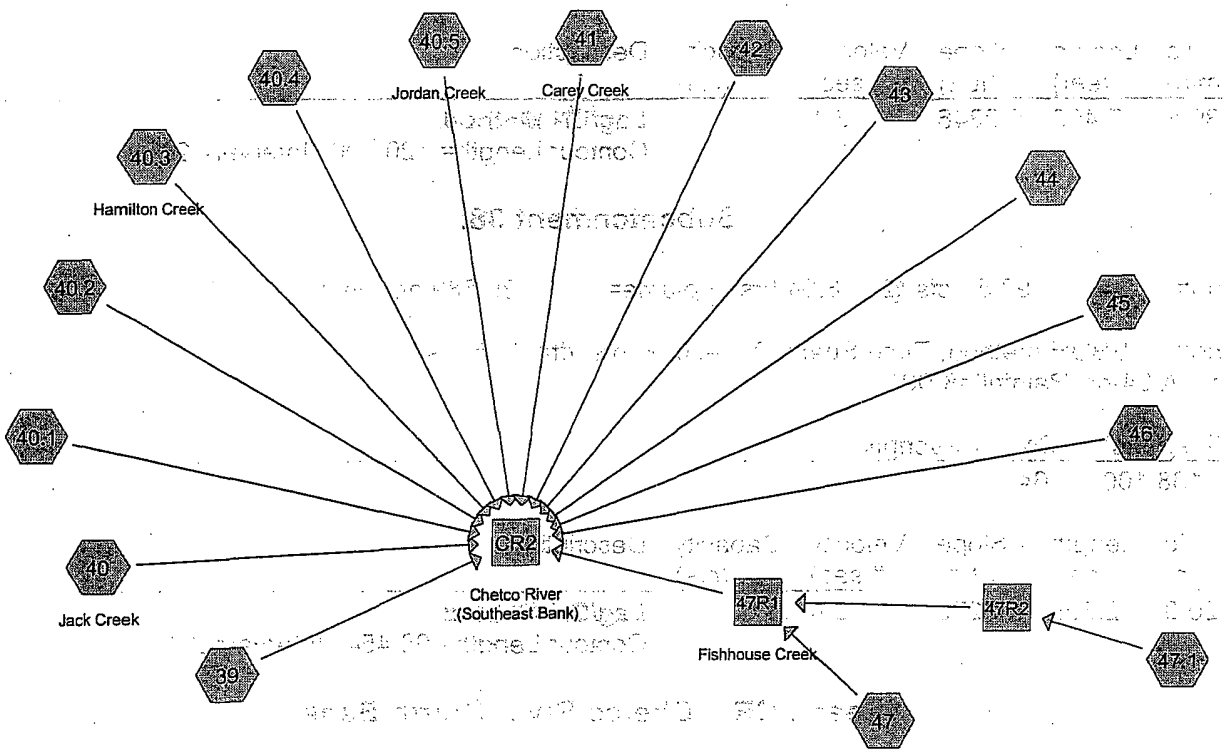
Area (ac)	CN	Description
138.100	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.3	2,899	0.3273	2.4		**Lag/CN Method,** Contour Length= 98,454' Interval= 20'

Reach CR1: Chetco River (North Bank)

Inflow Area = 3,300.040 ac, Inflow Depth > 4.03"
Inflow = 2,544.42 cfs @ 8.06 hrs, Volume= 1,107.691 af
Outflow = 2,544.42 cfs @ 8.06 hrs, Volume= 1,107.691 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs



Drainage Diagram for Chetco River (Southeast Bank)
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Subcatchment 39:

Runoff = 233.01 cfs @ 7.99 hrs, Volume= 71.355 af, Depth> 4.28"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
200.220	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.9	3,749	1.2087	6.3		**Lag/CN Method,** Contour Length= 527,103' Interval= 20'

Subcatchment 40: Jack Creek

Runoff = 1,323.36 cfs @ 9.02 hrs, Volume= 1,014.738 af, Depth> 3.46"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
3,520.040	70	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
131.9	34,149	0.2935	4.3		**Lag/CN Method,** Contour Length= 2,249,930' Interval= 20'

Subcatchment 40.1:

Runoff = 54.75 cfs @ 8.01 hrs, Volume= 18.168 af, Depth> 4.70"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
46.400	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	2,416	0.1759	2.5		**Lag/CN Method,** Contour Length= 17,778' Interval= 20'

Subcatchment 40.2:

Runoff = 80.36 cfs @ 8.04 hrs, Volume= 30.177 af, Depth> 4.34"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
83.370	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.0	3,846	0.2038	2.7		**Lag/CN Method,** Contour Length= 37,005' Interval= 20'

Subcatchment 40.3: Hamilton Creek

Runoff = 590.77 cfs @ 8.24 hrs, Volume= 318.876 af, Depth> 3.91"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
977.860	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
57.9	11,460	0.2382	3.3		**Lag/CN Method,** Contour Length= 507,216' Interval= 20'

Subcatchment 40.4:

Runoff = 265.41 cfs @ 8.04 hrs, Volume= 99.453 af, Depth> 3.91"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
304.840	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0	3,943	0.3152	3.0		**Lag/CN Method,** Contour Length= 209,258' Interval= 20'

Subcatchment 40.5: Jordan Creek

Runoff = 436.23 cfs @ 8.18 hrs, Volume= 219.762 af, Depth> 3.63"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
726.280	69	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
45.9	8,774	0.2915	3.2		**Lag/CN Method,** Contour Length= 461,048' Interval= 20'

Subcatchment 41: Carey Creek

Runoff = 124.20 cfs @ 8.06 hrs, Volume= 50.841 af, Depth> 3.38"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
180.760	66	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0	4,638	0.4136	3.1		**Lag/CN Method,** Contour Length= 162,833' Interval= 20'

Subcatchment 42:

Runoff = 22.69 cfs @ 8.03 hrs, Volume= 8.434 af, Depth> 3.19"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
31.750	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.1	2,879	0.4599	2.8		**Lag/CN Method,** Contour Length= 31,805' Interval= 20'

Subcatchment 43:

Runoff = 142.31 cfs @ 8.05 hrs, Volume= 56.908 af, Depth> 3.48"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
196.080	67	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.1	4,175	0.3568	2.9		**Lag/CN Method,** Contour Length= 152,357' Interval= 20'

Subcatchment 44:

Runoff = 368.08 cfs @ 8.02 hrs, Volume= 126.866 af, Depth> 4.36"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
349.020	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.0	3,614	0.3287	3.3		**Lag/CN Method,** Contour Length= 249,890' Interval= 20'

Subcatchment 45:

Runoff = 52.87 cfs @ 8.01 hrs, Volume= 17.477 af, Depth> 4.59"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
45.700	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	2,396	0.1963	2.5		**Lag/CN Method,** Contour Length= 78,164' Interval= 5'

Subcatchment 46:

Runoff = 110.32 cfs @ 7.97 hrs, Volume= 33.680 af, Depth> 6.44"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
62.750	93	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	754	0.0320	1.4		**Lag/CN Method,** Contour Length= 17,507' Interval= 5'

Subcatchment 47:

Runoff = 21.67 cfs @ 8.05 hrs, Volume= 8.630 af, Depth> 3.59"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
28.870	68	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.5	2,532	0.1477	1.7		**Lag/CN Method,** Contour Length= 37,138' Interval= 5'

Subcatchment 47.1:

Runoff = 202.80 cfs @ 8.04 hrs, Volume= 76.578 af, Depth> 4.45"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
206.460	76	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.8	5,314	0.3030	3.6		**Lag/CN Method,** Contour Length= 136,256' Interval= 20'

Reach 47R1: Fishhouse Creek

Inflow Area = 235.330 ac, Inflow Depth > 4.34"
Inflow = 224.01 cfs @ 8.06 hrs, Volume= 85.126 af
Outflow = 224.01 cfs @ 8.06 hrs, Volume= 85.126 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 47R2:

Inflow Area = 206.460 ac, Inflow Depth > 4.45"
Inflow = 202.80 cfs @ 8.04 hrs, Volume= 76.578 af
Outflow = 202.35 cfs @ 8.06 hrs, Volume= 76.495 af, Atten= 0%, Lag= 1.1 min

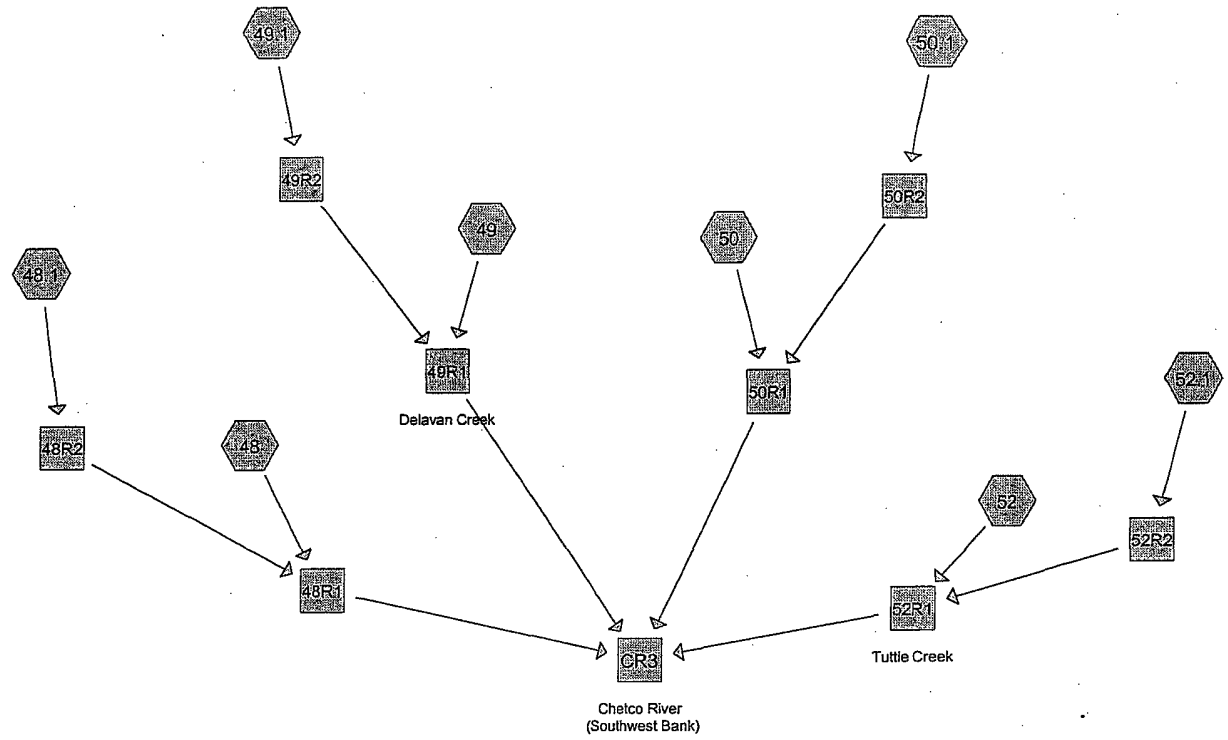
Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 28.5 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 18.8 fps, Avg. Travel Time= 0.9 min

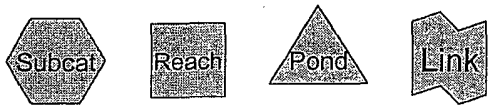
Peak Depth= 2.21' @ 8.05 hrs
Capacity at bank full= 344.36 cfs
Inlet Invert= 80.00', Outlet Invert= 20.00'
48.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,044.0' Slope= 0.0575 '/'

Reach CR2: Chetco River (Southeast Bank)

Inflow Area = 6,960.400 ac, Inflow Depth > 3.71"
Inflow = 3,791.30 cfs @ 8.07 hrs, Volume= 2,151.860 af
Outflow = 3,791.30 cfs @ 8.07 hrs, Volume= 2,151.860 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs





Drainage Diagram for Chetco River (Southwest Bank)
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Subcatchment 48:

Runoff = 31.39 cfs @ 8.02 hrs, Volume= 10.578 af, Depth> 5.03"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
25.240	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.9	2,203	0.1043	2.0		**Lag/CN Method,** Contour Length= 22,926' Interval= 5'

Subcatchment 48.1:

Runoff = 45.20 cfs @ 8.02 hrs, Volume= 15.745 af, Depth> 4.69"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
40.300	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.6	2,899	0.1636	2.5		**Lag/CN Method,** Contour Length= 57,423' Interval= 5'

Subcatchment 49:

Runoff = 58.70 cfs @ 8.02 hrs, Volume= 19.742 af, Depth> 4.70"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
50.450	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.2	2,377	0.1541	2.3		**Lag/CN Method,** Contour Length= 67,742' Interval= 5'

Subcatchment 49.1:

Runoff = 90.55 cfs @ 8.05 hrs, Volume= 35.177 af, Depth> 3.70"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
114.190	69	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.4	4,252	0.3500	3.0		**Lag/CN Method,** Contour Length= 87,054' Interval= 20'

Subcatchment 50:

Runoff = 51.60 cfs @ 8.06 hrs, Volume= 20.721 af, Depth> 4.33"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
57.460	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.2	2,977	0.0914	1.7		**Lag/CN Method,** Contour Length= 45,771' Interval= 5'

Subcatchment 50.1:

Runoff = 59.22 cfs @ 8.01 hrs, Volume= 19.126 af, Depth> 5.04"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
45.550	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	2,744	0.2126	3.1		**Lag/CN Method,** Contour Length= 84,368' Interval= 5'

Subcatchment 52:

Runoff = 97.40 cfs @ 8.05 hrs, Volume= 38.093 af, Depth> 4.77"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
95.810	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.6	3,652	0.1045	2.1		**Lag/CN Method,** Contour Length= 87,248' Interval= 5'

Subcatchment 52.1:

Runoff = 163.04 cfs @ 8.07 hrs, Volume= 73.215 af, Depth> 3.15"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
278.610	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0	5,759	0.4511	3.2		**Lag/CN Method,** Contour Length= 273,725' Interval= 20'

Reach 48R1:

Inflow Area = 65.540 ac, Inflow Depth > 4.81"
Inflow = 75.74 cfs @ 8.05 hrs, Volume= 26.273 af
Outflow = 75.74 cfs @ 8.05 hrs, Volume= 26.273 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 48R2:

Inflow Area = 40.300 ac, Inflow Depth > 4.69"
Inflow = 45.20 cfs @ 8.02 hrs, Volume= 15.745 af
Outflow = 44.83 cfs @ 8.08 hrs, Volume= 15.695 af, Atten= 1%, Lag= 3.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 12.7 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 8.1 fps, Avg. Travel Time= 2.9 min

Peak Depth= 1.51' @ 8.05 hrs
Capacity at bank full= 89.45 cfs
Inlet Invert= 145.00', Outlet Invert= 120.00'
36.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,390.0' Slope= 0.0180 '/'

Reach 49R1: Delavan Creek

Inflow Area =	164.640 ac,	Inflow Depth >	3.99"		
Inflow =	146.78 cfs @	8.07 hrs,	Volume=	54.789 af	
Outflow =	146.78 cfs @	8.07 hrs,	Volume=	54.789 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 49R2:

Inflow Area =	114.190 ac,	Inflow Depth >	3.70"		
Inflow =	90.55 cfs @	8.05 hrs,	Volume=	35.177 af	
Outflow =	89.98 cfs @	8.11 hrs,	Volume=	35.046 af,	Atten= 1%, Lag= 3.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 16.1 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 10.8 fps, Avg. Travel Time= 2.9 min

Peak Depth= 1.83' @ 8.07 hrs
Capacity at bank full= 210.88 cfs
Inlet Invert= 165.00', Outlet Invert= 125.00'
48.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,856.0' Slope= 0.0216 '/'

Reach 50R1:

Inflow Area =	103.010 ac,	Inflow Depth >	4.62"		
Inflow =	108.35 cfs @	8.13 hrs,	Volume=	39.672 af	
Outflow =	108.35 cfs @	8.13 hrs,	Volume=	39.672 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 50R2:

Inflow Area =	45.550 ac,	Inflow Depth >	5.04"		
Inflow =	59.22 cfs @	8.01 hrs,	Volume=	19.126 af	
Outflow =	57.74 cfs @	8.15 hrs,	Volume=	18.951 af,	Atten= 2%, Lag= 8.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.6 fps, Min. Travel Time= 5.3 min
Avg. Velocity = 4.6 fps, Avg. Travel Time= 8.8 min

Peak Depth= 1.43' @ 8.06 hrs
Capacity at bank full= 798.23 cfs
Inlet Invert= 140.00', Outlet Invert= 20.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,415.0' Slope= 0.0497 '/'

Reach 52R1: Tuttle Creek

Inflow Area = 374.420 ac, Inflow Depth > 3.54"
Inflow = 251.35 cfs @ 8.22 hrs, Volume= 110.480 af
Outflow = 251.35 cfs @ 8.22 hrs, Volume= 110.480 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 52R2:

Inflow Area = 278.610 ac, Inflow Depth > 3.15"
Inflow = 163.04 cfs @ 8.07 hrs, Volume= 73.215 af
Outflow = 160.47 cfs @ 8.27 hrs, Volume= 72.387 af, Atten= 2%, Lag= 11.9 min

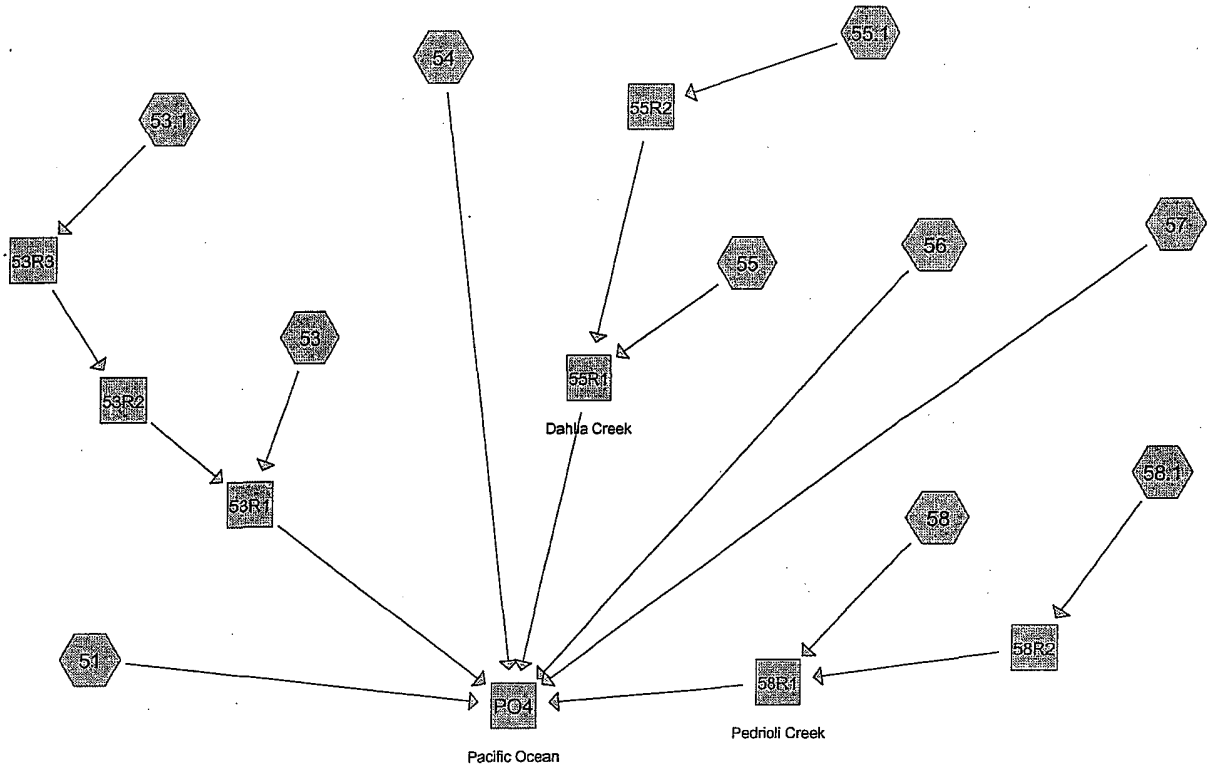
Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.4 fps, Min. Travel Time= 5.5 min
Avg. Velocity = 6.6 fps, Avg. Travel Time= 7.8 min

Peak Depth= 2.45' @ 8.18 hrs
Capacity at bank full= 705.34 cfs
Inlet Invert= 140.00', Outlet Invert= 20.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 3,093.0' Slope= 0.0388 '/'

Reach CR3: Chetco River (Southwest Bank)

Inflow Area = 707.610 ac, Inflow Depth > 3.92"
Inflow = 572.43 cfs @ 8.13 hrs, Volume= 231.214 af
Outflow = 572.43 cfs @ 8.13 hrs, Volume= 231.214 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs



Drainage Diagram for Harbor (North)
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Subcatchment 51:

Runoff = 32.21 cfs @ 7.98 hrs, Volume= 9.630 af, Depth> 4.17"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
27.690	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	561	0.0986	1.2		**Lag/CN Method,** Contour Length= 23,777' Interval= 5'

Subcatchment 53:

Runoff = 90.75 cfs @ 8.23 hrs, Volume= 48.524 af, Depth> 4.44"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
131.090	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
61.6	4,735	0.0384	1.3		**Lag/CN Method,** Contour Length= 43,859' Interval= 5'

Subcatchment 53.1:

Runoff = 53.53 cfs @ 8.01 hrs, Volume= 17.418 af, Depth> 4.26"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
49.010	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9	2,087	0.2414	2.5		**Lag/CN Method,** Contour Length= 103,055' Interval= 5'

Subcatchment 54:

Runoff = 78.91 cfs @ 8.07 hrs, Volume= 33.757 af, Depth> 4.10"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
98.880	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.4	2,241	0.0496	1.1		**Lag/CN Method,** Contour Length= 42,697' Interval= 5'

Subcatchment 55:

Runoff = 55.80 cfs @ 8.32 hrs, Volume= 33.223 af, Depth> 4.07"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
97.950	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
75.6	5,527	0.0389	1.2		**Lag/CN Method,** Contour Length= 33,168' Interval= 5'

Subcatchment 55.1:

Runoff = 137.28 cfs @ 8.07 hrs, Volume= 61.158 af, Depth> 3.16"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
232.610	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.4	4,542	0.3221	2.6		**Lag/CN Method,** Contour Length= 652,772' Interval= 5'

Subcatchment 56:

Runoff = 22.69 cfs @ 8.06 hrs, Volume= 9.087 af, Depth> 5.10"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
21.390	82	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
31.4	2,241	0.0327	1.2		**Lag/CN Method,** Contour Length= 6,090' Interval= 5'

Subcatchment 57:

Runoff = 7.62 cfs @ 8.00 hrs, Volume= 2.449 af, Depth> 3.94"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
7.450	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	696	0.0666	1.0		**Lag/CN Method,** Contour Length= 4,325' Interval= 5'

Subcatchment 58:

Runoff = 88.12 cfs @ 8.16 hrs, Volume= 43.495 af, Depth> 4.59"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
113.820	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.4	3,827	0.0370	1.2		**Lag/CN Method,** Contour Length= 36,720' Interval= 5'

Subcatchment 58.1:

Runoff = 101.46 cfs @ 8.07 hrs, Volume= 43.473 af, Depth> 3.57"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
146.060	68	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0	4,697	0.2648	2.6		**Lag/CN Method,** Contour Length= 336,944' Interval= 5'

Reach 53R1:

Inflow Area = 180.100 ac, Inflow Depth > 4.38"
Inflow = 142.82 cfs @ 8.15 hrs, Volume= 65.800 af
Outflow = 142.82 cfs @ 8.15 hrs, Volume= 65.800 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 53R2:

Inflow Area = 49.010 ac, Inflow Depth > 4.25"
Inflow = 52.95 cfs @ 8.06 hrs, Volume= 17.357 af
Outflow = 52.54 cfs @ 8.13 hrs, Volume= 17.276 af, Atten= 1%, Lag= 4.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 11.8 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 7.3 fps, Avg. Travel Time= 4.0 min

Peak Depth= 1.00' @ 8.09 hrs
Capacity at bank full= 1,554.67 cfs
Inlet Invert= 95.00', Outlet Invert= 60.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.013 Concrete pipe, bends & connections
Length= 1,758.0' Slope= 0.0199 '/'

Reach 53R3:

Inflow Area = 49.010 ac, Inflow Depth > 4.26"
Inflow = 53.53 cfs @ 8.01 hrs, Volume= 17.418 af
Outflow = 52.95 cfs @ 8.06 hrs, Volume= 17.357 af, Atten= 1%, Lag= 3.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 17.0 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 11.0 fps, Avg. Travel Time= 3.0 min

Peak Depth= 1.52' @ 8.03 hrs
Capacity at bank full= 77.71 cfs
Inlet Invert= 165.00', Outlet Invert= 95.00'
30.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,950.0' Slope= 0.0359 '/'

Reach 55R1: Dahlia Creek

Inflow Area = 330.560 ac, Inflow Depth > 3.39"
Inflow = 189.05 cfs @ 8.35 hrs, Volume= 93.399 af
Outflow = 189.05 cfs @ 8.35 hrs, Volume= 93.399 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 55R2:

Inflow Area = 232.610 ac, Inflow Depth > 3.16"
Inflow = 137.28 cfs @ 8.07 hrs, Volume= 61.158 af
Outflow = 133.27 cfs @ 8.35 hrs, Volume= 60.176 af, Atten= 3%, Lag= 16.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.8 fps, Min. Travel Time= 7.8 min
Avg. Velocity = 5.5 fps, Avg. Travel Time= 11.1 min

Peak Depth= 2.45' @ 8.22 hrs
Capacity at bank full= 586.76 cfs
Inlet Invert= 163.00', Outlet Invert= 65.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 3,650.0' Slope= 0.0268 '/'

Reach 58R1: Pedrioli Creek

Inflow Area = 259.880 ac, Inflow Depth > 3.99"
Inflow = 185.41 cfs @ 8.29 hrs, Volume= 86.330 af
Outflow = 185.41 cfs @ 8.29 hrs, Volume= 86.330 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 58R2:

Inflow Area = 146.060 ac, Inflow Depth > 3.57"
Inflow = 101.46 cfs @ 8.07 hrs, Volume= 43.473 af
Outflow = 98.56 cfs @ 8.33 hrs, Volume= 42.834 af, Atten= 3%, Lag= 15.4 min

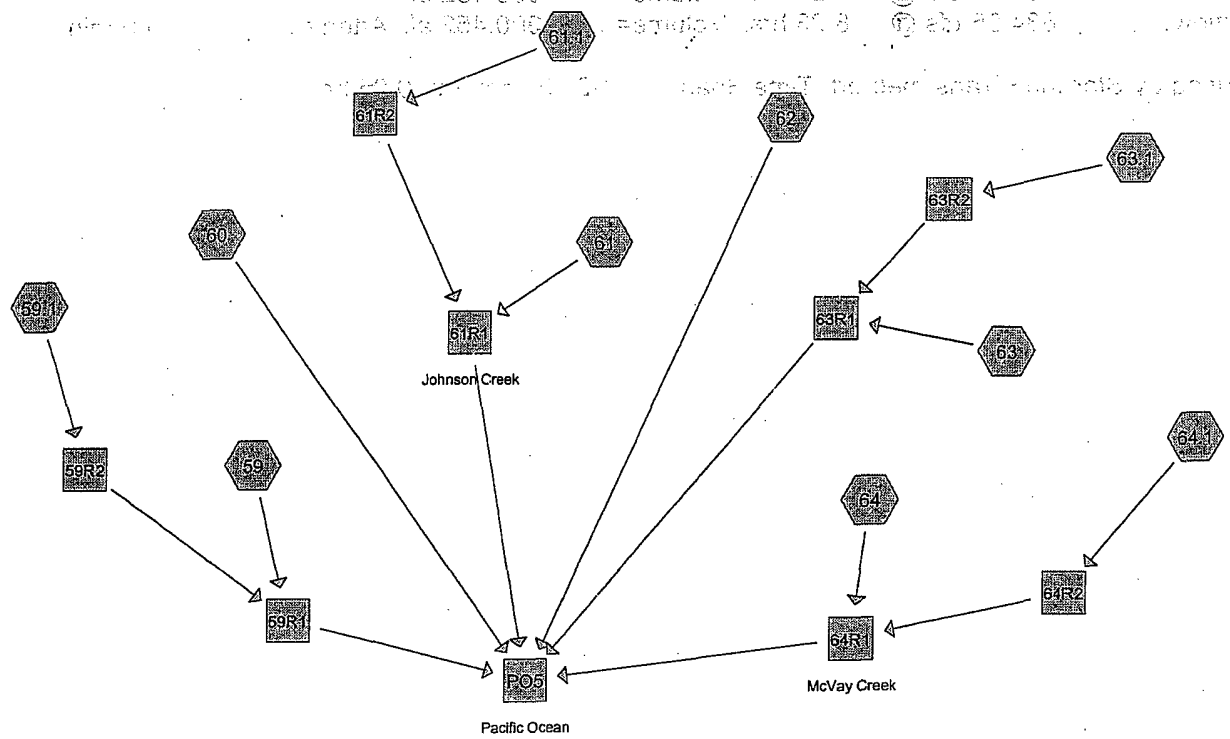
Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.8 fps, Min. Travel Time= 7.5 min
Avg. Velocity = 4.6 fps, Avg. Travel Time= 11.0 min

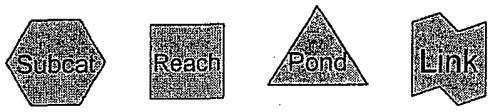
Peak Depth= 2.20' @ 8.20 hrs
Capacity at bank full= 543.83 cfs
Inlet Invert= 125.00', Outlet Invert= 55.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 3,035.0' Slope= 0.0231 '/'

Reach PO4: Pacific Ocean

Inflow Area =	925.950 ac,	Inflow Depth >	3.89"		
Inflow =	634.95 cfs @	8.23 hrs,	Volume=	300.452 af	
Outflow =	634.95 cfs @	8.23 hrs,	Volume=	300.452 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs





Drainage Diagram for Harbor (South)
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Subcatchment 59:

Runoff = 33.13 cfs @ 8.18 hrs, Volume= 16.679 af, Depth> 4.15"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
48.220	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.8	3,208	0.0361	1.1		**Lag/CN Method,** Contour Length= 15,155' Interval= 5'

Subcatchment 59.1:

Runoff = 42.80 cfs @ 8.06 hrs, Volume= 18.277 af, Depth> 3.26"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
67.180	65	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.2	4,155	0.3090	2.5		**Lag/CN Method,** Contour Length= 180,835' Interval= 5'

Subcatchment 60:

Runoff = 31.81 cfs @ 8.06 hrs, Volume= 13.089 af, Depth> 3.79"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
41.450	70	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	2,029	0.0696	1.2		**Lag/CN Method,** Contour Length= 25,143' Interval= 5'

Subcatchment 61:

Runoff = 50.15 cfs @ 8.13 hrs, Volume= 23.640 af, Depth> 3.96"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
71.570	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
41.6	3,168	0.0591	1.3		**Lag/CN Method,** Contour Length= 36,837' Interval= 5'

Subcatchment 61.1:

Runoff = 138.20 cfs @ 8.13 hrs, Volume= 66.883 af, Depth> 3.14"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
255.830	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.0	5,663	0.3051	2.6		**Lag/CN Method,** Contour Length= 170,000' Interval= 20'

Subcatchment 62:

Runoff = 11.45 cfs @ 8.00 hrs, Volume= 3.564 af, Depth> 4.16"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
10.270	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	754	0.0843	1.2		**Lag/CN Method,** Contour Length= 1,886' Interval= 20'

Subcatchment 63:

Runoff = 55.83 cfs @ 8.10 hrs, Volume= 25.498 af, Depth> 4.51"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
67.890	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
41.8	3,730	0.0571	1.5		**Lag/CN Method,** Contour Length= 8,445' Interval= 20'

Subcatchment 63.1:

Runoff = 98.97 cfs @ 8.06 hrs, Volume= 41.507 af, Depth> 3.27"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
152.400	65	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	4,232	0.3501	2.7		**Lag/CN Method,** Contour Length= 116,195' Interval= 20'

Subcatchment 64:

Runoff = 30.14 cfs @ 8.28 hrs, Volume= 17.075 af, Depth> 3.79"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
54.080	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
63.6	3,923	0.0375	1.0		**Lag/CN Method,** Contour Length= 4,419' Interval= 20'

Subcatchment 64.1:

Runoff = 106.32 cfs @ 8.19 hrs, Volume= 55.511 af, Depth> 3.02"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=8.00"

Area (ac)	CN	Description
220.690	63	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.0	6,783	0.3147	2.7		**Lag/CN Method,** Contour Length= 151,275' Interval= 20'

Reach 59R1:

Inflow Area = 115.400 ac, Inflow Depth > 3.60"
Inflow = 73.93 cfs @ 8.31 hrs, Volume= 34.646 af
Outflow = 73.93 cfs @ 8.31 hrs, Volume= 34.646 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 59R2:

Inflow Area = 67.180 ac, Inflow Depth > 3.26"
Inflow = 42.80 cfs @ 8.06 hrs, Volume= 18.277 af
Outflow = 41.28 cfs @ 8.35 hrs, Volume= 17.967 af, Atten= 4%, Lag= 16.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.5 fps, Min. Travel Time= 8.3 min
Avg. Velocity = 3.8 fps, Avg. Travel Time= 12.1 min

Peak Depth= 1.42' @ 8.21 hrs
Capacity at bank full= 574.46 cfs
Inlet Invert= 130.00', Outlet Invert= 60.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,720.0' Slope= 0.0257 '/'

Reach 61R1: Johnson Creek

Inflow Area = 327.400 ac, Inflow Depth > 3.30"
Inflow = 186.87 cfs @ 8.25 hrs, Volume= 89.929 af
Outflow = 186.87 cfs @ 8.25 hrs, Volume= 89.929 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 61R2:

Inflow Area = 255.830 ac, Inflow Depth > 3.14"
Inflow = 138.20 cfs @ 8.13 hrs, Volume= 66.883 af
Outflow = 137.51 cfs @ 8.27 hrs, Volume= 66.288 af, Atten= 1%, Lag= 8.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.4 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 6.0 fps, Avg. Travel Time= 6.1 min

Peak Depth= 2.38' @ 8.20 hrs
Capacity at bank full= 641.24 cfs
Inlet Invert= 140.00', Outlet Invert= 70.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,183.0' Slope= 0.0321 '/'

Reach 63R1:

Inflow Area = 220.290 ac, Inflow Depth > 3.63"
Inflow = 152.57 cfs @ 8.20 hrs, Volume= 66.606 af
Outflow = 152.57 cfs @ 8.20 hrs, Volume= 66.606 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 63R2:

Inflow Area = 152.400 ac, Inflow Depth > 3.27"
Inflow = 98.97 cfs @ 8.06 hrs, Volume= 41.507 af
Outflow = 97.31 cfs @ 8.22 hrs, Volume= 41.107 af, Atten= 2%, Lag= 9.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.1 fps, Min. Travel Time= 4.7 min
Avg. Velocity = 5.6 fps, Avg. Travel Time= 6.9 min

Peak Depth= 1.93' @ 8.13 hrs
Capacity at bank full= 708.36 cfs
Inlet Invert= 155.00', Outlet Invert= 65.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,300.0' Slope= 0.0391 '/'

Reach 64R1: McVay Creek

Inflow Area = 274.770 ac, Inflow Depth > 3.14"
Inflow = 135.66 cfs @ 8.37 hrs, Volume= 71.917 af
Outflow = 135.66 cfs @ 8.37 hrs, Volume= 71.917 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 64R2:

Inflow Area = 220.690 ac, Inflow Depth > 3.02"
Inflow = 106.32 cfs @ 8.19 hrs, Volume= 55.511 af
Outflow = 105.65 cfs @ 8.38 hrs, Volume= 54.842 af, Atten= 1%, Lag= 11.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.2 fps, Min. Travel Time= 5.8 min
Avg. Velocity = 5.3 fps, Avg. Travel Time= 7.9 min

Peak Depth= 2.21' @ 8.28 hrs
Capacity at bank full= 576.03 cfs
Inlet Invert= 145.00', Outlet Invert= 80.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,512.0' Slope= 0.0259 '/'

Reach PO5: Pacific Ocean

Inflow Area = 989.580 ac, Inflow Depth > 3.39"
Inflow = 583.97 cfs @ 8.25 hrs, Volume= 279.751 af
Outflow = 583.97 cfs @ 8.25 hrs, Volume= 279.751 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Appendix 6.3:

HydroCAD Model Results Summary
(50-Year, 24-hour Event Basis)

Reach CR4: Chetco River (South Bank Subtotal)

Inflow Area = 7,668.010 ac, Inflow Depth > 4.47"
Inflow = 5,332.11 cfs @ 8.07 hrs, Volume= 2,859.496 af
Outflow = 5,332.11 cfs @ 8.07 hrs, Volume= 2,859.496 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach CR5: Chetco River (Subtotal)

Inflow Area = 10,968.050 ac, Inflow Depth > 4.58"
Inflow = 8,415.31 cfs @ 8.07 hrs, Volume= 4,182.045 af
Outflow = 8,415.31 cfs @ 8.07 hrs, Volume= 4,182.045 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO: Pacific Ocean (Total)

Inflow Area = 20,756.470 ac, Inflow Depth > 4.49"
Inflow = 13,452.15 cfs @ 8.11 hrs, Volume= 7,769.548 af
Outflow = 13,452.15 cfs @ 8.11 hrs, Volume= 7,769.548 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO6: Pacific Ocean (Brookings Subtotal)

Inflow Area = 7,872.890 ac, Inflow Depth > 4.40"
Inflow = 5,166.76 cfs @ 10.05 hrs, Volume= 2,888.400 af
Outflow = 5,166.76 cfs @ 10.05 hrs, Volume= 2,888.400 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO7: Pacific Ocean (Harbor Subtotal)

Inflow Area = 1,915.530 ac, Inflow Depth > 4.38"
Inflow = 1,505.21 cfs @ 8.22 hrs, Volume= 699.103 af
Outflow = 1,505.21 cfs @ 8.22 hrs, Volume= 699.103 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO8: Pacific Ocean (Ocean Only) Subtotal

Inflow Area = 9,788.420 ac, Inflow Depth > 4.40"
Inflow = 5,965.99 cfs @ 10.04 hrs, Volume= 3,587.503 af
Outflow = 5,965.99 cfs @ 10.04 hrs, Volume= 3,587.503 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link CR1: Chetco River (North Bank)

Inflow Area = 3,300.040 ac, Inflow Depth > 4.81"
Inflow = 3,084.80 cfs @ 8.06 hrs, Volume= 1,322.549 af
Primary = 3,084.80 cfs @ 8.06 hrs, Volume= 1,322.549 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (North Bank)~Reach CR1

Link CR2: Chetco River (Southeast Bank)

Inflow Area = 6,960.400 ac, Inflow Depth > 4.45"
Inflow = 4,641.19 cfs @ 8.07 hrs, Volume= 2,582.947 af
Primary = 4,641.19 cfs @ 8.07 hrs, Volume= 2,582.947 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (Southeast Bank)~Reach CR2

Link CR3: Chetco River (Southwest Bank)

Inflow Area = 707.610 ac, Inflow Depth > 4.69"
Inflow = 696.42 cfs @ 8.12 hrs, Volume= 276.549 af
Primary = 696.42 cfs @ 8.12 hrs, Volume= 276.549 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (Southwest Bank)~Reach CR3

Link PO1: Pacific Ocean (Brookings North)

Inflow Area = 4,976.350 ac, Inflow Depth > 4.08"
Inflow = 2,851.29 cfs @ 8.23 hrs, Volume= 1,693.215 af
Primary = 2,851.29 cfs @ 8.23 hrs, Volume= 1,693.215 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Brookings (North)~Reach PO1

Link PO2: Pacific Ocean (Brookings Central)

Inflow Area = 2,169.250 ac, Inflow Depth > 4.60"
Inflow = 2,727.76 cfs @ 10.06 hrs, Volume= 831.134 af
Primary = 2,727.76 cfs @ 10.06 hrs, Volume= 831.134 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Brookings (Central)~Reach PO2

Link PO3: Pacific Ocean (Brookings South)

Inflow Area = 727.290 ac, Inflow Depth > 6.01"
Inflow = 660.22 cfs @ 8.02 hrs, Volume= 364.051 af
Primary = 660.22 cfs @ 8.02 hrs, Volume= 364.051 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Brookings (South)~Reach PO3

Link PO4: Pacific Ocean (Harbor North)

Inflow Area = 925.950 ac, Inflow Depth > 4.66"
Inflow = 776.48 cfs @ 8.22 hrs, Volume= 359.564 af
Primary = 776.48 cfs @ 8.22 hrs, Volume= 359.564 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Harbor (North)~Reach PO4

Link PO5: Pacific Ocean (Harbor South)

Inflow Area = 989.580 ac, Inflow Depth > 4.12"
Inflow = 728.56 cfs @ 8.23 hrs, Volume= 339.540 af
Primary = 728.56 cfs @ 8.23 hrs, Volume= 339.540 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Harbor (South)~Reach PO5

Subcatchment 1:

Runoff = 286.66 cfs @ 8.04 hrs, Volume= 105.125 af, Depth> 5.27"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
239.300	76	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	3,875	0.2059	2.8		**Lag/CN Method,** Contour Length= 107,304' Interval= 20'

Subcatchment 2: Lone Ranch Creek

Runoff = 847.37 cfs @ 8.29 hrs, Volume= 487.188 af, Depth> 4.64"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
1,260.750	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
70.1	16,130	0.2806	3.8		**Lag/CN Method,** Contour Length= 770,629' Interval= 20'

Subcatchment 2.1: Duley Creek

Runoff = 443.82 cfs @ 8.23 hrs, Volume= 236.856 af, Depth> 4.68"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
607.500	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
58.8	13,103	0.2859	3.7		**Lag/CN Method,** Contour Length= 378,315' Interval= 20'

Subcatchment 3:

Runoff = 21.35 cfs @ 8.05 hrs, Volume= 8.334 af, Depth> 3.77"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
26.510	63	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	1,874	0.1529	1.4		**Lag/CN Method,** Contour Length= 35,305' Interval= 5'

Subcatchment 4:

Runoff = 126.14 cfs @ 8.89 hrs, Volume= 91.335 af, Depth> 3.11"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
352.370	59	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
90.9	10,416	0.1639	1.9		**Lag/CN Method,** Contour Length= 125,771' Interval= 20'

Subcatchment 4.1:

Runoff = 9.72 cfs @ 8.01 hrs, Volume= 3.187 af, Depth> 4.83"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
7.910	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.5	1,333	0.1211	1.5		**Lag/CN Method,** Contour Length= 8,342' Interval= 5'

Subcatchment 4A:

Runoff = 16.78 cfs @ 8.04 hrs, Volume= 6.278 af, Depth> 4.57"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
16.470	70	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.6	1,217	0.0482	0.9		**Lag/CN Method,** Contour Length= 6,909' Interval= 5'

Subcatchment 5:

Runoff = 54.59 cfs @ 8.07 hrs, Volume= 23.453 af, Depth> 4.20"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
67.030	67	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
31.4	3,286	0.1432	1.7		**Lag/CN Method,** Contour Length= 83,626' Interval= 5'

Subcatchment 5.1:

Runoff = 18.37 cfs @ 8.04 hrs, Volume= 6.947 af, Depth> 4.69"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
17.790	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	1,682	0.0690	1.2		**Lag/CN Method,** Contour Length= 10,690' Interval= 5'

Subcatchment 6:

Runoff = 10.88 cfs @ 7.98 hrs, Volume= 3.203 af, Depth> 5.21"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
7.380	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	774	0.1476	1.6		**Lag/CN Method,** Contour Length= 9,490' Interval= 5'

Subcatchment 7:

Runoff = 75.90 cfs @ 8.06 hrs, Volume= 30.459 af, Depth> 4.33"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
84.430	68	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.7	2,783	0.1440	1.7		**Lag/CN Method,** Contour Length= 105,905' Interval= 5'

Subcatchment 8: Taylor Creek

Runoff = 477.30 cfs @ 9.01 hrs, Volume= 362.511 af, Depth> 3.17"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
1,374.000	60	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
107.2	17,819	0.2643	2.8		**Lag/CN Method,** Contour Length= 791,031' Interval= 20'

Subcatchment 10:

Runoff = 47.70 cfs @ 8.01 hrs, Volume= 15.601 af, Depth> 5.07"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
36.950	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.9	2,320	0.2483	2.6		**Lag/CN Method,** Contour Length= 79,931' Interval= 5'

Subcatchment 10.1:

Runoff = 527.73 cfs @ 8.32 hrs, Volume= 313.743 af, Depth> 4.29"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
877.960	69	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.8	12,872	0.2193	3.0		**Lag/CN Method,** Contour Length= 419,343' Interval= 20'

Reach 2R1: Lone Ranch Creek

Inflow Area = 1,868.250 ac, Inflow Depth > 4.65"
Inflow = 1,290.52 cfs @ 8.27 hrs, Volume= 724.043 af
Outflow = 1,290.52 cfs @ 8.27 hrs, Volume= 724.043 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 4R1: Ram Creek

Inflow Area = 360.280 ac, Inflow Depth > 3.15"
Inflow = 130.82 cfs @ 8.82 hrs, Volume= 94.522 af
Outflow = 130.82 cfs @ 8.82 hrs, Volume= 94.522 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 5R1:

Inflow Area = 84.820 ac, Inflow Depth > 4.30"
Inflow = 72.92 cfs @ 8.06 hrs, Volume= 30.400 af
Outflow = 72.92 cfs @ 8.06 hrs, Volume= 30.400 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 10R1: Shy Creek

Inflow Area = 914.910 ac, Inflow Depth > 4.31"
Inflow = 561.93 cfs @ 8.30 hrs, Volume= 328.339 af
Outflow = 561.93 cfs @ 8.30 hrs, Volume= 328.339 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 10R2:

Inflow Area = 877.960 ac, Inflow Depth > 4.29"
Inflow = 527.73 cfs @ 8.32 hrs, Volume= 313.743 af
Outflow = 527.46 cfs @ 8.37 hrs, Volume= 312.738 af, Atten= 0%, Lag= 3.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.6 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 10.9 fps, Avg. Travel Time= 2.3 min

Peak Depth= 4.02' @ 8.34 hrs
Capacity at bank full= 825.06 cfs
Inlet Invert= 100.00', Outlet Invert= 20.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Mountain streams
Length= 1,507.0' Slope= 0.0531 '/'

Reach PO1: Pacific Ocean

Inflow Area = 4,976.350 ac, Inflow Depth > 4.08"
Inflow = 2,851.29 cfs @ 8.23 hrs, Volume= 1,693.215 af
Outflow = 2,851.29 cfs @ 8.23 hrs, Volume= 1,693.215 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Subcatchment 9:

Runoff = 60.47 cfs @ 9.95 hrs, Volume= 5.904 af, Depth> 6.14"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
11.530	82	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	696	0.2924	2.8		**Lag/CN Method,** Contour Length= 29,373' Interval= 5'

Subcatchment 11:

Runoff = 61.19 cfs @ 9.95 hrs, Volume= 5.980 af, Depth> 6.25"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
11.480	83	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	638	0.2390	2.6		**Lag/CN Method,** Contour Length= 23,901' Interval= 5'

Subcatchment 12:

Runoff = 140.91 cfs @ 10.01 hrs, Volume= 25.260 af, Depth> 5.99"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
50.570	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.9	2,648	0.0859	1.9		**Lag/CN Method,** Contour Length= 37,852' Interval= 5'

Subcatchment 13:

Runoff = 42.05 cfs @ 9.99 hrs, Volume= 6.024 af, Depth> 5.91"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
12.240	80	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.2	1,716	0.1186	2.0		**Lag/CN Method,** Contour Length= 12,645' Interval= 5'

Subcatchment 14:

Runoff = 128.24 cfs @ 10.05 hrs, Volume= 32.323 af, Depth> 4.22"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
91.880	66	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
38.4	4,290	0.1553	1.9		**Lag/CN Method,** Contour Length= 124,333' Interval= 5'

Subcatchment 14.1:

Runoff = 1,054.96 cfs @ 10.15 hrs, Volume= 384.995 af, Depth> 4.70"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
983.810	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
72.3	14,474	0.2344	3.3		**Lag/CN Method,** Contour Length= 502,362' Interval= 20'

Subcatchment 15:

Runoff = 166.78 cfs @ 10.00 hrs, Volume= 25.559 af, Depth> 3.82"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
80.250	62	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.8	1,257	0.1790	1.4		**Lag/CN Method,** Contour Length= 125,141' Interval= 5'

Subcatchment 16: Eiler Creek

Runoff = 186.88 cfs @ 10.07 hrs, Volume= 59.311 af, Depth> 4.17"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
170.660	66	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
55.6	5,509	0.1103	1.7		**Lag/CN Method,** Contour Length= 164,029' Interval= 5'

Subcatchment 17:

Runoff = 146.17 cfs @ 9.99 hrs, Volume= 19.707 af, Depth> 5.23"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
45.190	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	1,315	0.1534	1.8		**Lag/CN Method,** Contour Length= 60,410' Interval= 5'

Subcatchment 17.1:

Runoff = 65.15 cfs @ 10.04 hrs, Volume= 17.111 af, Depth> 5.93"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
34.610	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
45.0	5,230	0.0661	1.9		**Lag/CN Method,** Contour Length= 19,930' Interval= 5'

Subcatchment 18: Ransom Creek

Runoff = 585.01 cfs @ 10.15 hrs, Volume= 210.158 af, Depth> 4.25"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
593.740	67	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.9	10,803	0.2064	2.7		**Lag/CN Method,** Contour Length= 266,910' Interval= 20'

Subcatchment 18A:

Runoff = 108.27 cfs @ 9.99 hrs, Volume= 14.535 af, Depth> 5.69"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
30.660	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	1,044	0.0842	1.4		**Lag/CN Method,** Contour Length= 22,486' Interval= 5'

Subcatchment 20:

Runoff = 121.82 cfs @ 10.00 hrs, Volume= 18.226 af, Depth> 6.01"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
36.380	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.7	1,894	0.1065	2.0		**Lag/CN Method,** Contour Length= 33,753' Interval= 5'

Subcatchment 21:

Runoff = 72.51 cfs @ 9.96 hrs, Volume= 7.873 af, Depth> 5.81"

Runoff by SBUH method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type I 24-hr Rainfall=9.00"

Area (ac)	CN	Description
16.250	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	832	0.1913	2.1		**Lag/CN Method,** Contour Length= 27,085' Interval= 5'

Reach 14R1: Harris Creek

Inflow Area = 1,075.690 ac, Inflow Depth > 4.64"
Inflow = 1,173.72 cfs @ 10.20 hrs, Volume= 415.487 af
Outflow = 1,173.72 cfs @ 10.20 hrs, Volume= 415.487 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 14R2:

Inflow Area = 983.810 ac, Inflow Depth > 4.70"
Inflow = 1,054.96 cfs @ 10.15 hrs, Volume= 384.995 af
Outflow = 1,054.17 cfs @ 10.24 hrs, Volume= 383.164 af, Atten= 0%, Lag= 5.3 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.4 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 9.1 fps, Avg. Travel Time= 4.3 min

Peak Depth= 5.33' @ 10.19 hrs
Capacity at bank full= 928.58 cfs
Inlet Invert= 80.00', Outlet Invert= 0.00'
20.00' x 5.00' deep Parabolic Channel, n= 0.040 Mountain streams
Length= 2,358.0' Slope= 0.0339 '/'

Reach 17R1:

Inflow Area =	79.800 ac,	Inflow Depth >	5.54"		
Inflow	=	210.14 cfs @	10.00 hrs, Volume=	36.818 af	
Outflow	=	210.14 cfs @	10.00 hrs, Volume=	36.818 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach PO2: Pacific Ocean

Inflow Area =	2,169.250 ac,	Inflow Depth >	4.60"		
Inflow	=	2,727.76 cfs @	10.06 hrs, Volume=	831.134 af	
Outflow	=	2,727.76 cfs @	10.06 hrs, Volume=	831.134 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Subcatchment 19.10:

Runoff = 173.98 cfs @ 8.04 hrs, Volume= 65.235 af, Depth> 6.32"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
123.810	85	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.2	5,876	0.1794	3.7		**Lag/CN Method,** Contour Length= 193,529' Interval= 5'

Subcatchment 19.3:

Runoff = 18.95 cfs @ 8.01 hrs, Volume= 6.523 af, Depth> 6.95"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
11.270	90	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.8	1,778	0.0355	1.6		**Lag/CN Method,** Contour Length= 3,483' Interval= 5'

Subcatchment 19.4:

Runoff = 18.87 cfs @ 7.97 hrs, Volume= 5.894 af, Depth> 7.58"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
9.330	95	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	870	0.0316	1.6		**Lag/CN Method,** Contour Length= 2,572' Interval= 5'

Subcatchment 19.5:

Runoff = 45.30 cfs @ 8.01 hrs, Volume= 15.532 af, Depth> 7.31"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
25.500	93	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	1,874	0.0348	1.8		**Lag/CN Method,** Contour Length= 7,724' Interval= 5'

Subcatchment 19.7:

Runoff = 19.19 cfs @ 8.01 hrs, Volume= 6.352 af, Depth> 6.00"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
12.700	82	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.9	1,682	0.0716	1.7		**Lag/CN Method,** Contour Length= 7,920' Interval= 5'

Subcatchment 19.8:

Runoff = 40.01 cfs @ 8.00 hrs, Volume= 12.850 af, Depth> 6.84"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
22.530	89	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	1,798	0.0695	2.1		**Lag/CN Method,** Contour Length= 13,632' Interval= 5'

Subcatchment 19.9:

Runoff = 202.49 cfs @ 8.17 hrs, Volume= 100.945 af, Depth> 5.39".

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
224.620	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
53.9	6,764	0.0838	2.1		**Lag/CN Method,** Contour Length= 164,024' Interval= 5'

Reach 19R10:

Inflow Area = 12.700 ac, Inflow Depth > 6.00"
Inflow = 19.19 cfs @ 8.01 hrs, Volume= 6.352 af
Outflow = 9.97 cfs @ 7.71 hrs, Volume= 6.327 af, Atten= 48%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.6 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 6.8 fps, Avg. Travel Time= 3.6 min

Peak Depth= 1.25' @ 7.70 hrs
Capacity at bank full= 9.29 cfs
Inlet Invert= 135.00', Outlet Invert= 105.00'
15.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,450.0' Slope= 0.0207 '/'

Reach 19R11:

Inflow Area = 22.530 ac, Inflow Depth > 6.84"
Inflow = 40.01 cfs @ 8.00 hrs, Volume= 12.850 af
Outflow = 39.88 cfs @ 8.00 hrs, Volume= 12.842 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 17.1 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 10.3 fps, Avg. Travel Time= 0.6 min

Peak Depth= 1.07' @ 8.00 hrs
Capacity at bank full= 163.43 cfs
Inlet Invert= 135.00', Outlet Invert= 117.00'
38.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 400.0' Slope= 0.0450 '/'

Reach 19R20:

Inflow Area = 123.810 ac, Inflow Depth > 6.32"
Inflow = 173.98 cfs @ 8.04 hrs, Volume= 65.235 af
Outflow = 83.21 cfs @ 7.62 hrs, Volume= 65.156 af, Atten= 52%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 12.9 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 10.4 fps, Avg. Travel Time= 1.1 min

Peak Depth= 3.00' @ 7.65 hrs
Capacity at bank full= 79.72 cfs
Inlet Invert= 127.00', Outlet Invert= 117.00'
36.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 700.0' Slope= 0.0143 '/'

Reach 19R4:

Inflow Area = 429.760 ac, Inflow Depth > 5.95"
Inflow = 306.13 cfs @ 8.00 hrs, Volume= 212.965 af
Outflow = 306.11 cfs @ 8.00 hrs, Volume= 212.960 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 42.2 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 31.1 fps, Avg. Travel Time= 0.0 min

Peak Depth= 1.99' @ 8.00 hrs
Capacity at bank full= 920.80 cfs
Inlet Invert= 105.00', Outlet Invert= 100.00'
60.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 40.0' Slope= 0.1250 '/'

Reach 19R5:

Inflow Area = 370.960 ac, Inflow Depth > 5.78"
Inflow = 213.91 cfs @ 8.00 hrs, Volume= 178.792 af
Outflow = 213.84 cfs @ 8.01 hrs, Volume= 178.688 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 20.8 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 16.6 fps, Avg. Travel Time= 0.5 min

Peak Depth= 2.59' @ 8.01 hrs
Capacity at bank full= 403.48 cfs
Inlet Invert= 117.00', Outlet Invert= 105.00'
60.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0240 '/'

Reach 19R6:

Inflow Area = 224.620 ac, Inflow Depth > 5.39"
Inflow = 97.17 cfs @ 7.63 hrs, Volume= 100.811 af
Outflow = 97.22 cfs @ 7.64 hrs, Volume= 100.794 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 25.3 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 21.8 fps, Avg. Travel Time= 0.1 min

Peak Depth= 1.25' @ 7.63 hrs
Capacity at bank full= 709.85 cfs
Inlet Invert= 130.00', Outlet Invert= 117.00'
60.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 175.0' Slope= 0.0743 '/'

Reach 19R7:

Inflow Area = 224.620 ac, Inflow Depth > 5.39"
Inflow = 99.23 cfs @ 7.61 hrs, Volume= 100.866 af
Outflow = 97.17 cfs @ 7.63 hrs, Volume= 100.811 af, Atten= 2%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.6 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 12.6 fps, Avg. Travel Time= 0.4 min

Peak Depth= 2.12' @ 7.62 hrs
Capacity at bank full= 179.55 cfs
Inlet Invert= 135.00', Outlet Invert= 130.00'
48.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 320.0' Slope= 0.0156 '/'

Reach 19R8:

Inflow Area = 224.620 ac, Inflow Depth > 5.39"
Inflow = 202.49 cfs @ 8.17 hrs, Volume= 100.945 af
Outflow = 99.23 cfs @ 7.61 hrs, Volume= 100.866 af, Atten= 51%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 15.2 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 12.5 fps, Avg. Travel Time= 0.7 min

Peak Depth= 3.00' @ 7.65 hrs
Capacity at bank full= 94.33 cfs
Inlet Invert= 145.00', Outlet Invert= 135.00'
36.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0200 '/'

Reach 19R9:

Inflow Area =	23.970 ac,	Inflow Depth >	6.43"		
Inflow =	28.24 cfs @	8.01 hrs,	Volume=	12.850 af	
Outflow =	28.24 cfs @	8.01 hrs,	Volume=	12.850 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Pond 1P: Maclyn Creek (Pond)

Inflow Area =	429.760 ac,	Inflow Depth >	5.95"		
Inflow =	306.11 cfs @	8.00 hrs,	Volume=	212.960 af	
Primary =	306.11 cfs @	8.00 hrs,	Volume=	212.960 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Subcatchment 19:

Runoff = 71.93 cfs @ 8.02 hrs, Volume= 25.312 af, Depth> 6.10"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
49.760	83	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.3	2,416	0.0751	1.9		**Lag/CN Method,** Contour Length= 32,576' Interval= 5'

Subcatchment 19.1:

Runoff = 17.88 cfs @ 8.10 hrs, Volume= 8.093 af, Depth> 5.32"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
18.250	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
41.9	2,570	0.0313	1.0		**Lag/CN Method,** Contour Length= 4,977' Interval= 5'

Subcatchment 19.2:

Runoff = 22.05 cfs @ 8.04 hrs, Volume= 8.184 af, Depth> 5.62"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
17.480	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.9	1,507	0.0333	1.0		**Lag/CN Method,** Contour Length= 5,078' Interval= 5'

Subcatchment 19.6:

Runoff = 66.09 cfs @ 8.06 hrs, Volume= 27.638 af, Depth> 5.70"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
58.210	80	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.3	3,247	0.0535	1.5		**Lag/CN Method,** Contour Length= 27,124' Interval= 5'

Subcatchment 22:

Runoff = 89.11 cfs @ 8.05 hrs, Volume= 35.939 af, Depth> 6.54"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
65.980	87	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
32.4	3,093	0.0365	1.6		**Lag/CN Method,** Contour Length= 20,968' Interval= 5'

Subcatchment 23:

Runoff = 51.21 cfs @ 8.05 hrs, Volume= 20.267 af, Depth> 6.19"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
39.310	84	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.8	2,203	0.0290	1.2		**Lag/CN Method,** Contour Length= 9,938' Interval= 5'

Subcatchment 23.1:

Runoff = 57.37 cfs @ 8.02 hrs, Volume= 19.952 af, Depth> 6.58"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
36.370	87	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	1,991	0.0462	1.6		**Lag/CN Method,** Contour Length= 14,633' Interval= 5'

Subcatchment 24:

Runoff = 20.24 cfs @ 7.96 hrs, Volume= 5.884 af, Depth> 5.80"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
12.170	80	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	792	0.1484	1.9		**Lag/CN Method,** Contour Length= 15,733' Interval= 5'

Reach 19R1: Maclyn Creek

Inflow Area = 573.460 ac, Inflow Depth > 5.90"
Inflow = 444.58 cfs @ 8.01 hrs, Volume= 282.061 af
Outflow = 444.58 cfs @ 8.01 hrs, Volume= 282.061 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 19R2:

Inflow Area = 93.940 ac, Inflow Depth > 5.60"
Inflow = 79.59 cfs @ 8.06 hrs, Volume= 43.839 af
Outflow = 69.47 cfs @ 7.81 hrs, Volume= 43.789 af, Atten= 13%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 10.8 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 8.4 fps, Avg. Travel Time= 1.0 min

Peak Depth= 3.00' @ 7.85 hrs
Capacity at bank full= 66.70 cfs
Inlet Invert= 105.00', Outlet Invert= 100.00'
36.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0100 '/'

Reach 19R3:

Inflow Area =	58.210 ac,	Inflow Depth >	5.70"		
Inflow =	66.09 cfs @	8.06 hrs,	Volume=	27.638 af	
Outflow =	40.68 cfs @	11.08 hrs,	Volume=	27.563 af,	Atten= 38%, Lag= 181.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.4 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 11.3 fps, Avg. Travel Time= 2.4 min

Peak Depth= 2.00' @ 7.75 hrs
Capacity at bank full= 39.71 cfs
Inlet Invert= 155.00', Outlet Invert= 105.00'
24.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,623.0' Slope= 0.0308 '/'

Reach 23R1:

Inflow Area =	75.680 ac,	Inflow Depth >	6.37"		
Inflow =	108.14 cfs @	8.06 hrs,	Volume=	40.168 af	
Outflow =	108.14 cfs @	8.06 hrs,	Volume=	40.168 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 23R2:

Inflow Area =	36.370 ac,	Inflow Depth >	6.58"		
Inflow =	57.37 cfs @	8.02 hrs,	Volume=	19.952 af	
Outflow =	56.96 cfs @	8.07 hrs,	Volume=	19.901 af,	Atten= 1%, Lag= 2.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.2 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 8.8 fps, Avg. Travel Time= 2.7 min

Peak Depth= 1.43' @ 8.04 hrs
Capacity at bank full= 210.27 cfs
Inlet Invert= 105.00', Outlet Invert= 75.00'
48.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,400.0' Slope= 0.0214 '/'

Reach PO3: Pacific Ocean

Inflow Area =	727.290 ac,	Inflow Depth >	6.01"		
Inflow =	660.22 cfs @	8.02 hrs,	Volume=	364.051 af	
Outflow =	660.22 cfs @	8.02 hrs,	Volume=	364.051 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 19L1: Maclyn Creek (Pond)

Inflow Area =	429.760 ac,	Inflow Depth >	5.95"		
Inflow =	306.11 cfs @	8.00 hrs,	Volume=	212.960 af	
Primary =	306.11 cfs @	8.00 hrs,	Volume=	212.960 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Primary Outflow Imported from Brookings (Maclyn Creek)~Pond 1P

Subcatchment 25:

Runoff = 46.12 cfs @ 8.01 hrs, Volume= 15.278 af, Depth> 5.65"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
32.460	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.7	2,241	0.1405	2.2		**Lag/CN Method,** Contour Length= 39,728' Interval= 5'

Subcatchment 26:

Runoff = 23.29 cfs @ 8.04 hrs, Volume= 8.516 af, Depth> 4.81"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
21.250	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.8	1,816	0.0879	1.4		**Lag/CN Method,** Contour Length= 16,266' Interval= 5'

Subcatchment 27:

Runoff = 148.51 cfs @ 8.06 hrs, Volume= 60.773 af, Depth> 5.82"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
125.260	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.5	4,619	0.0978	2.3		**Lag/CN Method,** Contour Length= 106,723' Interval= 5'

Subcatchment 28:

Runoff = 71.82 cfs @ 7.97 hrs, Volume= 20.914 af, Depth> 5.68"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
44.160	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	774	0.1516	1.9		**Lag/CN Method,** Contour Length= 14,581' Interval= 20'

Subcatchment 29:

Runoff = 44.50 cfs @ 8.00 hrs, Volume= 14.005 af, Depth> 5.19"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
32.370	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	1,566	0.1770	2.1		**Lag/CN Method,** Contour Length= 12,478' Interval= 20'

Subcatchment 30:

Runoff = 89.99 cfs @ 8.02 hrs, Volume= 31.372 af, Depth> 5.40"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
69.700	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.9	3,711	0.2492	3.1		**Lag/CN Method,** Contour Length= 37,827' Interval= 20'

Subcatchment 31:

Runoff = 72.06 cfs @ 8.00 hrs, Volume= 22.613 af, Depth> 5.31"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
51.110	76	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	2,183	0.2815	2.9		**Lag/CN Method,** Contour Length= 31,332' Interval= 20'

Subcatchment 32:

Runoff = 456.60 cfs @ 8.10 hrs, Volume= 207.036 af, Depth> 4.86"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
510.990	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.0	9,469	0.3477	3.9		**Lag/CN Method,** Contour Length= 386,957' Interval= 20'

Subcatchment 33:

Runoff = 177.48 cfs @ 8.02 hrs, Volume= 60.115 af, Depth> 5.29"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
136.330	76	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.7	3,247	0.2689	3.1		**Lag/CN Method,** Contour Length= 79,852' Interval= 20'

Subcatchment 34:

Runoff = 969.37 cfs @ 8.15 hrs, Volume= 470.903 af, Depth> 4.61"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
1,225.980	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
46.0	11,402	0.3950	4.1		**Lag/CN Method,** Contour Length= 1,054,663' Interval= 20'

Subcatchment 35:

Runoff = 526.14 cfs @ 8.06 hrs, Volume= 212.018 af, Depth> 4.90"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
519.360	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.6	6,551	0.3534	3.7		**Lag/CN Method,** Contour Length= 399,699' Interval= 20'

Subcatchment 36:

Runoff = 202.43 cfs @ 8.06 hrs, Volume= 80.774 af, Depth> 4.90"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
197.750	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.8	4,947	0.2367	2.9		**Lag/CN Method,** Contour Length= 101,939' Interval= 20'

Subcatchment 37:

Runoff = 159.13 cfs @ 8.11 hrs, Volume= 73.460 af, Depth> 4.52"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
195.220	70	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.8	7,499	0.2846	3.1		**Lag/CN Method,** Contour Length= 120,990' Interval= 20'

Subcatchment 38:

Runoff = 117.98 cfs @ 8.04 hrs, Volume= 44.773 af, Depth> 3.89"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
138.100	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.3	2,899	0.3273	2.4		**Lag/CN Method,** Contour Length= 98,454' Interval= 20'

Reach CR1: Chetco River (North Bank)

Inflow Area = 3,300.040 ac, Inflow Depth > 4.81"
Inflow = 3,084.80 cfs @ 8.06 hrs, Volume= 1,322.549 af
Outflow = 3,084.80 cfs @ 8.06 hrs, Volume= 1,322.549 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Subcatchment 39:

Runoff = 279.49 cfs @ 7.99 hrs, Volume= 84.823 af, Depth> 5.08"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
200.220	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.9	3,749	1.2087	6.3		**Lag/CN Method,** Contour Length= 527,103' Interval= 20'

Subcatchment 40: Jack Creek

Runoff = 1,623.58 cfs @ 8.97 hrs, Volume= 1,223.595 af, Depth> 4.17"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
3,520.040	70	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
131.9	34,149	0.2935	4.3		**Lag/CN Method,** Contour Length= 2,249,930' Interval= 20'

Subcatchment 40.1:

Runoff = 64.82 cfs @ 8.01 hrs, Volume= 21.389 af, Depth> 5.53"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
46.400	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	2,416	0.1759	2.5		**Lag/CN Method,** Contour Length= 17,778' Interval= 20'

Subcatchment 40.2:

Runoff = 96.32 cfs @ 8.04 hrs, Volume= 35.793 af, Depth> 5.15"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
83.370	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.0	3,846	0.2038	2.7		**Lag/CN Method,** Contour Length= 37,005' Interval= 20'

Subcatchment 40.3: Hamilton Creek

Runoff = 719.55 cfs @ 8.22 hrs, Volume= 381.520 af, Depth> 4.68"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
977.860	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
57.9	11,460	0.2382	3.3		**Lag/CN Method,** Contour Length= 507,216' Interval= 20'

Subcatchment 40.4:

Runoff = 323.23 cfs @ 8.04 hrs, Volume= 119.199 af, Depth> 4.69"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
304.840	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0	3,943	0.3152	3.0		**Lag/CN Method,** Contour Length= 209,258' Interval= 20'

Subcatchment 40.5: Jordan Creek

Runoff = 538.04 cfs @ 8.16 hrs, Volume= 265.056 af, Depth> 4.38"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
726.280	69	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
45.9	8,774	0.2915	3.2		**Lag/CN Method,** Contour Length= 461,048' Interval= 20'

Subcatchment 41: Carey Creek

Runoff = 155.06 cfs @ 8.05 hrs, Volume= 61.830 af, Depth> 4.10"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
180.760	66	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0	4,638	0.4136	3.1		**Lag/CN Method,** Contour Length= 162,833' Interval= 20'

Subcatchment 42:

Runoff = 28.58 cfs @ 8.03 hrs, Volume= 10.320 af, Depth> 3.90"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
31.750	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.1	2,879	0.4599	2.8		**Lag/CN Method,** Contour Length= 31,805' Interval= 20'

Subcatchment 43:

Runoff = 176.70 cfs @ 8.05 hrs, Volume= 68.996 af, Depth> 4.22"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
196.080	67	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.1	4,175	0.3568	2.9		**Lag/CN Method,** Contour Length= 152,357' Interval= 20'

Subcatchment 44:

Runoff = 440.71 cfs @ 8.02 hrs, Volume= 150.458 af, Depth> 5.17"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
349.020	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.0	3,614	0.3287	3.3		**Lag/CN Method,** Contour Length= 249,890' Interval= 20'

Subcatchment 45:

Runoff = 62.82 cfs @ 8.01 hrs, Volume= 20.625 af, Depth> 5.42"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
45.700	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	2,396	0.1963	2.5		**Lag/CN Method,** Contour Length= 78,164' Interval= 5'

Subcatchment 46:

Runoff = 125.11 cfs @ 7.97 hrs, Volume= 38.394 af, Depth> 7.34"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
62.750	93	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	754	0.0320	1.4		**Lag/CN Method,** Contour Length= 17,507' Interval= 5'

Subcatchment 47:

Runoff = 26.78 cfs @ 8.05 hrs, Volume= 10.433 af, Depth> 4.34"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
28.870	68	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.5	2,532	0.1477	1.7		**Lag/CN Method,** Contour Length= 37,138' Interval= 5'

Subcatchment 47.1:

Runoff = 242.20 cfs @ 8.04 hrs, Volume= 90.606 af, Depth> 5.27"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
206.460	76	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.8	5,314	0.3030	3.6		**Lag/CN Method,** Contour Length= 136,256' Interval= 20'

Reach 47R1: Fishhouse Creek

Inflow Area = 235.330 ac, Inflow Depth > 5.15"
Inflow = 268.45 cfs @ 8.06 hrs, Volume= 100.948 af
Outflow = 268.45 cfs @ 8.06 hrs, Volume= 100.948 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 47R2:

Inflow Area = 206.460 ac, Inflow Depth > 5.27"
Inflow = 242.20 cfs @ 8.04 hrs, Volume= 90.606 af
Outflow = 241.69 cfs @ 8.06 hrs, Volume= 90.515 af, Atten= 0%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 29.7 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 19.6 fps, Avg. Travel Time= 0.9 min

Peak Depth= 2.47' @ 8.05 hrs
Capacity at bank full= 344.36 cfs
Inlet Invert= 80.00', Outlet Invert= 20.00'
48.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,044.0' Slope= 0.0575 '/'

Reach CR2: Chetco River (Southeast Bank)

Inflow Area = 6,960.400 ac, Inflow Depth > 4.45"
Inflow = 4,641.19 cfs @ 8.07 hrs, Volume= 2,582.947 af
Outflow = 4,641.19 cfs @ 8.07 hrs, Volume= 2,582.947 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Subcatchment 48:

Runoff = 36.80 cfs @ 8.02 hrs, Volume= 12.367 af, Depth> 5.88"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
25.240	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.9	2,203	0.1043	2.0		**Lag/CN Method,** Contour Length= 22,926' Interval= 5'

Subcatchment 48.1:

Runoff = 53.55 cfs @ 8.02 hrs, Volume= 18.537 af, Depth> 5.52"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
40.300	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.6	2,899	0.1636	2.5		**Lag/CN Method,** Contour Length= 57,423' Interval= 5'

Subcatchment 49:

Runoff = 69.51 cfs @ 8.01 hrs, Volume= 23.242 af, Depth> 5.53"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
50.450	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.2	2,377	0.1541	2.3		**Lag/CN Method,** Contour Length= 67,742' Interval= 5'

Subcatchment 49.1:

Runoff = 111.31 cfs @ 8.05 hrs, Volume= 42.399 af, Depth> 4.46"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
114.190	69	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.4	4,252	0.3500	3.0		**Lag/CN Method,** Contour Length= 87,054' Interval= 20'

Subcatchment 50:

Runoff = 61.91 cfs @ 8.06 hrs, Volume= 24.581 af, Depth> 5.13"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
57.460	75	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.2	2,977	0.0914	1.7		**Lag/CN Method,** Contour Length= 45,771' Interval= 5'

Subcatchment 50.1:

Runoff = 69.39 cfs @ 8.00 hrs, Volume= 22.359 af, Depth> 5.89"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
45.550	81	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0	2,744	0.2126	3.1		**Lag/CN Method,** Contour Length= 84,368' Interval= 5'

Subcatchment 52:

Runoff = 115.14 cfs @ 8.05 hrs, Volume= 44.750 af, Depth> 5.60"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
95.810	79	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.6	3,652	0.1045	2.1		**Lag/CN Method,** Contour Length= 87,248' Interval= 5'

Subcatchment 52.1:

Runoff = 206.22 cfs @ 8.07 hrs, Volume= 89.622 af, Depth> 3.86"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
278.610	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0	5,759	0.4511	3.2		**Lag/CN Method,** Contour Length= 273,725' Interval= 20'

Reach 48R1:

Inflow Area = 65.540 ac, Inflow Depth > 5.65"
Inflow = 89.39 cfs @ 8.05 hrs, Volume= 30.850 af
Outflow = 89.39 cfs @ 8.05 hrs, Volume= 30.850 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 48R2:

Inflow Area = 40.300 ac, Inflow Depth > 5.52"
Inflow = 53.55 cfs @ 8.02 hrs, Volume= 18.537 af
Outflow = 53.11 cfs @ 8.08 hrs, Volume= 18.482 af, Atten= 1%, Lag= 3.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.2 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 8.4 fps, Avg. Travel Time= 2.7 min

Peak Depth= 1.67' @ 8.05 hrs
Capacity at bank full= 89.45 cfs
Inlet Invert= 145.00', Outlet Invert= 120.00'
36.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,390.0' Slope= 0.0180 '/'

Reach 49R1: Delavan Creek

Inflow Area =	164.640 ac,	Inflow Depth >	4.77"		
Inflow =	178.05 cfs @	8.06 hrs,	Volume=	65.497 af	
Outflow =	178.05 cfs @	8.06 hrs,	Volume=	65.497 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 49R2:

Inflow Area =	114.190 ac,	Inflow Depth >	4.46"		
Inflow =	111.31 cfs @	8.05 hrs,	Volume=	42.399 af	
Outflow =	110.59 cfs @	8.10 hrs,	Volume=	42.254 af,	Atten= 1%, Lag= 3.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 17.0 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 11.3 fps, Avg. Travel Time= 2.7 min

Peak Depth= 2.06' @ 8.07 hrs
Capacity at bank full= 210.88 cfs
Inlet Invert= 165.00', Outlet Invert= 125.00'
48.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,856.0' Slope= 0.0216 '/'

Reach 50R1:

Inflow Area =	103.010 ac,	Inflow Depth >	5.45"		
Inflow =	128.50 cfs @	8.12 hrs,	Volume=	46.749 af	
Outflow =	128.50 cfs @	8.12 hrs,	Volume=	46.749 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 50R2:

Inflow Area =	45.550 ac,	Inflow Depth >	5.89"		
Inflow =	69.39 cfs @	8.00 hrs,	Volume=	22.359 af	
Outflow =	67.74 cfs @	8.14 hrs,	Volume=	22.168 af,	Atten= 2%, Lag= 8.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.0 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 4.8 fps, Avg. Travel Time= 8.4 min

Peak Depth= 1.54' @ 8.05 hrs
Capacity at bank full= 798.23 cfs
Inlet Invert= 140.00', Outlet Invert= 20.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,415.0' Slope= 0.0497 '/'

Reach 52R1: Tuttle Creek

Inflow Area =	374.420 ac,	Inflow Depth >	4.28"		
Inflow =	311.04 cfs @	8.20 hrs,	Volume=	133.453 af	
Outflow =	311.04 cfs @	8.20 hrs,	Volume=	133.453 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 52R2:

Inflow Area =	278.610 ac,	Inflow Depth >	3.86"		
Inflow =	206.22 cfs @	8.07 hrs,	Volume=	89.622 af	
Outflow =	202.94 cfs @	8.25 hrs,	Volume=	88.703 af,	Atten= 2%, Lag= 10.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 10.0 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 6.9 fps, Avg. Travel Time= 7.5 min

Peak Depth= 2.74' @ 8.16 hrs
Capacity at bank full= 705.34 cfs
Inlet Invert= 140.00', Outlet Invert= 20.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 3,093.0' Slope= 0.0388 '/'

Reach CR3: Chetco River (Southwest Bank)

Inflow Area =	707.610 ac,	Inflow Depth >	4.69"		
Inflow =	696.42 cfs @	8.12 hrs,	Volume=	276.549 af	
Outflow =	696.42 cfs @	8.12 hrs,	Volume=	276.549 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Subcatchment 51:

Runoff = 38.75 cfs @ 7.98 hrs, Volume= 11.477 af; Depth> 4.97"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
27.690	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	561	0.0986	1.2		**Lag/CN Method,** Contour Length= 23,777' Interval= 5'

Subcatchment 53:

Runoff = 108.39 cfs @ 8.22 hrs, Volume= 57.318 af, Depth> 5.25"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
131.090	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
61.6	4,735	0.0384	1.3		**Lag/CN Method,** Contour Length= 43,859' Interval= 5'

Subcatchment 53.1:

Runoff = 64.28 cfs @ 8.01 hrs, Volume= 20.707 af, Depth> 5.07"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
49.010	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.9	2,087	0.2414	2.5		**Lag/CN Method,** Contour Length= 103,055' Interval= 5'

Subcatchment 54:

Runoff = 95.51 cfs @ 8.07 hrs, Volume= 40.256 af, Depth> 4.89"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
98.880	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.4	2,241	0.0496	1.1		**Lag/CN Method,** Contour Length= 42,697' Interval= 5'

Subcatchment 55:

Runoff = 67.49 cfs @ 8.31 hrs, Volume= 39.557 af, Depth> 4.85"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
97.950	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
75.6	5,527	0.0389	1.2		**Lag/CN Method,** Contour Length= 33,168' Interval= 5'

Subcatchment 55.1:

Runoff = 173.60 cfs @ 8.07 hrs, Volume= 74.861 af, Depth> 3.86"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
232.610	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
29.4	4,542	0.3221	2.6		**Lag/CN Method,** Contour Length= 652,772' Interval= 5'

Subcatchment 56:

Runoff = 26.56 cfs @ 8.05 hrs, Volume= 10.602 af, Depth> 5.95"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
21.390	82	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
31.4	2,241	0.0327	1.2		**Lag/CN Method,** Contour Length= 6,090' Interval= 5'

Subcatchment 57:

Runoff = 9.26 cfs @ 8.00 hrs, Volume= 2.934 af, Depth> 4.73"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
7.450	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	696	0.0666	1.0		**Lag/CN Method,** Contour Length= 4,325' Interval= 5'

Subcatchment 58:

Runoff = 104.77 cfs @ 8.15 hrs, Volume= 51.241 af, Depth> 5.40"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
113.820	78	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
51.4	3,827	0.0370	1.2		**Lag/CN Method,** Contour Length= 36,720' Interval= 5'

Subcatchment 58.1:

Runoff = 125.53 cfs @ 8.06 hrs, Volume= 52.560 af, Depth> 4.32"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
146.060	68	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0	4,697	0.2648	2.6		**Lag/CN Method,** Contour Length= 336,944' Interval= 5'

Reach 53R1:

Inflow Area = 180.100 ac, Inflow Depth > 5.19"
Inflow = 170.96 cfs @ 8.14 hrs, Volume= 77.869 af
Outflow = 170.96 cfs @ 8.14 hrs, Volume= 77.869 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 53R2:

Inflow Area = 49.010 ac, Inflow Depth > 5.05"
Inflow = 63.59 cfs @ 8.06 hrs, Volume= 20.640 af
Outflow = 63.10 cfs @ 8.13 hrs, Volume= 20.551 af, Atten= 1%, Lag= 4.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 12.5 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 7.6 fps, Avg. Travel Time= 3.9 min

Peak Depth= 1.09' @ 8.09 hrs
Capacity at bank full= 1,554.67 cfs
Inlet Invert= 95.00', Outlet Invert= 60.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.013 Concrete pipe, bends & connections
Length= 1,758.0' Slope= 0.0199 '/'

Reach 53R3:

Inflow Area = 49.010 ac, Inflow Depth > 5.07"
Inflow = 64.28 cfs @ 8.01 hrs, Volume= 20.707 af
Outflow = 63.59 cfs @ 8.06 hrs, Volume= 20.640 af, Atten= 1%, Lag= 3.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 17.7 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 11.4 fps, Avg. Travel Time= 2.8 min

Peak Depth= 1.73' @ 8.03 hrs
Capacity at bank full= 77.71 cfs
Inlet Invert= 165.00', Outlet Invert= 95.00'
30.0" Diameter Pipe, n= 0.013 Concrete pipe, bends & connections
Length= 1,950.0' Slope= 0.0359 '/'

Reach 55R1: Dahlia Creek

Inflow Area =	330.560 ac,	Inflow Depth >	4.11"		
Inflow =	236.27 cfs @	8.32 hrs,	Volume=	113.330 af	
Outflow =	236.27 cfs @	8.32 hrs,	Volume=	113.330 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 55R2:

Inflow Area =	232.610 ac,	Inflow Depth >	3.86"		
Inflow =	173.60 cfs @	8.07 hrs,	Volume=	74.861 af	
Outflow =	168.79 cfs @	8.32 hrs,	Volume=	73.773 af,	Atten= 3%, Lag= 15.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.3 fps, Min. Travel Time= 7.3 min
Avg. Velocity = 5.7 fps, Avg. Travel Time= 10.6 min

Peak Depth= 2.74' @ 8.20 hrs
Capacity at bank full= 586.76 cfs
Inlet Invert= 163.00', Outlet Invert= 65.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 3,650.0' Slope= 0.0268 '/'

Reach 58R1: Pedrioli Creek

Inflow Area =	259.880 ac,	Inflow Depth >	4.76"		
Inflow =	225.68 cfs @	8.27 hrs,	Volume=	103.097 af	
Outflow =	225.68 cfs @	8.27 hrs,	Volume=	103.097 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 58R2:

Inflow Area =	146.060 ac,	Inflow Depth >	4.32"		
Inflow =	125.53 cfs @	8.06 hrs,	Volume=	52.560 af	
Outflow =	122.18 cfs @	8.30 hrs,	Volume=	51.855 af,	Atten= 3%, Lag= 14.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.2 fps, Min. Travel Time= 7.0 min
Avg. Velocity = 4.8 fps, Avg. Travel Time= 10.5 min

Peak Depth= 2.44' @ 8.18 hrs
Capacity at bank full= 543.83 cfs
Inlet Invert= 125.00', Outlet Invert= 55.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 3,035.0' Slope= 0.0231 '/'

Reach PO4: Pacific Ocean

Inflow Area =	925.950 ac,	Inflow Depth >	4.66"		
Inflow	=	776.48 cfs @	8.22 hrs,	Volume=	359.564 af
Outflow	=	776.48 cfs @	8.22 hrs,	Volume=	359.564 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Subcatchment 59:

Runoff = 39.99 cfs @ 8.17 hrs, Volume= 19.846 af, Depth> 4.94"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
48.220	74	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.8	3,208	0.0361	1.1		**Lag/CN Method,** Contour Length= 15,155' Interval= 5'

Subcatchment 59.1:

Runoff = 53.77 cfs @ 8.06 hrs, Volume= 22.299 af, Depth> 3.98"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
67.180	65	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
27.2	4,155	0.3090	2.5		**Lag/CN Method,** Contour Length= 180,835' Interval= 5'

Subcatchment 60:

Runoff = 38.96 cfs @ 8.06 hrs, Volume= 15.733 af, Depth> 4.55"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
41.450	70	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	2,029	0.0696	1.2		**Lag/CN Method,** Contour Length= 25,143' Interval= 5'

Subcatchment 61:

Runoff = 61.01 cfs @ 8.12 hrs, Volume= 28.272 af, Depth> 4.74"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
71.570	72	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
41.6	3,168	0.0591	1.3		**Lag/CN Method,** Contour Length= 36,837' Interval= 5'

Subcatchment 61.1:

Runoff = 174.90 cfs @ 8.11 hrs, Volume= 81.889 af, Depth> 3.84"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
255.830	64	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.0	5,663	0.3051	2.6		**Lag/CN Method,** Contour Length= 170,000' Interval= 20'

Subcatchment 62:

Runoff = 13.79 cfs @ 7.99 hrs, Volume= 4.248 af, Depth> 4.96"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
10.270	73	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	754	0.0843	1.2		**Lag/CN Method,** Contour Length= 1,886' Interval= 20'

Subcatchment 63:

Runoff = 66.58 cfs @ 8.10 hrs, Volume= 30.106 af, Depth> 5.32"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
67.890	77	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
41.8	3,730	0.0571	1.5		**Lag/CN Method,** Contour Length= 8,445' Interval= 20'

Subcatchment 63.1:

Runoff = 124.28 cfs @ 8.06 hrs, Volume= 50.638 af, Depth> 3.99"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
152.400	65	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.9	4,232	0.3501	2.7		**Lag/CN Method,** Contour Length= 116,195' Interval= 20'

Subcatchment 64:

Runoff = 36.88 cfs @ 8.26 hrs, Volume= 20.489 af, Depth> 4.55"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
54.080	71	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
63.6	3,923	0.0375	1.0		**Lag/CN Method,** Contour Length= 4,419' Interval= 20'

Subcatchment 64.1:

Runoff = 135.41 cfs @ 8.17 hrs, Volume= 68.207 af, Depth> 3.71"

Runoff by SBUH method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=9.00"

Area (ac)	CN	Description
220.690	63	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.0	6,783	0.3147	2.7		**Lag/CN Method,** Contour Length= 151,275' Interval= 20'

Reach 59R1:

Inflow Area = 115.400 ac, Inflow Depth > 4.35"
Inflow = 91.45 cfs @ 8.29 hrs, Volume= 41.802 af
Outflow = 91.45 cfs @ 8.29 hrs, Volume= 41.802 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 59R2:

Inflow Area = 67.180 ac, Inflow Depth > 3.98"
Inflow = 53.77 cfs @ 8.06 hrs, Volume= 22.299 af
Outflow = 51.98 cfs @ 8.32 hrs, Volume= 21.956 af, Atten= 3%, Lag= 15.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.8 fps, Min. Travel Time= 7.8 min
Avg. Velocity = 3.9 fps, Avg. Travel Time= 11.5 min

Peak Depth= 1.58' @ 8.19 hrs
Capacity at bank full= 574.46 cfs
Inlet Invert= 130.00', Outlet Invert= 60.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,720.0' Slope= 0.0257 '/'

Reach 61R1: Johnson Creek

Inflow Area = 327.400 ac, Inflow Depth > 4.01"
Inflow = 234.17 cfs @ 8.23 hrs, Volume= 109.501 af
Outflow = 234.17 cfs @ 8.23 hrs, Volume= 109.501 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 61R2:

Inflow Area = 255.830 ac, Inflow Depth > 3.84"
Inflow = 174.90 cfs @ 8.11 hrs, Volume= 81.889 af
Outflow = 174.00 cfs @ 8.25 hrs, Volume= 81.229 af, Atten= 1%, Lag= 8.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.9 fps, Min. Travel Time= 4.1 min
Avg. Velocity = 6.3 fps, Avg. Travel Time= 5.8 min

Peak Depth= 2.67' @ 8.18 hrs
Capacity at bank full= 641.24 cfs
Inlet Invert= 140.00', Outlet Invert= 70.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,183.0' Slope= 0.0321 '/'

Reach 63R1:

Inflow Area = 220.290 ac, Inflow Depth > 4.37"
Inflow = 188.23 cfs @ 8.19 hrs, Volume= 80.302 af
Outflow = 188.23 cfs @ 8.19 hrs, Volume= 80.302 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 63R2:

Inflow Area = 152.400 ac, Inflow Depth > 3.99"
Inflow = 124.28 cfs @ 8.06 hrs, Volume= 50.638 af
Outflow = 122.26 cfs @ 8.20 hrs, Volume= 50.195 af, Atten= 2%, Lag= 8.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.7 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 5.8 fps, Avg. Travel Time= 6.6 min

Peak Depth= 2.15' @ 8.12 hrs
Capacity at bank full= 708.36 cfs
Inlet Invert= 155.00', Outlet Invert= 65.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,300.0' Slope= 0.0391 '/'

Reach 64R1: McVay Creek

Inflow Area = 274.770 ac, Inflow Depth > 3.84"
Inflow = 171.34 cfs @ 8.34 hrs, Volume= 87.953 af
Outflow = 171.34 cfs @ 8.34 hrs, Volume= 87.953 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach 64R2:

Inflow Area = 220.690 ac, Inflow Depth > 3.71"
Inflow = 135.41 cfs @ 8.17 hrs, Volume= 68.207 af
Outflow = 134.58 cfs @ 8.35 hrs, Volume= 67.465 af, Atten= 1%, Lag= 10.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.7 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 5.5 fps, Avg. Travel Time= 7.6 min

Peak Depth= 2.48' @ 8.25 hrs
Capacity at bank full= 576.03 cfs
Inlet Invert= 145.00', Outlet Invert= 80.00'
15.00' x 5.00' deep Parabolic Channel, n= 0.040 Earth, cobble bottom, clean sides
Length= 2,512.0' Slope= 0.0259 '/'

Reach PO5: Pacific Ocean

Inflow Area = 989.580 ac, Inflow Depth > 4.12"
Inflow = 728.56 cfs @ 8.23 hrs, Volume= 339.540 af
Outflow = 728.56 cfs @ 8.23 hrs, Volume= 339.540 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach CR4: Chetco River (South Bank Subtotal)

Inflow Area = 7,668.010 ac, Inflow Depth > 4.47"
Inflow = 5,332.11 cfs @ 8.07 hrs, Volume= 2,859.496 af
Outflow = 5,332.11 cfs @ 8.07 hrs, Volume= 2,859.496 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach CR5: Chetco River (Subtotal)

Inflow Area = 10,968.050 ac, Inflow Depth > 4.58"
Inflow = 8,415.31 cfs @ 8.07 hrs, Volume= 4,182.045 af
Outflow = 8,415.31 cfs @ 8.07 hrs, Volume= 4,182.045 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO: Pacific Ocean (Total)

Inflow Area = 20,756.470 ac, Inflow Depth > 4.49"
Inflow = 13,452.15 cfs @ 8.11 hrs, Volume= 7,769.548 af
Outflow = 13,452.15 cfs @ 8.11 hrs, Volume= 7,769.548 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO6: Pacific Ocean (Brookings Subtotal)

Inflow Area = 7,872.890 ac, Inflow Depth > 4.40"
Inflow = 5,166.76 cfs @ 10.05 hrs, Volume= 2,888.400 af
Outflow = 5,166.76 cfs @ 10.05 hrs, Volume= 2,888.400 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO7: Pacific Ocean (Harbor Subtotal)

Inflow Area = 1,915.530 ac, Inflow Depth > 4.38"
Inflow = 1,505.21 cfs @ 8.22 hrs, Volume= 699.103 af
Outflow = 1,505.21 cfs @ 8.22 hrs, Volume= 699.103 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Reach PO8: Pacific Ocean (Ocean Only) Subtotal

Inflow Area = 9,788.420 ac, Inflow Depth > 4.40"
Inflow = 5,965.99 cfs @ 10.04 hrs, Volume= 3,587.503 af
Outflow = 5,965.99 cfs @ 10.04 hrs, Volume= 3,587.503 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link CR1: Chetco River (North Bank)

Inflow Area = 3,300.040 ac, Inflow Depth > 4.81"
Inflow = 3,084.80 cfs @ 8.06 hrs, Volume= 1,322.549 af
Primary = 3,084.80 cfs @ 8.06 hrs, Volume= 1,322.549 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (North Bank)~Reach CR1

Link CR2: Chetco River (Southeast Bank)

Inflow Area = 6,960.400 ac, Inflow Depth > 4.45"
Inflow = 4,641.19 cfs @ 8.07 hrs, Volume= 2,582.947 af
Primary = 4,641.19 cfs @ 8.07 hrs, Volume= 2,582.947 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (Southeast Bank)~Reach CR2

Link CR3: Chetco River (Southwest Bank)

Inflow Area = 707.610 ac, Inflow Depth > 4.69"
Inflow = 696.42 cfs @ 8.12 hrs, Volume= 276.549 af
Primary = 696.42 cfs @ 8.12 hrs, Volume= 276.549 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Chetco River (Southwest Bank)~Reach CR3

Link PO1: Pacific Ocean (Brookings North)

Inflow Area = 4,976.350 ac, Inflow Depth > 4.08"
Inflow = 2,851.29 cfs @ 8.23 hrs, Volume= 1,693.215 af
Primary = 2,851.29 cfs @ 8.23 hrs, Volume= 1,693.215 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Brookings (North)~Reach PO1

Link PO2: Pacific Ocean (Brookings Central)

Inflow Area = 2,169.250 ac, Inflow Depth > 4.60"
Inflow = 2,727.76 cfs @ 10.06 hrs, Volume= 831.134 af
Primary = 2,727.76 cfs @ 10.06 hrs, Volume= 831.134 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Outflow Imported from Brookings (Central)~Reach PO2

ADDENDUM (No. 1)
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For
Addendum to
Storm and Surface
Water Facilities Plan
for
Brookings-Harbor Area
June 26, 2007

ADDENDUM (No. 1)

ATTACHMENT #1

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for
Brookings-Harbor Area
June 26, 2007

Stormwater Phase II Regulatory Requirements

Minimum Measure #1: Public Education and Outreach on Stormwater Impacts

40 CFR 122.34(b)(1)

(1) Public education and outreach on stormwater impacts.

(i) You must implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of stormwater discharges on water bodies and the steps that the public can take to reduce pollutants in stormwater runoff.

(ii) Guidance: You may use stormwater educational materials provided by your State, Tribe, EPA, environmental, public interest or trade organizations, or other MS4s. The public education program should inform individuals and households about the steps they can take to reduce stormwater pollution, such as ensuring proper septic system maintenance, ensuring the proper use and disposal of landscape and garden chemicals including fertilizers and pesticides, protecting and restoring riparian vegetation, and properly disposing of used motor oil or household hazardous wastes. EPA recommends that the program inform individuals and groups how to become involved in local stream and beach restoration activities as well as activities that are coordinated by youth service and conservation corps or other citizen groups. EPA recommends that the public education program be tailored, using a mix of locally appropriate strategies, to target specific audiences and communities. Examples of strategies include distributing brochures or fact sheets, sponsoring speaking engagements before community groups, providing public service announcements, implementing educational programs targeted at school age children, and conducting community-based projects such as storm drain stenciling, and watershed and beach cleanups. In addition, EPA recommends that some of the materials or outreach programs be directed toward targeted groups of commercial, industrial, and institutional entities likely to have significant stormwater impacts. For example, providing information to restaurants on the impact of grease clogging storm drains and to garages on the impact of oil discharges. You are encouraged to tailor your outreach program to address the viewpoints and concerns of all communities, particularly minority and disadvantaged communities, as well as any special concerns relating to children.

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Minimum Measure #2: Public Involvement/Participation

40 CFR 122.34(b)(2)

(2) Public involvement/participation.

(i) You must, at a minimum, comply with State, Tribal and local public notice requirements when implementing a public involvement/ participation program.

(ii) Guidance: EPA recommends that the public be included in developing, implementing, and reviewing your stormwater management program and that the public participation process should make efforts to reach out and engage all economic and ethnic groups. Opportunities for members of

the public to participate in program development and implementation include serving as citizen representatives on a local stormwater management panel, attending public hearings, working as citizen volunteers to educate other individuals about the program, assisting in program coordination with other pre-existing programs, or participating in volunteer monitoring efforts. (Citizens should obtain approval where necessary for lawful access to monitoring sites.)

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Minimum Measure #3: Illicit Discharge Detection and Elimination

40 CFR 122.34(b)(3)

(3) Illicit discharge detection and elimination.

(i) You must develop, implement and enforce a program to detect and eliminate illicit discharges (as defined at Sec. 122.26(b)(2)) into your small MS4.

(ii) You must:

(A) Develop, if not already completed, a storm sewer system map, showing the location of all outfalls and the names and location of all waters of the United States that receive discharges from those outfalls;

(B) To the extent allowable under State, Tribal or local law, effectively prohibit, through ordinance, or other regulatory mechanism, non-stormwater discharges into your storm sewer system and implement appropriate enforcement procedures and actions;

(C) Develop and implement a plan to detect and address non-stormwater discharges, including illegal dumping, to your system; and

(D) Inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.

(iii) You need address the following categories of non-stormwater discharges or flows (i.e., illicit discharges) only if you identify them as significant contributors of pollutants to your small MS4: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)), uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash water (discharges or flows from fire fighting activities are excluded from the effective prohibition against non-stormwater and need only be addressed where they are identified as significant sources of pollutants to waters of the United States).

(iv) Guidance: EPA recommends that the plan to detect and address illicit discharges include the following four components: procedures for locating priority areas likely to have illicit discharges; procedures for tracing the source of an illicit discharge; procedures for removing the source of the discharge; and procedures for program evaluation and assessment. EPA recommends visually screening outfalls during dry weather and conducting field tests of selected pollutants as part of the procedures for locating priority areas. Illicit discharge education actions may include storm drain stenciling, a program to promote, publicize, and facilitate public reporting of illicit connections or discharges, and distribution of outreach materials.

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Minimum Measure #4: Construction site stormwater runoff control

40 CFR 122.34(b)(4)

(4) Construction site stormwater runoff control.

(i) You must develop, implement, and enforce a program to reduce pollutants in any stormwater runoff to your small MS4 from construction activities that result in a land disturbance of greater than or equal to one acre. Reduction of stormwater discharges from construction activity disturbing less than one acre must be included in your program if that construction activity is part of a larger common plan of development or sale that would disturb one acre or more. If the NPDES permitting authority waives requirements for stormwater discharges associated with small construction activity in accordance with Sec. 122.26(b)(15)(i), you are not required to develop, implement, and/or enforce a program to reduce pollutant discharges from such sites.

(ii) Your program must include the development and implementation of, at a minimum:

(A) An ordinance or other regulatory mechanism to require erosion and sediment controls, as well as sanctions to ensure compliance, to the extent allowable under State, Tribal, or local law;

(B) Requirements for construction site operators to implement appropriate erosion and sediment control best management practices;

(C) Requirements for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality;

(D) Procedures for site plan review which incorporate consideration of potential water quality impacts;

(E) Procedures for receipt and consideration of information submitted by the public, and

(F) Procedures for site inspection and enforcement of control measures.

(iii) Guidance: Examples of sanctions to ensure compliance include non-monetary penalties, fines, bonding requirements and/or permit denials for non-compliance. EPA recommends that procedures for site plan review include the review of individual pre-construction site plans to ensure consistency with local sediment and erosion control requirements. Procedures for site inspections and enforcement of control measures could include steps to identify priority sites for inspection and enforcement based on the nature of the construction activity, topography, and the characteristics of soils and receiving water quality. You are encouraged to provide appropriate educational and training measures for construction site operators. You may wish to require a stormwater pollution prevention plan for construction sites within your jurisdiction that discharge into your system. See Sec. 122.44(s) (NPDES permitting authorities' option to incorporate qualifying State, Tribal and local erosion and sediment control programs into NPDES permits for stormwater discharges from construction sites). Also see Sec. 122.35(b) (The NPDES permitting authority may recognize that another government entity, including the permitting authority, may be responsible for implementing one or more of the minimum measures on your behalf.)

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Minimum Measure #5: Post-Construction Stormwater Management in New Development and Redevelopment

40 CFR 122.34(b)(5)

(5) Post-construction stormwater management in new development and redevelopment.

(i) You must develop, implement, and enforce a program to address stormwater runoff from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, that discharge into your small MS4. Your program must ensure that controls are in place that would

prevent or minimize water quality impacts.

(ii) You must:

(A) Develop and implement strategies which include a combination of structural and/or non-structural best management practices (BMPs) appropriate for your community;

(B) Use an ordinance or other regulatory mechanism to address post-construction runoff from new development and redevelopment projects to the extent allowable under State, Tribal or local law; and

(C) Ensure adequate long-term operation and maintenance of BMPs.

(iii) Guidance: If water quality impacts are considered from the beginning stages of a project, new development and potentially redevelopment provide more opportunities for water quality protection. EPA recommends that the BMPs chosen: be appropriate for the local community; minimize water quality impacts; and attempt to maintain pre-development runoff conditions. In choosing appropriate BMPs, EPA encourages you to participate in locally-based watershed planning efforts which attempt to involve a diverse group of stakeholders including interested citizens. When developing a program that is consistent with this measure's intent, EPA recommends that you adopt a planning process that identifies the municipality's program goals (e.g., minimize water quality impacts resulting from post-construction runoff from new development and redevelopment), implementation strategies (e.g., adopt a combination of structural and/or non-structural BMPs), operation and maintenance policies and procedures, and enforcement procedures. In developing your program, you should consider assessing existing ordinances, policies, programs and studies that address stormwater runoff quality. In addition to assessing these existing documents and programs, you should provide opportunities to the public to participate in the development of the program. Non-structural BMPs are preventative actions that involve management and source controls such as: policies and ordinances that provide requirements and standards to direct growth to identified areas, protect sensitive areas such as wetlands and riparian areas, maintain and/or increase open space (including a dedicated funding source for open space acquisition), provide buffers along sensitive water bodies, minimize impervious surfaces, and minimize disturbance of soils and vegetation; policies or ordinances that encourage infill development in higher density urban areas, and areas with existing infrastructure; education programs for developers and the public about project designs that minimize water quality impacts; and measures such as minimization of percent impervious area after development and minimization of directly connected impervious areas. Structural BMPs include: storage practices such as wet ponds and extended-detention outlet structures; filtration practices such as grassed swales, sand filters and filter strips; and infiltration practices such as infiltration basins and infiltration trenches. EPA recommends that you ensure the appropriate implementation of the structural BMPs by considering some or all of the following: pre-construction review of BMP designs; inspections during construction to verify BMPs are built as designed; post-construction inspection and maintenance of BMPs; and penalty provisions for the noncompliance with design, construction or operation and maintenance. Stormwater technologies are constantly being improved, and EPA recommends that your requirements be responsive to these changes, developments or improvements in control technologies.

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Minimum Measure #6: Pollution Prevention/Good Housekeeping for Municipal Operations

40 CFR 122.34(b)(6)

(6) Pollution prevention/good housekeeping for municipal operations.

(i) You must develop and implement an operation and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations. Using training materials that are available from EPA, your State, Tribe, or other organizations, your program must include employee training to prevent and reduce stormwater pollution from activities such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, and stormwater system maintenance.

(ii) Guidance: EPA recommends that, at a minimum, you consider the following in developing your program: maintenance activities, maintenance schedules, and long-term inspection procedures for structural and non-structural stormwater controls to reduce floatables and other pollutants discharged from your separate storm sewers; controls for reducing or eliminating the discharge of pollutants from streets, roads, highways, municipal parking lots, maintenance and storage yards, fleet or maintenance shops with outdoor storage areas, salt/sand storage locations and snow disposal areas operated by you, and waste transfer stations; procedures for properly disposing of waste removed from the separate storm sewers and areas listed above (such as dredge spoil, accumulated sediments, floatables, and other debris); and ways to ensure that new flood management projects assess the impacts on water quality and examine existing projects for incorporating additional water quality protection devices or practices. Operation and maintenance should be an integral component of all stormwater management programs. This measure is intended to improve the efficiency of these programs and require new programs where necessary. Properly developed and implemented operation and maintenance programs reduce the risk of water quality problems.

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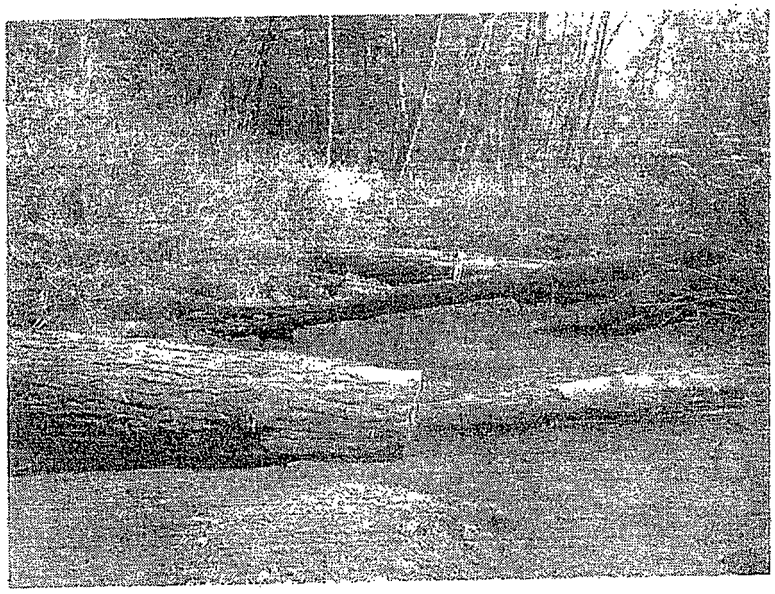
ADDENDUM (No. 1)

ATTACHMENT #2

For
Addendum to
Storm and Surface
Water Facilities Plan
for
Brookings-Harbor Area
June 26, 2007

ATTACHMENT #2

Curry County
Water Quality Implementation Plan



FINAL

June 30, 2006

CURRY COUNTY COMPREHENSIVE WATER QUALITY IMPLEMENTATION PLAN

FINAL

JUNE 30, 2006

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Appendix A. County Stormwater Management Ordinance

Appendix B. Performance Measures for Water Quality

Curry County Water Quality Implementation Plan
DEQ Project Number W 04555-00; Agreement # 001-05
June 30, 2006

INTRODUCTION:

This Water Quality Implementation Plan (WQIP) is a compilation and synthesis of existing documents describing Curry County's efforts to maintain and improve water quality in areas where the county has jurisdiction. This document does not repeat or exhaustively describe every word of the county's efforts. Rather, it pulls together in one place the essential information on the county's water quality efforts, ordinances and laws. These statutes and regulations are designed to meet state water quality standards.

The Bibliography at the end of the WQIP will refer the reader to the complete documents, with their attendant information.

SETTING & BACKGROUND:

The county's approach to maintaining and improving water quality is based on the unique geography of the county. Curry County is the heart of America's Wild Rivers Coast, and is part of the Klamath Mountains Province, an area of the West Coast marked by rocky terrain, botanical diversity, and steep, short, clean, clear rivers.

10 major rivers and watersheds can be found in the county. From north to south they are:

- Floras Creek/New River
- Sixes River
- Elk River
- Hubbard Creek & Port Orford watersheds
- Euchre Creek
- Rogue River
- Hunter Creek
- Pistol River
- Chetco River
- Winchuck River

Part of the rationale for a robust WQIP is the recognition that nowhere else in the lower 48 states is there such an assemblage of rivers in one place, in one county, which all support healthy runs of native salmon and steelhead.

The water quality in Curry County rivers is, overall, good, and this plan outlines efforts to keep water quality healthy, recognizing the cost efficiency of preserving the benefits of working ecosystems - rather than letting them degrade and then employing expensive attempts to " fix" them.

The economic benefits of healthy salmon and steelhead runs are well-documented. For example, a single three-day "Slammin Salmon Derby" in Brookings (Labor Day, 2005) brought in over $1 million to the economy of south Curry County.

In the central county area, the opportunity to catch a fish in the Rogue River is available 365 days a year. In the north county, the Elk and Sixes Rivers can see upwards of 150 boats per day during the fall salmon migration. All these activities translate into substantial economic benefits for fishing guides, motels, restaurants, and associated services. A great deal of the county's tourism industry is built on the recreational opportunities (fishing, boating, sight-seeing, etc) that the county's rivers and the Pacific Ocean provide.

MAJOR DOCUMENTS & SOURCES:

Curry County Comprehensive Plan (CCCP)
Curry County Zoning Ordinances (CCZO)
Curry County Road Department Standards and Guidelines (Roads)
Curry County Stormwater Ordinance (Stormwater)
Curry County Agricultural Water Quality Management Plan (AgPlan)

Oregon Division of State Lands -- Wetlands Protection Inventory & Statutes (DSL)
Oregon DEQ Stormwater Requirements (DEQ)
Oregon DEQ – On-Site Wastewater Treatment Rules (Septic)
Oregon Department of Forestry --Forest Practices Act (ODF)
Oregon Revised Statutes (ORS)
Oregon Administrative Rules (OAR)

HIGHLIGHTS OF WATER QUALITY STATUTES:

A collection of different state agencies partner with Curry County to enforce water quality regulations and statutes. What follows is a brief summary of the statutes in place to protect water quality.

General: ORS Chapter 468 B states: "No person shall cause pollution of any waters of the state or place or cause to be placed any wastes in a location where such wastes are likely to escape or be carried into the waters of the state by any means." (ORS 468)

Riparian Ordinance: In addition to the blanket protection provided above in state statutes, the backbone of Curry County's legislation to maintain good water quality is the county's riparian ordinance. (Article III; Section 3.280 – CCCP).

The riparian corridor for a river basin that has an annual stream flow of greater than 1,000 cubic feet per second (cfs) shall be 75 feet from the top of each bank. The riparian corridor for a river basin that has an annual stream flow of less than 1,000 cubic feet per second shall be 50 feet from the top of each bank. In practice this means that for the Chetco and Rogue Rivers (the biggest rivers in the county) the "setback" is 75 feet, and for all other rivers and streams it is 50 feet.

Removal of vegetation in these riparian corridors is forbidden (with a few minor exceptions). Also prohibited is the building of dwellings or other structures, or the creation of any impervious surface. The result of this ordinance is to provide a valuable "buffer" between anthropogenic (human-caused) activities – and the stream or river. Riparian corridors can filter out nutrients, fertilizers, pollutants, pesticides, chemicals, and other products that can impair water quality. Healthy riparian corridors are the first line of defense to protect the county's water resources.

Riparian vegetation is also vital for long-term shade for our rivers and streams. Many of the county's waterways are listed for temperature under the DEQ's 303D list of water quality impaired streams. Shading, especially of smaller streams, reduces the amount of solar radiation and heating in streams. Over time, shade can substantially cool water temperatures. Thus the county riparian ordinance is an effective, long-term strategy for keeping our rivers and streams cool and clean.

Estuaries: The county has 10 estuaries, most of which are in good condition, and for the most part, unimpaired. The Rogue River and Chetco River have jetties in the estuary to improve navigability and reduce "sanding in" of the estuaries and mudflats at the mouths of these rivers. Goal 16 of the State's Land Use Code "recognizes the unique environmental, economic and social values of estuaries and seeks to protect, maintain and develop their long term values and benefits." (Exhibit E; Chap 17; Goal 16 – CCCP).

Specifically, Curry County pledges to protect estuaries, including their:

- Biological productivity
- Habitat & diversity
- Unique features
- Water quality

Curry County also recognizes that some restoration of estuaries is needed. The county identifies appropriate sites for restoration as areas of :

- Heavy erosion or sedimentation
- Degraded fish and wildlife habitat
- Anadromous fish spawning or rearing areas
- Diked or abandoned estuarine marshes
- Water quality degraded reaches

Estuaries, cont : Recent work to improve estuaries has been done by the South Coast and Lower Rogue Watershed Councils, and the Curry Soil and Water Conservation District. This work has included the following activities:

- Baseline water quality testing (all estuaries)
- Placement of large wood (Winchuck; Pistol, Euchre; Floras / New River)
- Removal of invasive beach grass (Elk River)
- Removal of old fill (Winchuck)

Since all of Curry County's estuaries are (relatively) short and small, their value for salmonids increases, and potential impacts (fill, pollution) are magnified because of their small area. The watershed councils, SWCD, and ODFW are looking at ways to enhance estuaries, including removing old fill, or actually expanding estuary size. In addition, the councils are looking at all estuaries to reduce immediate impacts (especially from small streams flowing directly into estuaries through rural residential land).

Wetlands: The county coordinates with the Oregon Division of State Lands (DSL) for the protection of wetlands. Wetlands filter run-off and improve water quality. They have been called the "kidneys" of the planet for their ability to filter and purify water. County wetlands are identified in the Statewide Wetlands Inventory. These wetlands receive special protection. Normally they cannot be filled or altered; however, there are exceptions, if appropriate mitigation (creating new wetlands) occurs in conjunction with the project. Permits are required through the DSL for any activities in a wetland. (DSL Chapter 196 – all sections, especially 196.672 and 196.681) & (OAR 629-655-000).

Stormwater management: On March 6, 2006, Curry County passed a Stormwater ordinance, in response to increasing concerns about development and impervious surfaces, especially in the fast-growing areas surrounding Brookings. In some areas of Curry County (especially the Brookings-Harbor area), previous development and construction of impervious surfaces (roads, driveways, roofs, etc) has resulted in excess run-off and sedimentation. The complete text of the Stormwater Ordinance is included here in ***Appendix A***.

In addition to the county ordinance, the DEQ also restricts the amount of stormwater run-off anyone can pass on to downstream neighbors, and requires that there be no damage, or increase in stormwater from any upstream development. In effect, the law says if there were 10,000 gallons per minute running off before development, there can *be no more than* 10,000 gallons running off ***after*** development.

To mitigate the effects of driveways, roads, roofs, and other impervious surfaces, techniques such as detention basins, pipes, vegetation, and armoring are often used. The county is currently working on site-specific language to require developers to meet these standards to protect both themselves and downstream neighbors.

County roads and culverts: The County Road Department employs Best Management Practices (BMPs) in all their road maintenance activities. The Road Dept is responsible for maintaining approximately 230 miles of road, 30 bridges, and hundreds of culverts. Over the past ten years the department has been aggressively replacing and upgrading its entire drainage system. As of 2006, they have completed replacement on one-half to three-quarters of the system. This commitment to drainage management has significantly reduced both turbidity and winter maintenance needs.

The Road Dept. has worked closely with the Oregon Department of Fish and Wildlife, the US Forest Service, and the South Coast / Lower Rogue Watershed Councils to replace culverts that are barriers to fish passage. In 2005 they replaced six fish barriers with pipes ranging in size from 72 inches to 96 inches and costs ranging from $23,000 to $82,000. They design their culverts to accommodate a 50-year flood event, but because the size of a fish pipe needs to match the existing channel width, most of their fish pipes will pass a 100-year event. Additionally, the department replaces about 2,000 feet of culvert per year. Their biggest project to date was replacing a fish barrier culvert with a bridge on Deep Creek, a tributary to Pistol River. Prior to replacement, this crossing was the source of constant maintenance. Now, there are virtually no maintenance issues.

The Road Department is dedicated to implementing erosion control during all activities. They try to do the work during the dry season and keep the duration short to minimize impacts to streams. The entire crew has been to Best Management Practices (BMPs) training with the Oregon Department of Transportation.

The biggest barrier to getting projects accomplished is the National Marine Fisheries Service's (NMFS) review of the permit application. Part of the problem, as seen by the Road Department, is that NMFS gives the same amount of scrutiny to "standard" culvert replacement as they do to more unconventional projects that may need a higher level of review. Therefore, NMFS often does not complete their review within the timeframe set by their own guidelines.

The Road Dept has an on-going plan to repair and upgrade all of the county's culverts. As this is done, virtually all of the county's infrastructure will ensure fish passage.

Septic tanks: Curry County maintains an environmental sanitation program for the regulation of on-site sewage disposal in order to protect water quality in the county. The program is run by a supervisory sanitarian, Sara Hunter, who is an agent of the Oregon Department of Environmental Quality (DEQ) and is a Registered Sanitarian. The Sanitarian makes decisions on existing septic systems and permits for new systems following guidelines set forth in a manual put out by the DEQ, *Onsite Wastewater Treatment Systems Rules*. This manual sets out the rules for acceptable systems based on factors such as groundwater levels, soil type, slope and proximity to streams and wells.

Depending on the existing conditions of the site (soil, slope, drainage, etc), a property owner has several options when it comes to installing a septic system that will treat their wastewater so that it meets current water quality standards. All systems require setbacks of 100 feet from a perennial stream or well, and 50 feet from an intermittent stream. The Sanitarian performs site inspections to help the landowner understand the minimum requirements necessary to have a system in compliance. Septic systems can be grouped into three basic categories based on the complexity of the system: standard, mid-level, and advanced. The cost of installing a system depends greatly on how complex it is. Costs can be substantial when installing an advanced system.

If there is a good soil column with no groundwater, the soils are not rapidly draining, and proper setbacks are met, a ***standard system*** of tank and leach field can be installed. Standard systems are the least expensive system but work well when installed properly and maintained regularly.

The next most sophisticated system is called a ***mid-level*** or sometimes a "pressurized" system. Under some conditions, wastewater and effluent need some pre-treatment before being released into the ground, and these mid-level types of systems can do that. They typically cost $10,000-$15,000 more than a standard system.

The most ***advanced type*** of septic system is a sand, textile, and/or recirculating filter system, which also pre-treats effluent. Systems of this caliber are installed by a qualified contractor and come with a contract for yearly maintenance. The Sanitarian keeps copies of the maintenance contracts, evidence of the contractor's qualifications and copies of the yearly report provided by the maintenance contractor. These pretreatment filters can treat 95-98% of pathogens and fecal coliforms, and also a percentage of nitrates. This advanced pretreatment allows for smaller leach fields and in some cases, the system can be placed closer to a perennial stream than the standard 100-foot setback.

For all types of new systems the Sanitarian requires a DEQ-tested and approved tank which can be made of plastic, concrete, or fiberglass. This insures that no water quality problems arise from faulty tanks and that the Sanitarian does not need to inspect the tank, which saves the landowner time and money.

There are several problem areas in the county, where old septic systems are now suspected of leaking, allowing pathogens, turbidity, and bacteria into our waters. Many of these older systems were installed prior to 1974, when permitting was first required. Problems areas include:

- In the Brookings area: Ocean View Lane, Park View Drive, and Pedro Gulch.
- In the central Curry area: Hunter Creek, including Mateer Rd and Brooks Lane.
- In the north county: Garrison Lake; and some areas around Floras Lake.

All these areas have out-dated systems that need to be replaced. One opportunity is to secure grants to help landowners replace these systems with new, updated systems to improve water quality. The cost of a new septic system can range from $10,000 to $30,000 or more. The county and the watershed councils are seeking funds to help defray to costs of upgrading the systems that are failing. Possible funding sources include the DEQ 319 (Clean Water) program; the Oregon Watershed Enhancement Board; EPA; private foundations; and others.

Fish resources: Curry County has four main species of salmonids in its 10 major river systems. These iconic fish are symbols of the wildness, promise and freedom of the Great Northwest. This collection of rivers in Curry County offers one of the last, best holdouts of wild salmon populations in the lower 48 states. Principal anadromous species in the county's rivers are : chinook, coho, steelhead, and cutthroat trout. (CCCP)

The county recognizes that adequate water supply (quantity), along with good water conditions (quality) – are the key components to sustaining these wild fish for the next 100 years.

The Oregon Water Resources Department regulates instream water flows, irrigation, and municipal water rights (for drinking water, etc). Problem areas appear to be in the north and south of the county, with Floras Creek overallocated (due to past allocation decisions made 100 years ago) and the Brookings area facing rapid population growth, with attendant pressure on water resources. Brookings has adopted a city water management plan that outlines measures it will take to maintain flows of at least 80 cfs (cubic feet per second) during the months of low flows (usually August, Sept and October). In June, 2006, the City of Brookings allocated $20,000 to water conservation education for its citizens.

Gravel Removal: Gravel extraction in Curry County is regulated by the Oregon Division of State Lands (DSL). There are large gravel removal operations on the county's two largest rivers (Rogue and Chetco), and several smaller operations (Hunter Creek; Elk River). State regulations function to reduce turbidity from these operations; ensure that fish habitat is not damaged during instream gravel removal; and that gravel "recruitment" replenishes the gravel removed each year. As part of the Klamath Mountains Province, our rivers are rich in gravel, appearing to have a good and reliable supply. (CCCP)

A gravel workshop sponsored by OSU Extension Service in spring 2006 outlined many of the issues associated with gravel removal, and offered the benefits of what science knows (and doesn't know) about the impacts of gravel removal. The National Marine Fisheries Service in spring 2006, issued a draft biological opinion that said gravel removal (specifically on the Chetco) could impact coho salmon production, and recommended changes, including reductions, in the existing gravel removal permits.

Agriculture and Forest Lands: Agricultural lands and their associated water quality issues are regulated by the Curry County Agricultural Water Quality Management Plan -- produced by the direction of Senate Bill 1010. The Plan is housed at the Curry County Soil and Water Conservation District. This approach to agricultural run-off focuses on riparian areas as buffers between agricultural lands and streams& rivers. Although it does not prescribe a specific "buffer width" the Plan does talk about maintaining the function of riparian areas to filter agricultural run-off, which can include fertilizers, pesticides and herbicides, and soil erosion from high flow events. Complaints about possible violations are referred first to the Curry County Soil and Water Conservation District for resolution. (AgPlan)

Private forest lands are regulated by the State Department of Forestry. The Forest Practices Act stipulates a 20 foot "no touch" buffer on fish-bearing streams, and a "Riparian Management Area" of 20 feet to 100 feet from the stream where a certain percentage of the basal area of trees must be left standing (for shade and soil retention). Private industrial forest lands make up about 30 % of the county's land base. (ODF and ORS 527.610 & ORS 527.765)

Recreational Opportunities: Good water quality can directly influence recreational opportunities for both county residents and visitors. Good fishing opportunities are directly tied to healthy water quality. In addition, our area is marketed world-wide as the "Heart of America's Wild Rivers Coast." People from all over the world come to recreate on our rivers or pursue fishing adventures in the nearshore ocean. They usually come from more urban areas and carry with them an expectation of "good scenery and clean rivers."

In addition to fishing on the county's 10 major rivers, recreational jetboats (MailBoats and Jerrys Jet Boats) take over 50,000 passengers each year up the Rogue River to Agness and beyond. The Rogue River was one of the eight original Wild and Scenic Rivers included in the National Wild and Scenic Rivers System established in 1968.

Landfills / Recycling: Curry County has developed an active solid waste recovery and recycling program which promotes the recycling and proper disposal of solid waste in order to protect the quality of the air, WATER and land resources of the county. (CCCP)

Coastal Shorelands: Curry County recognizes the importance of coastal shorelands, and has defined the coastal shoreland area by a boundary that is related to the physical processes that affect the shoreland. The county also states: "Curry County will not permit residential developments and commercial and industrial buildings on beaches, active foredunes, or other foredunes which are conditionally stable, or interdune areas that are subject to ocean flooding." Ocean resources are part of the whole "water quality gestalt" of Curry County, and protection of shorelands will prevent impairment of water quality in these areas. (CCCP)

EDUCATIONAL OPPORTUNITIES

Contractor's Workshop:
A workshop for building contractors would be a valuable thing. The training could include best management practices (BMPs) for contractors; erosion control techniques; review of current regulations; stormwater management; "green" building options, and other topics.

Real Estate Brokers' Workshop:
A workshop for real estate brokers could focus on the "liveability" of our county; the ethic of "America's Wild Rivers Coast," information on the existing riparian ordinance; homesite selection for rural properties; and other topics. Real estate brokers are often the first point of contact for newcomers moving in to Curry County.

Neighborhood Septic Upgrades and Vouchers:
There are some areas of the county where failing septic tanks pose a problem to water quality. Failing septics can overload streams and rivers with nitrates, *E. coli*, other bacteria, and water-borne pathogens. A program that could provide vouchers --- financial help from $2,000 to $10,000 @ --- to help landowners replace failing or out-dated septic systems could go a long ways towards alleviating this problem.

Key areas:
Mateer Road and Brooks Road (Hunter Creek)
Parkview Drive and Ocean View Drive (Brookings)
Garrison Lake & environs
Floras Lake

GIS Displays and Maps: The county now has a very professional GIS (Geographic Information System) coordinator (Toni Fisher). GIS is a powerful tool that can be used to display information and coordinate comprehensive efforts. For example, the county's road network can now be displayed on an up-to-date map. This could include all the county's culverts and road crossings. That information can be linked with a GIS "layer" that shows fish distribution. This kind of information can then determine priorities for a coming years funding allocations.

Another example: The county could create a GIS map showing all rural residential properties that are adjacent to streams and rivers. This could produce a targeted list for outreach and education for riparian projects and protection.

A third example: The county GIS shop could partner with the watershed council to identify areas of potential shade along rivers, and use existing analyses to target the best areas to plant riparian trees --- for long-term shading and water cooling. (This is being implemented now).

TIMELINE FOR PLAN IMPLEMENTATION:

First Draft of WQMP: Water Quality Implement Plan (WQIP)	December 2005
Review & Suggestions by all parties	Jan – Feb 2006
Incorporate suggestions into Final WQMP	Mar-April 2006
Publish Final WQMP	June 2006
Begin Educational workshops	2006 – 2007
First "Check-In" meeting (see below)	Dec 2006
Secure grants for educational elements	on-going

PLAN FOR PERFORMANCE MONITORING:

At the end of each calendar year, in December, it is recommended that The County Board of Commissioners meet with the County Planning Director and a representative of the Oregon DEQ and ODFW to review the elements listed above for the county WQIP (wetlands, estuaries, roads, septics, etc).

This periodic review would serve as a coordinated "check point" to evaluate how the county is doing on maintaining or improving water quality. **This WQIP, if implemented, can result in *improvements* in water quality over time.** This would mean not just slowing the rate of water quality degradation, or maintaining the status quo, but actual improvements in water quality, with attendant benefits (recreation, tourism, fish populations, etc). See ***Appendix B*** for a more complete discussion of "Performance Measures for Water Quality."

Currently, the county commissioners meet monthly to review any violations of county ordinances or regulations (these meetings include the Planning Director, County Counsel, Environmental Health Officer, and sometimes the Sanitarian). These meetings also offer an excellent opportunity to do regular "check-ins" on water quality issues.

BARRIERS TO IMPLEMENTATION

Complacency: Only vigilance will continue to protect and improve the water quality in our rivers and streams, especially in the face of accelerating development pressures. If we become complacent, we will lose the excellent water quality we now enjoy. In the long, 200-year history of urbanization and salmon populations, salmon always lose. Citizens should hold their elected officials responsible for obeying and improving existing laws and regulations.

BARRIERS TO IMPLEMENTATION cont

Institutional turn-over: County commissioners are elected every four years. The Planning Director serves at the will of the county commissioners. These positions "set the tone" for how the existing water quality regulations will be interpreted and enforced. New people coming in to these positions may not understand or appreciate the importance of water quality to our county's economic health. They may not understand the existing network of laws that protects our resources.

Non-enforcement: The county has a robust & effective riparian ordinance, and good statutes in place for roads, culverts, septic tanks, and other engineered structures. However, these regulations are only as good as the enforcement behind them. If citizens or developers think they can "get away with things" by non-compliance, water quality will suffer. The regular enforcement meetings mentioned above are an excellent check-point.

Development pressures: The history of urbanization and water quality / salmon numbers is not good. In general, throughout the last century, urbanization has caused hardening of surfaces (pavements, driveways, roads, asphalt, concrete, roofs, etc). When an area reaches a certain per cent impervious surface (usually around 10%), then water quality declines precipitously and salmon populations suffer. Curry County is not near that 10% number yet, but in our more urbanized areas (Brookings; Harbor), we are approaching that threshold. Impervious surfaces collect pollutants and toxins, increase run-off and erosion, and reduce the infiltration and filtering capacity of the soil. These factors generally degrade water quality. It is much easier to *prevent* a water quality problem, than it is to go back in and try to "fix" it.

COSTS – AND SOURCES OF FUNDING:

There are no additional county costs for implementing this water quality plan (WQIP). County employees in place (Road Dept., Sanitarian, Planning Director, etc) have the responsibility for enforcing the existing regulations as part of their regular job requirements.

To improve water quality, some of the workshops recommended would have slight organizational costs. In addition, in Appendix B, several existing programs are identified that, if continued, would bring improved water quality throughout our area.

Sources of funding:

Oregon Watershed Enhancement Board (OWEB)
Oregon Dept of Environmental Quality (DEQ)
Environmental Protection Agency (EPA)
Private foundations.

Curry County Water Quality Implementation Plan
DEQ Project Number W 04555-00
DEQ Agreement Number 001-05

BIBLIOGRAPHY

Curry County Comprehensive Plan (CCCP). Available from the Curry County Planning Department.

Curry County Zoning Ordinances (CCZO) Available from the Curry County Planning Department.

Curry County Road Department Standards and Guidelines (Roads). Available from the Curry County Road Department; 28425 Hunter Creek Road; Gold Beach

Curry County Stormwater Management Plan (Adopted March 6, 2006) (Stormwater) Available from the Curry County Planning Department and on-line at www.co.curry.or.us

Oregon Division of State Lands -- Wetlands Protection Inventory & Statutes (DSL) www.statelandsonline.com

Oregon DEQ Stormwater Requirements (DEQ) www.deq.state.or.us

Oregon Forest Practices Act www.odf.state.or.us

Is GIS on webpage??

Comp plan on LCDC website?

Appendix A

Curry County Stormwater Ordinance

See Appendix 4.1 of the Plan.

Appendix B

Performance Measures for Water Quality

Pollutant: Temperature
Source: Inadequate riparian shade – 10 major rivers

Strategy: Watershed council, SWCD, and private landowners should commit to planting 10,000 trees per year in riparian areas for the next 10 years. Use existing shade assessments for priority planting areas.
Cost: Approx $40,000 per year (trees, labor, coordination, supplies and mileage).

Strategy: Continue to monitor and enforce existing county riparian ordinance to maintain vegetative buffers now in place
Cost: None -- existing personnel.
Timeline: Focus on the next five years, 2006 – 2011.

Pollutant: Excess Sediment
Source: Poorly constructed upland roads

Strategy: Continue watershed councils' sediment abatement program, which identifies priority areas through road surveys, and then seeks funds to fix and "storm-proof" roads. Partner with county roads to fix any public chronic sediment sources. Work with landowners on private lands through existing programs
Cost: $75,000 per year for watershed council program.
Timeline: Focus on the next five years, 2006 – 2011

Pollutant: Nitrogen, phosphorus, other agricultural chemicals, including pesticides, herbicides.
Source: fertilizers, spraying for bugs & weeds done by agricultural operators and rural residents (lawn fertilizers, weed killers).

Strategy: Outreach and education to rural residential and urbanites to limit chemical use. Agricultural use falls under the Curry Agricultural Management Plan. Several workshops have been held. Ranchers are currently conducting experiments to reduce fertilizers (nitrogen, ammonia) plus measure how much of their application ends up in waterways.
Timeline: The next meeting to review the Curry Agricultural Management Plan is spring, 2008. This would be a good time to schedule a workshop on reducing pollution -- as well as hearing reports on progress and projects implemented from 2006 – 2008.

Pollutant: *E.coli*; coliform bacteria

Source: Failing septic tanks; livestock having access to streams and rivers. Some natural sources (beaver, elk, deer).

Strategy: Pinpoint sources through continued water quality monitoring. When sources of bacteria are identified, offer incentives to landowners or alternatives -- or guidelines for implementing BMP's

Cost: $20,000 - $30,000 per year for water quality testing program

Timeline: DEQ, Oregon State University, and the watershed councils are doing a comprehensive "Beach bacteria source search" in 2006 and 2007. This study will help narrow the focus of where high bacteria counts occur in the Brookings area (Mill Beach and Harris Beach).

Additionally, the "Storm Chasers" program funded by Curry County will continue in 2006 -7. This program can identify sites in other areas of the county, areas that have high bacteria county during winter storms.

ADDENDUM (No. 1)

ATTACHMENT #3

For
Addendum to
Storm and Surface
Water Facilities Plan
for
Brookings-Harbor Area
June 26, 2007

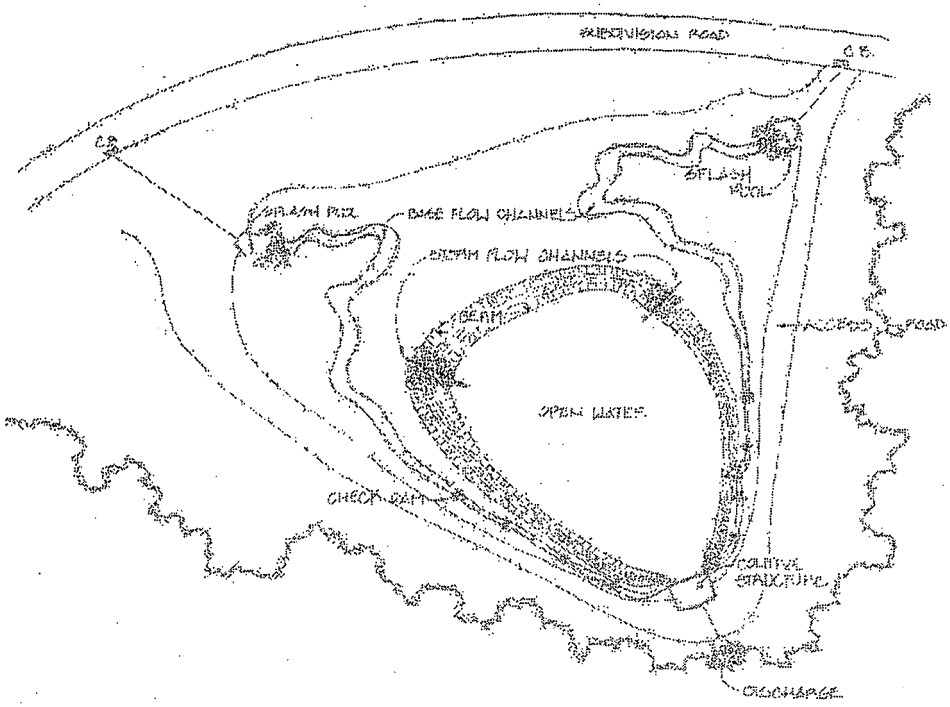
United States
Environmental Protection
Agency

Office of Water (4303)
Washington, DC 20460

EPA-821-R-99-012
August 1999

EPA Preliminary Data Summary of Urban Storm Water Best Management Practices

ATTACHMENT #3



5.0 Description and Performance of Storm Water Best Management Practices

A storm water best management practice (BMP) is a technique, measure or structural control that is used for a given set of conditions to manage the quantity and improve the quality of storm water runoff in the most cost-effective manner. BMPs can be either engineered and constructed systems ("structural BMPs") that improve the quality and/or control the quantity of runoff such as detention ponds and constructed wetlands, or institutional, education or pollution prevention practices designed to limit the generation of storm water runoff or reduce the amounts of pollutants contained in the runoff ("non-structural BMPs"). No single BMP can address all storm water problems. Each type has certain limitations based on drainage area served, available land space, cost, pollutant removal efficiency, as well as a variety of site-specific factors such as soil types, slopes, depth of groundwater table, etc. Careful consideration of these factors is necessary in order to select the appropriate BMP or group of BMPs for a particular location.

5.1 Goals of Storm Water Best Management Practices

Storm water BMPs can be designed to meet a variety of goals, depending on the needs of the practitioner. In existing urbanized areas, BMPs can be implemented to address a range of water quantity and water quality considerations. For new urban development, BMPs should be designed and implemented so that the post-development peak discharge rate, volume and pollutant loadings to receiving waters are the same as pre-development values. In order to meet these goals, BMPs can be implemented to address three main factors: flow control, pollutant removal and pollutant source reductions.

5.1.1 Flow Control

Flow control involves managing both the volume and intensity of storm water discharges to receiving waters. Urbanization significantly alters the hydrology of a watershed. Increasing development leads to higher amounts of impervious surfaces. As a result, the response of an urbanized watershed to precipitation is significantly different from the response of a natural watershed. The most common effects are reduced infiltration and decreased travel time, which significantly increase peak discharges and runoff volumes. Factors that influence the amount of runoff produced include precipitation depth, infiltrative capacity of soils, soil moisture, antecedent rainfall, cover type, the amount of impervious surfaces and surface retention. Travel time is determined primarily by slope, length of flow path, depth of flow and roughness of flow surfaces. Peak discharges are based on the relationship of these parameters, and on the total drainage area of the watershed, the time distribution of rainfall, and the effects of any natural or manmade storage (USDA/NRCS, 1986).

High flow rates of storm water discharges can cause a number of impacts to receiving streams (see section 4.3), and may also increase the pollutant concentrations in storm water runoff. High velocity runoff can detach and transport significant amounts of suspended solids and

associated pollutants such as nutrients and metals from the urban landscape. In addition, high flow rates in drainage channels and receiving waters can erode stream banks and channels, further increasing suspended solids concentrations in waters that receive storm water discharges. In order to reduce the pollutant concentrations in runoff and receiving water impacts associated with high storm water flow rates, BMPs that provide flow attenuation are frequently implemented.

In areas undergoing new development or redevelopment, the most effective method of controlling impacts from storm water discharges is to limit the amount of rainfall that is converted to runoff. By utilizing site design techniques that incorporate on-site storage and infiltration and reduce the amounts of directly connected impervious surfaces, the amount of runoff generated from a site can be significantly reduced. This can reduce the necessity for traditional structural BMPs to manage runoff from newly developed areas. There are a number of practices that can be used to promote on-site storage and infiltration and to limit the amount of impervious surfaces that are generated. However, the use of on-site infiltration can be limited in certain areas due to factors such as slope, depth to the water table, and geologic conditions.

- *Site design features* such as providing rain barrels, dry wells or infiltration trenches to capture rooftop and driveway runoff, maintaining open space, preserving stream buffers and riparian corridors, using porous pavement systems for parking lots and driveways, and using grassed filter strips and vegetated swales in place of traditional curb-and-gutter type drainage systems can greatly reduce the amount of storm water generated from a site and the associated impacts.

- *Street construction features* such as placing sidewalks on only one side of the street, limiting street widths, reducing frontage requirements and eliminating or reducing the radius of cul-de-sacs also have the potential to significantly reduce the amount of impervious surfaces and therefore the amount of rainfall that is converted to runoff.

- *Construction practices* such as minimizing disturbance of soils and avoiding compaction of lawns and greenways with construction equipment can help to maintain the infiltrative capacity of soils.

There are several guides that contain useful information regarding development practices that can limit the impacts associated with storm water runoff (Delaware DNREC, 1997; US EPA, 1996b; Center for Watershed Protection, 1998).

In areas that are already developed, flow control can be more complicated. Since a drainage infrastructure already exists, retrofitting these systems to provide flow control can be prohibitively expensive. Regional storm water management systems can be used to manage runoff in these areas, but space considerations and high capital costs can limit their usefulness. Depending on site-specific constraints, however, there are a number of practices that can be incorporated on-site to reduce runoff volumes from these areas. Down spouts can be disconnected from the storm drain system and this rainfall can instead be collected and stored on a

property in rain barrels to be used for watering lawns and landscaping during inter-event periods. Infiltration and retention practices such as bioretention areas and infiltration trenches can be constructed to capture runoff from rooftops, lawns and driveways and reduce the volume of runoff discharged to storm sewers. Curb-and-gutter systems can be replaced with grassed swales or wetland channels to provide temporary ponding of runoff. Storm water from commercial areas and golf courses can be collected and stored in ponds and subsequently be used for irrigation. Storm water reuse can help to maintain a more natural, pre-development hydrologic balance in the watershed (Livingston et al, 1998). Parking lots can also be used as short-term storage areas for ponded storm water, and bioretention facilities placed around the perimeter of parking lots can be used to infiltrate this water volume.

Where the generation of runoff cannot be avoided, end-of-pipe structural BMPs may be implemented to decrease the impacts of storm water discharges to receiving streams. However, BMPs are limited in their ability to control impacts, and frequently cause secondary impacts such as increased temperatures of discharges to receiving streams. BMPs that can be designed to provide significant flow attenuation include grassed swales, vegetated filter strips, detention and retention basins, wetland basins, and wetland channels and swales. These BMPs can also provide the added benefit of removing pollutants such as suspended solids and associated nutrients and metals from storm water runoff.

The environmental aspects of storm water quantity control must be carefully balanced against the hazard and nuisance effects of flooding. Large or intense storm events or rapid snowmelt can produce significant quantities of runoff from urban areas with high levels of imperviousness. This runoff must be rapidly transported from urbanized areas in order to prevent loss of life and property due to flooding of streets, residences and businesses. This is frequently accomplished by replacing natural drainage paths in the watershed with paved gutters, storm sewers or other artificial means of drainage. These drainage systems can convey runoff at a faster rate than natural drainage paths, allowing rapid transport of runoff away from areas where flooding is likely to occur. However, as large quantities of runoff are conveyed rapidly from the urban landscape and discharged to receiving streams, downstream areas can flood. Following urbanization, large volumes of runoff can be produced from even small storm events due to the high amounts of impervious surfaces. As a result, flooding of streams that receive runoff can occur much more frequently following urbanization due to this excessive amount of runoff production. Therefore, design of storm water drainage systems must always balance flood protection with ecological concerns.

In highly urbanized and densely populated cities, little opportunity exists for retrofitting storm drainage systems with BMPs to provide water quantity control due to flooding considerations. The large area of impervious surfaces in heavily urbanized areas produce large quantities of runoff. Rapid conveyance by the storm drain system is frequently the only option that exists in order to prevent flooding of yards, streets and basements. In these areas, the most appropriate BMPs are those that limit the generation of pollutants or remove pollutants from the urban landscape. With this principle in mind, a unique opportunity exists in newly developing

areas or in more sparsely populated suburban areas to use BMPs that control runoff at the point of generation, instead of trying to manage it at the point of discharge to the receiving stream. When rainfall is managed as a *resource* instead of as a waste stream requiring treatment, future problems with quantity control may be avoidable. When rainfall is managed at the site level by promoting the concepts of conservation design, and by providing on-site storage, infiltration and usage of rainfall for irrigation of the urban landscape, the need for traditional curb-and-gutter storm drainage system can be reduced. As a result, the need for constructing and maintaining capital-, land- and maintenance-intensive regional BMPs to manage large flows from developed watersheds may be reduced. Nuisance flooding of downstream areas can also be limited by reducing the overall volume of water draining from a watershed. Limiting the discharge of large volumes of storm water to urban streams can help to prevent the degradation of these streams to the point of being non-supporting of a designated use.

5.1.2 Pollutant Removal

Urbanized areas export large quantities of pollutants during storm events. The high population of pollutant sources in urbanized areas contribute large quantities of pollutants that accumulate on streets, rooftops and other surfaces. During rainfall or snowmelt, these pollutants are mobilized and transported from the streets and rooftops into the storm drain system, where they are conveyed and ultimately discharged to waterways. In order to reduce the impacts to receiving waters from the high concentrations of pollutants contained in the runoff, BMPs can be implemented to remove these pollutants.

Properly-designed, constructed and maintained structural BMPs can effectively remove a wide range of pollutants from urban runoff. Pollutant removal in storm water BMPs can be accomplished through a number of physical and biochemical processes. The efficiency of a given BMP in removing pollutants is dependent upon a number of site-specific variables, including the size, type and design of the BMP; the soil types and characteristics; the geology and topography of the site; the intensity and duration of the rainfall; the length of antecedent dry periods; climatological factors such as temperature, solar radiation, and wind; the size and characteristics of the contributing watershed; and the properties and characteristics of the various pollutants.

Pollutant removal in urban storm water BMPs can occur through the following mechanisms:

Sedimentation

Sedimentation is the removal of suspended particulates from the water column by gravitational settling. The settling of discrete particles is dependent upon the particle velocity, the fluid density, the fluid viscosity, and the particle diameter and shape. Sedimentation can be a major mechanism of pollutant removal in BMPs such as ponds and constructed wetlands. Sedimentation can remove a variety of pollutants from storm water runoff. Pollutants such as metals, hydrocarbons, nutrients and oxygen demanding substances can become adsorbed or attached to particulate matter, particularly clay soils. Removal of these particulates by

sedimentation can therefore result in the removal of a large portion of these associated pollutants. The main factor governing the efficiency of a BMP at removing suspended matter by sedimentation is the time available for particles to undergo settling. Fine particulates such as clay and silt can require detention times of days or even weeks to settle out of suspension. Therefore, it is important to evaluate the settling characteristics of the particulates in runoff before BMP design in order to determine the detention time necessary for adequate settling to occur. The overall efficiency of a BMP in removing particulates by settling is also dependent upon the initial concentration of suspended solids in the runoff. In general, runoff with higher initial concentrations of suspended solids will have a greater removal efficiency. In addition, some particles, such as fine clays, will not settle out of suspension without the aid of a coagulant. As a result there is usually a minimum practical limit of approximately 10 mg/l of TSS, below which additional TSS removal can not be expected to occur (UDFCD, 1992).

Flotation

Flotation is the separation of particulates with a specific gravity less than that of water. Trash such as paper, styrofoam "peanuts" used for packaging, and other low-density materials can be removed from storm water by the mechanism of flotation. If the inlet area of the BMP is designed to allow for the accumulation of floatable materials, then these accumulated materials can periodically be manually removed from the BMP. Significant amounts of floatables can be removed from storm water in properly designed BMPs in this manner. In addition, oils and hydrocarbons will frequently rise to the surface in storm water BMPs. If the BMP is designed with an area for these materials to accumulate, then significant removals of these pollutants can occur. Many modular or drop-in filtration systems incorporate an oil and grease or hydrocarbon trap with a submerged outlet pipe that allows these contaminants to accumulate and to be periodically removed.

Filtration

Filtration is the removal of particulates from water by passing the water through a porous media. Media commonly used in storm water BMPs include soil, sand, gravel, peat, compost, and various combinations such as peat/sand, soil/sand and sand/gravel. Filtration is a complex process dependent on a number of variables. These include the particle shape and size, the size of the voids in the filter media, and the velocity at which the fluid moves through the media. Filtration can be used to remove solids and attached pollutants such as metals and nutrients. Organic filtration media such as peat or leaf compost can also be effective at removing soluble nutrients from urban runoff.

Infiltration

Infiltration is the most effective means of controlling storm water runoff since it reduces the volume of runoff that is discharged to receiving waters and the associated water quality and quantity impacts that runoff can cause. Infiltration is also an important mechanism for pollutant control. As runoff infiltrates into the ground, particulates and attached contaminants such as metals and nutrients are removed by filtration, and dissolved constituents can be removed by adsorption. However, infiltration is not appropriate in all areas.

Adsorption

Adsorption, while not a common mechanism used in storm water BMPs, can occur in infiltration systems where the underlying soils contain appreciable amounts of clay. Dissolved metals that are contained in storm water runoff can be bound to the clay particles as storm water runoff percolates through clay soils in infiltration systems.

Biological Uptake

Biological uptake of nutrients is an important mechanism of nutrient control in storm water BMPs. Urban runoff typically contains significant concentrations of nutrients. Ponds and wetlands can be useful for removing these nutrients through biological uptake. This occurs as aquatic plants, algae, microorganisms and phytoplankton utilize these nutrients for growth. Periodic harvesting of vegetation in BMPs allows for permanent removal of these nutrients. If plants are not harvested, however, nutrients can be re-released to the water column from plant tissue after the plants die.

Biological Conversion

Organic contaminants can be broken down by the action of aquatic microorganisms in storm water BMPs. Bacteria present in BMPs can degrade complex and/or toxic organic compounds into less harmful compounds that can reduce the toxicity of runoff to aquatic biota.

Degradation

BMPs such as ponds and wetlands can provide the conditions necessary for the degradation of certain organic compounds, including certain pesticides and herbicides. Open pool BMPs can provide the necessary conditions for volatilization, hydrolysis and photolysis of a variety of organic compounds to take place.

5.1.3 Pollutant Source Reductions

Source reduction is an effective non-structural way of controlling the amounts of pollutants entering storm water runoff. A wide range of pollutants are washed off of impervious surfaces during runoff events. Removing these contaminants from the urban landscape prior to precipitation can effectively limit the amounts of pollutants contained in the storm water runoff. Source reduction can be accomplished by a number of different processes including: limiting applications of fertilizers, pesticides and herbicides; periodic street sweeping to remove trash, litter and particulates from streets; collection and disposal of lawn debris; periodic cleaning of catch basins; elimination of improper dumping of used oil, antifreeze, household cleaners, paint, etc. into storm drains; and identification and elimination of illicit cross-connections between sanitary sewers and storm sewers.

5.2 Types of Storm Water Best Management Practices

There are a variety of storm water BMPs available for managing urban runoff. Regardless of the type, storm water BMPs are most effective when implemented as part of a comprehensive storm water management program that includes proper selection, design, construction, inspection and maintenance. Storm water BMPs can be grouped into two broad categories: structural and non-structural. *Structural* BMPs are used to treat the storm water at either the point of generation or the point of discharge to either the storm sewer system or to receiving waters. *Non-structural* BMPs include a range of pollution prevention, education, institutional, management and development practices designed to limit the conversion of rainfall to runoff and to prevent pollutants from entering runoff at the source of runoff generation. The descriptions in this section provide summary information on a variety of commonly used structural and nonstructural storm water BMPs. Information provided includes a general description of the technology or practice, important components and factors to incorporate into BMP design and planning, and the positive and negative aspects of the technology or practice. In addition, maintenance considerations for structural BMPs are discussed. Quantitative performance data for BMPs are not included in this section. These data are included in section 5.5, "Effectiveness of BMPs in Managing Urban Runoff."

5.2.1 Structural BMPs

There are a wide variety of structural BMPs in use for storm water management. Structural BMPs include engineered and constructed systems that are designed to provide for water quantity and/or water quality control of storm water runoff. Structural BMPs can be grouped into several general categories. However, the distinction between BMP types and the terminology used to group structural BMPs is an area that needs standardization. In particular, the terms "retention" and "detention" are sometimes used interchangeably, although they do have distinct meanings. Storm water detention is usually defined as providing temporary storage of a runoff volume for subsequent release (WEF/ASCE, 1992). Examples include detention basins, underground vaults, tanks or pipes, and deep tunnels, as well as temporary detention in parking lots, roof tops, depressed grassy areas, etc. Retention is generally defined as providing storage of storm water runoff without subsequent surface discharge (WEF/ASCE, 1992). With the strict interpretation of this definition, retention practices would be limited to those practices that either infiltrate or evaporate runoff, such as infiltration trenches, wells or basins. However, retention is also commonly used to describe practices that retain a runoff volume (and hence have a permanent pool) until it is displaced in part or in total by the runoff event from the next storm. Examples include retention ponds, tanks, tunnels, and underground vaults or pipes, and wetland basins. For purposes of this document, and in being consistent with the definitions and terminology used in the ASCE National Stormwater BMP Database, structural BMPs have been grouped and defined as follows:

- Infiltration systems capture a volume of runoff and infiltrates it into the ground.

- Detention systems capture a volume of runoff and temporarily retain that volume for subsequent release. Detention systems to not retain a significant permanent pool of water between runoff events.

- Retention systems capture a volume of runoff and retain that volume until it is displaced in part or in total by the next runoff event. Retention systems therefore maintain a significant permanent pool volume of water between runoff events.

- Constructed wetland systems are similar to retention and detention systems, except that a major portion of the BMP water surface area (in pond systems) or bottom (in meadow-type systems) contains wetland vegetation. This group also includes wetland channels.

- Filtration systems use some combination of a granular filtration media such as sand, soil, organic material, carbon or a membrane to remove constituents found in runoff.

- Vegetated systems (biofilters) such as swales and filter strips are designed to convey and treat either shallow flow (swales) or sheetflow (filter strips) runoff

- Minimizing directly connected impervious surfaces describes a variety of practices that can be used to reduce the amount of surface area directly connected to the storm drainage system by minimizing or eliminating traditional curb and gutter. This is considered by some to be a non-structural practice, but is has been included under the structural heading in this report due to the need to design and construct alternative conveyance and treatment options.

- Miscellaneous and vendor-supplied systems include a variety of proprietary and miscellaneous systems that do not fit under any of the above categories. These include catch basin inserts, hydrodynamic devices, and filtration devices.

5.2.1.1 Infiltration Systems

Infiltration systems include infiltration basins, porous pavement systems, and infiltration trenches or wells. An infiltration BMP is designed to capture a volume of storm water runoff, retain it and infiltrate that volume into the ground. Infiltration of storm water has a number of advantages and disadvantages. The advantages of infiltration include both water quantity control and water quality control. Water quantity control can occur by taking surface runoff and infiltrating this water into the underlying soil. This reduces the volume of water that is discharged to receiving streams, thereby reducing some of the potential impacts caused by an excess flow as well as increased pollutant concentrations in the receiving stream. Infiltration systems can be designed to capture a volume of storm water and infiltrate this water into the ground over a period of several hours or even days, thereby maximizing the infiltrative capacity of the BMP. Infiltration can have many secondary benefits such as increasing recharge of underlying aquifers

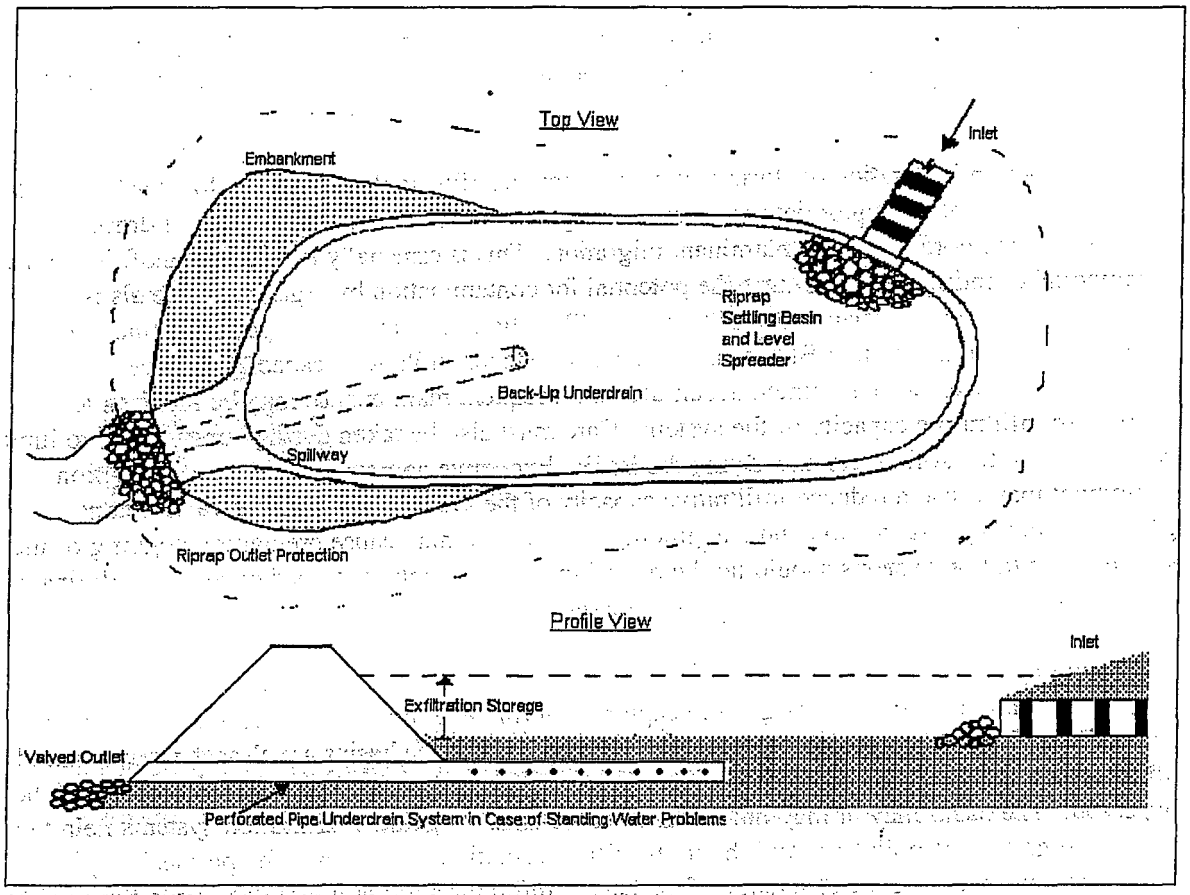
and increasing baseflow levels of nearby streams. Infiltration BMPs can also provide water quality treatment. Pollutant removal can occur as water percolates through the various soil layers. As the water moves through the soil, particles can be filtered out. In addition, microorganisms in the soil can degrade organic pollutants that are contained in the infiltrated storm water.

Although infiltration of storm water has many benefits, it also has some drawbacks. First, infiltration may not be appropriate in areas where groundwater is a primary source of drinking water due to the potential for contaminant migration. This is especially true if the runoff is from a commercial or industrial area where the potential for contamination by organics or metals is present. Also, the performance of infiltration BMPs is limited in areas with poorly permeable soils. In addition, infiltration BMPs can experience reduced infiltrative capacity and even clogging due to excessive sediment accumulation. Frequent maintenance may be required to restore the infiltrative capacity of the system. Care must also be taken during construction to limit compaction of the soil layers underlying the BMP. Excessive compaction due to construction equipment may cause a reduced infiltrative capacity of the system. Plus, excessive sediment generation during construction and site grading/stabilization may cause premature clogging of the system. Infiltration systems should not be placed into service until disturbed areas in the drainage have been stabilized by dense vegetation or grasses.

Infiltration Basins

Infiltration basins are designed to capture a storm water runoff volume, hold this volume and infiltrate it into the ground over a period of days. Infiltration basins are almost always placed off-line, and are designed to only intercept a certain volume of runoff. Any excess volume will be bypassed. The basin may or may not be lined with plants. Vegetated infiltration systems help to prevent migration of pollutants and the roots of the vegetation can increase the permeability of the soils, thereby increasing the efficiency of the basin. Infiltration basins are typically not designed to retain a permanent pool volume. Their main purpose is to simply transform a surface water flow into a ground water flow and to remove pollutants through mechanisms such as filtration, adsorption and biological conversion as the water percolates through the underlying soil. Infiltration basins should be designed to drain within 72 hours in order to prevent mosquito breeding and potential odor problems due to standing water and to ensure that the basin is ready to receive runoff from the next storm (US EPA, 1993a). In addition to removing pollutants, infiltration basins are useful to help restore or maintain pre-development hydrology in a watershed. Infiltration can increase the water table, increase baseflow and reduce the frequency of bankfull flooding events. A diagram of a typical infiltration basin is shown below.

Figure 5-1. Infiltration Basin



Source: Adapted from Schueler et al, 1992

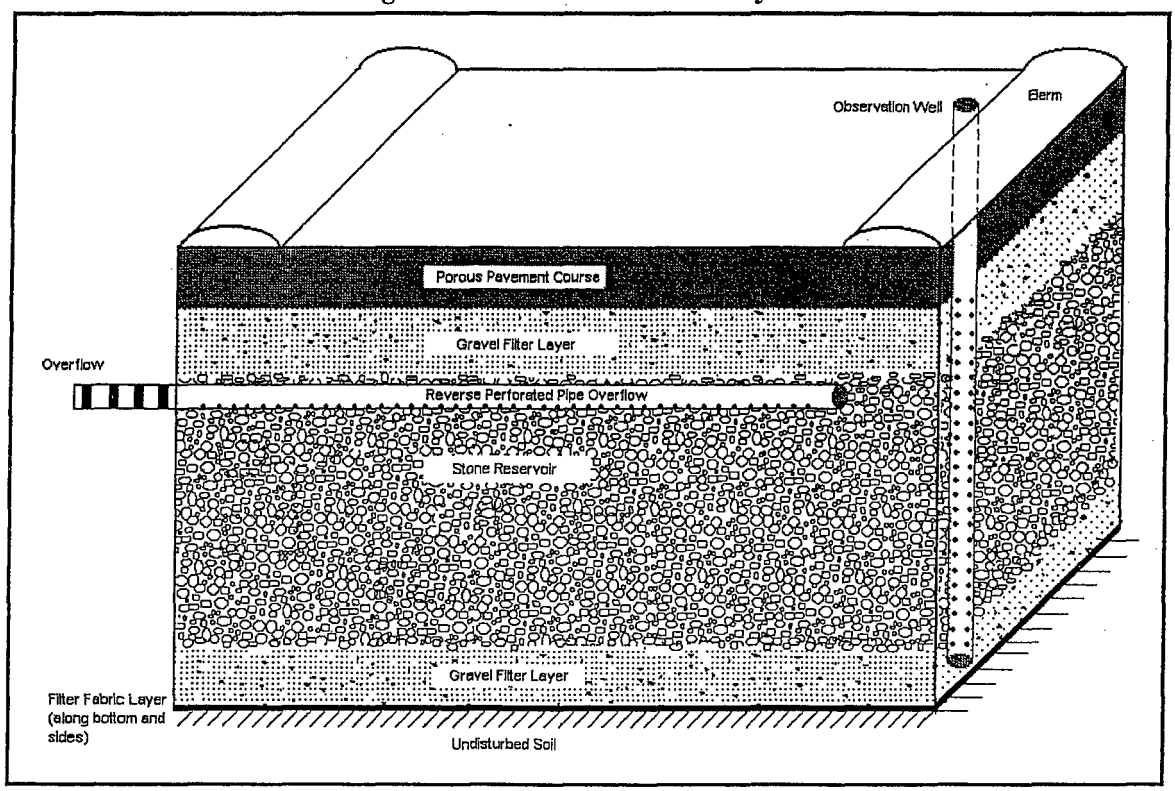
Porous Pavement Systems

Porous pavement is an infiltration system where storm water runoff is infiltrated into the ground through a permeable layer of pavement or other stabilized permeable surface. These systems can include porous asphalt, porous concrete, modular perforated concrete block, cobble pavers with porous joints or gaps or reinforced/stabilized turf (Urbonas and Strecker, 1996). Permeable pavement can be used in parking lots, roads and other paved areas and can greatly reduce the amount of runoff and associated pollutants leaving the area. Porous pavement systems are suitable for a limited number of applications. Typically, porous pavement can only be used in areas that are not exposed to high volumes of traffic or heavy equipment. They are particularly useful for driveways and streets and in residential areas, and in parking areas in commercial areas. Porous pavement is not effective in areas that receive runoff with high amounts of sediment due to the tendency of the pores to clog. Porous pavements require maintenance including periodic vacuuming or jet-washing to remove sediment from the pores. Paved areas should be clearly marked to indicate that a porous pavement system is in use and to prevent frequent use by

equipment, to prevent excess traffic volume, to limit the use of de-icing chemicals and sand, and to prevent resurfacing with non-porous pavement.

The performance of porous asphalt has been historically very poor in the mid-Atlantic region. However, many of these failures can be attributed to lack of proper erosion and sediment controls during construction or lack of contractor experience with installation of porous pavement systems. Porous concrete systems in use in Florida have performed very well (Florida Concrete and Products Assn., 1993). When properly designed and maintained, porous pavement systems can be an effective means of managing urban storm water runoff. Porous pavement systems are particularly useful for overflow parking areas that are not used on a daily basis. A diagram of a porous asphalt pavement system is shown below.

Figure 5-2. Porous Pavement System



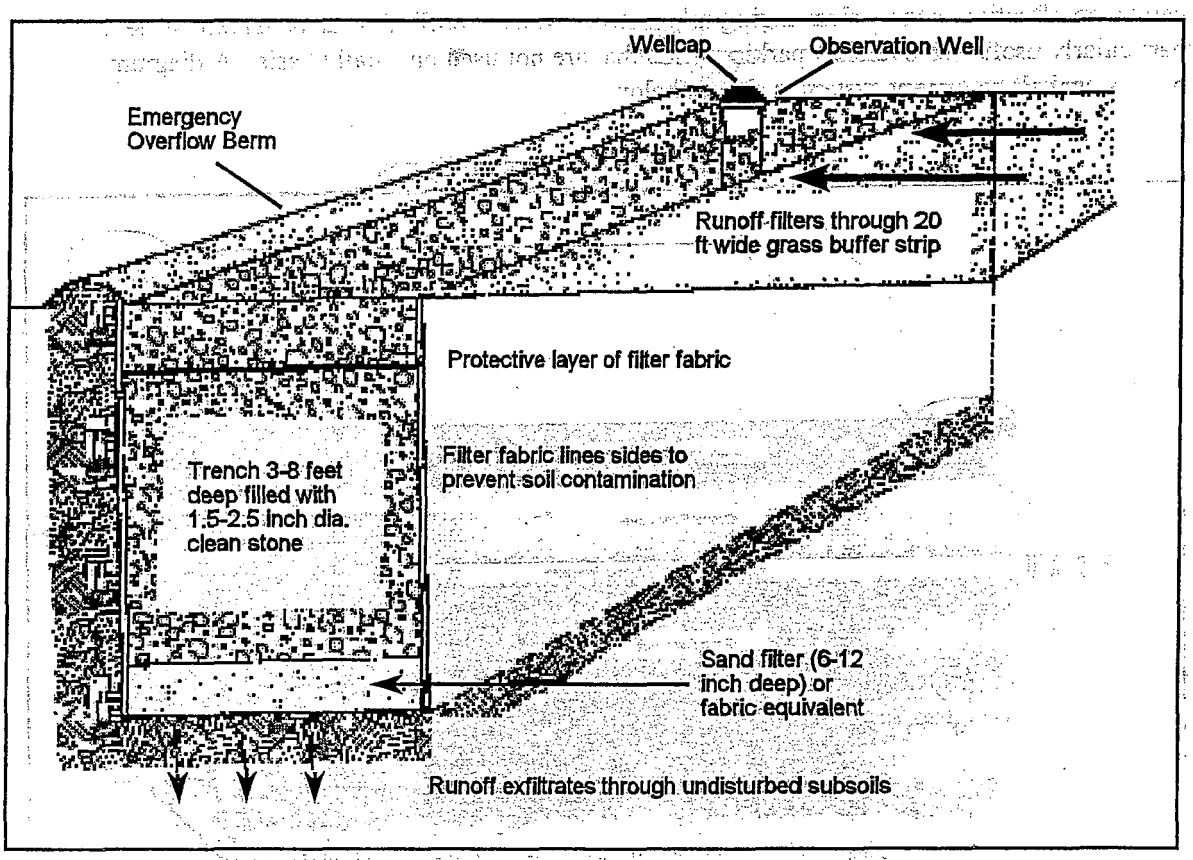
Source: Adapted from Schueler, 1987.

Infiltration Trenches and Wells

An infiltration trench or well is a gravel-filled trench or well designed to infiltrate storm water into the ground. A volume of storm water runoff is diverted into the trench or well where it infiltrates into the surrounding soil. Typically infiltration trenches and wells can only capture a small amount of runoff and therefore may be designed to capture the first flush of a runoff event. For this reason, they are frequently used in combination with another BMP such as a detention

basin to control peak hydraulic flows. Infiltration trenches and wells can be used to remove suspended solids, particulates, bacteria, organics and soluble metals and nutrients through the mechanisms of filtration, absorption and microbial decomposition. They are also useful to provide groundwater recharge and to increase base flow levels in nearby streams. As with all infiltration practices, the possibility for groundwater contamination exists and must be considered where groundwater is a source of drinking water. A diagram of an infiltration trench is shown below.

Figure 5-3. Infiltration Trench



Source: Schueler et al, 1992.

5.2.1.2 Detention Systems

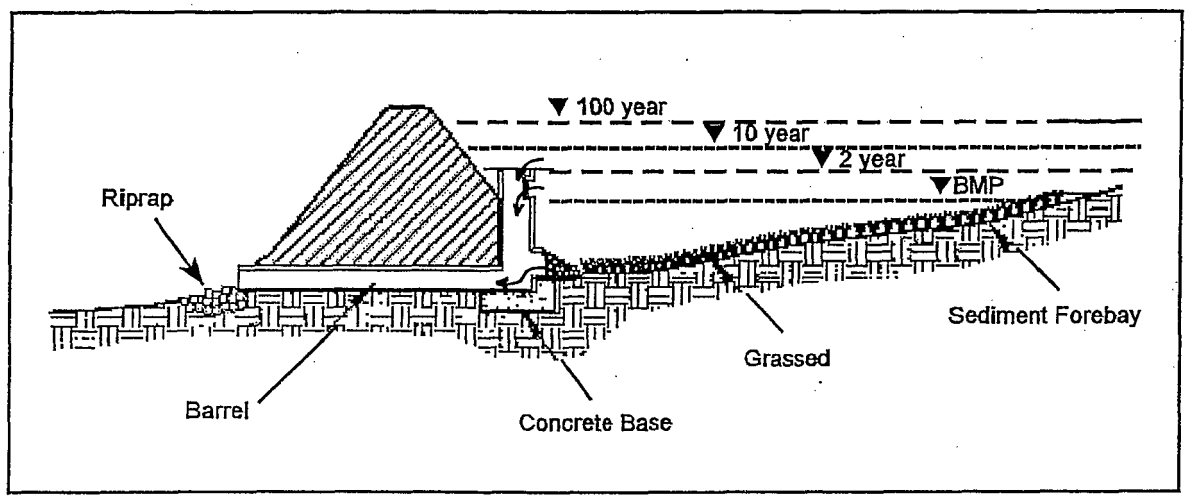
Detention systems are BMPs that are designed to intercept a volume of storm water runoff and temporarily impound the water for gradual release to the receiving stream or storm sewer system. Detention systems are designed to completely empty out between runoff events, and therefore provide mainly water quantity control as opposed to water quality control. Detention basins can provide limited settling of particulate matter, but a large portion of this material can be

re-suspended by subsequent runoff events. Detention facilities should be considered mainly as practices used to reduce the peak discharge of storm water to receiving streams to limit downstream flooding and to provide some degree of channel protection. There are several types of detention facilities used to manage storm water runoff, including detention basins and underground vaults, pipes and tanks.

Detention Basins

Detention basins are designed to intercept a volume of storm water, temporarily impound the water and release it shortly after the storm event. The main purpose of a detention basin is quantity control by reducing the peak flow rate of storm water discharges. They are designed to not retain a permanent pool volume between runoff events. and most basins are designed to empty in a time period of less than 24 hours. The treatment efficiency of detention basins is usually limited to removal of suspended solids and associated contaminants due to gravity settling. The efficiency can be increased by incorporating a forebay or pre-settling chamber for the accumulation of coarse sediment, facilitating periodic cleaning in order to prevent washout by subsequent runoff events. Detention basins can limit downstream scour and loss of aquatic habitat by reducing the peak flow rate and energy of storm water discharges to the receiving stream, but their removal of pollutant of potential water quality concern can be limited. A diagram of a typical detention basin is shown below.

Figure 5-4. Detention Basin



Source: NVPDC, 1992.

Underground Vaults, Pipes and Tanks

Underground detention facilities, such as vaults, pipes and tanks, are designed to provide temporary storage of storm water runoff. Significant water quality improvements should not be expected in underground detention facilities. They should mainly be used for providing storage to limit downstream effects due to high peak flow rates. Like detention basins, underground

detention systems are designed to empty out between runoff events so that storage capacity is available for subsequent runoff events. In addition, studies are being conducted to evaluate the usefulness of in-system detention (storing runoff temporarily in the storm drainage system through the use of valves, gates, orifices, etc.), although these evaluations are in the preliminary stages and are only useful in certain cases (Lake Barcroft Watershed Improvement District, 1998). This is a potential alternative for retrofitting existing storm drains in the upper portions of the drainage system to delay the peak discharge rate and provide a limited amount of additional temporary storage volume. However, a careful analysis of the storm drainage system is necessary in order to prevent flooding in the upper reaches of the drainage area.

5.2.1.3 Retention Systems

Retention systems include wet ponds and other retention systems such as underground pipes or tanks. Retention systems are designed to capture a volume of runoff and retain that volume until it is displaced in part or in total by the next runoff event. Retention systems can provide both water quantity and quality control. The volume available for storage, termed the water quality volume, is provided above the permanent pool level of the system. The main pollutant removal mechanisms in retention systems is sedimentation. By retaining a permanent pool of water, retention systems can benefit from the added biological and biochemical pollutant removal mechanisms provided by aquatic plants and microorganisms, mimicking a natural pond or lake ecosystem. Also, sediments that accumulate in the pond are less likely to be re-suspended and washed out due to the presence of a permanent pool of water. In addition to sedimentation, other pollutant removal mechanisms in retention systems include filtration of suspended solids by vegetation, infiltration, biological uptake of nutrients by aquatic plants and algae, volatilization of organic compounds, uptake of metals by plant tissue, and biological conversion of organic compounds.

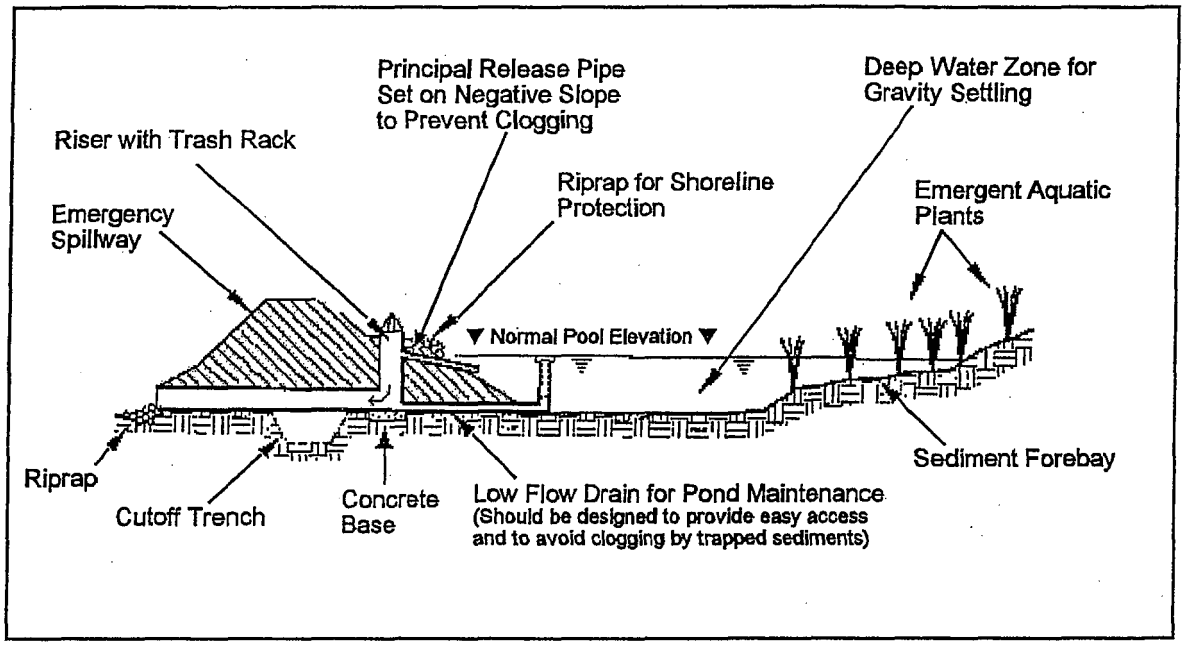
Retention Ponds

Retention ponds (also known as wet ponds) are designed to intercept a volume of storm water runoff and to provide storage and treatment of this runoff volume. Water in the pond above the permanent pool level is displaced in part or completely by the runoff volume from subsequent runoff events. Retention ponds, when properly designed and maintained, can be extremely effective BMPs, providing both water quality improvements and quantity control, as well as providing aesthetic value and aquatic and terrestrial habitat for a variety of plants and animals.

Pollutant removal in retention ponds can occur through a number of mechanisms. The main mechanism is the removal of suspended solids and associated pollutants through gravity settling. Aquatic plants and microorganisms can also provide uptake of nutrients and degradation of organic contaminants. Retention basins that incorporate an aquatic bench around the perimeter of the basin that is lined with aquatic vegetation can have an added pollutant removal efficiency. This littoral zone can aid in pollutant removal efficiency by incorporating mechanisms found in wetland systems. These mechanisms include removal of sediment by filtration by aquatic plants,

removal of metals and nutrients through biological uptake by aquatic vegetation and degradation of organic contaminants. If the bottom of the pond is not lined, then infiltration can occur aiding in the maintenance of local groundwater supplies. A diagram of a typical wet pond is shown below.

Figure 5-5. Retention Pond



Source: NVPDC, 1992.

Retention Tanks, Tunnels, Vaults and Pipes

Retention systems other than ponds include surface tanks and underground vaults, pipes and tunnels. These systems are not as prevalent as typical wet ponds, and therefore little information is contained in the literature about their design, applicability and usefulness.

5.2.1.4 Constructed Wetland Systems

Constructed wetland systems incorporate the natural functions of wetlands to aid in pollutant removal from storm water. Constructed wetlands can also provide for quantity control of storm water by providing a significant volume of ponded water above the permanent pool elevation. Constructed wetland systems have limits to their application. A water balance must be performed to determine the availability of water to sustain the aquatic vegetation between runoff events and during dry periods. In addition, a sediment forebay or some other pretreatment provision should be incorporated into the wetland system design to allow for the removal of coarse sediments that can degrade the performance of the system. Also, construction sediment should be prevented from entering constructed wetlands, as the resulting sediment loading can

severely degrade the performance of the system. Constructed wetlands are particularly appropriate where groundwater levels are close to the surface because groundwater can supply the water necessary to sustain the wetland system.

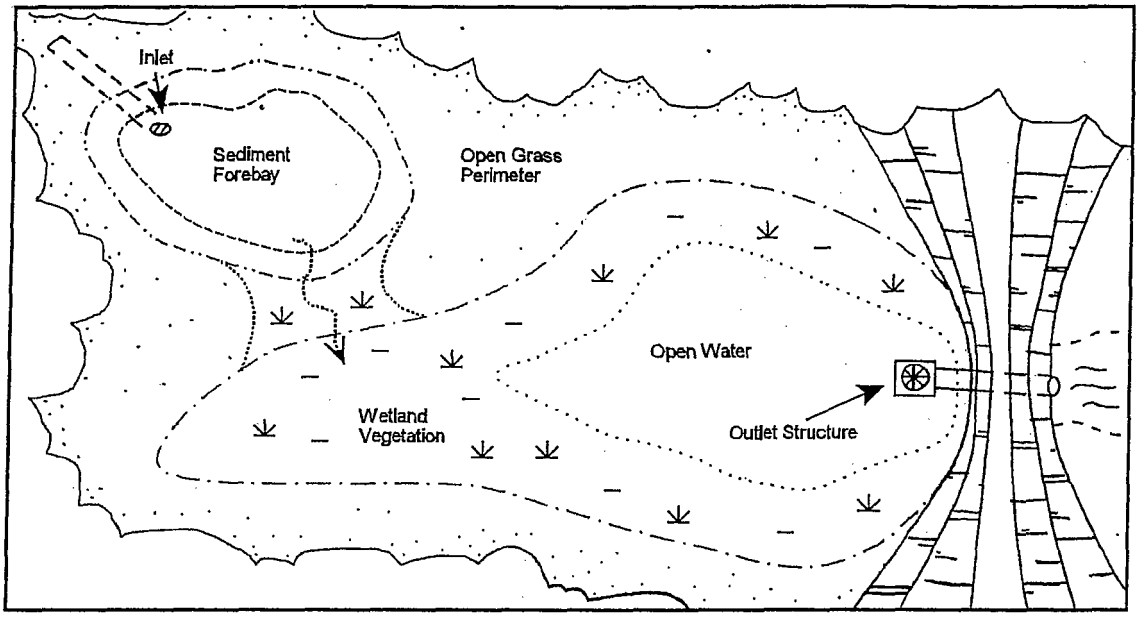
Storm water runoff should not be intentionally routed to natural wetlands without pretreatment due to the potentially damaging effects runoff can have on natural wetland systems. In addition, natural wetlands that receive storm water runoff should be evaluated to determine if the runoff is causing degradation of the wetland, and if so measures should be taken to protect the wetland from further degradation and to repair any damage that has been done. In addition, local permitting authorities should be consulted prior to designing and maintaining constructed wetland systems in order to determine if any local regulations apply to their use or maintenance.

Wetland Basins and Wetland Channels

Wetland basins and channels are any of a number of systems that incorporate mechanisms of natural wetland systems for water quality improvement and quantity control. A wetland channel is designed to develop dense wetland vegetation and to convey runoff very slowly (Urbonas and Strecker, 1996). Generally, this rate is less that 2 feet-per-second at the 2-year peak flow. Wetland basins may be designed with or without an open water (permanent pool) component. Wetland basins with open water are similar to retention ponds, except that a significant portion (usually 50 percent or more) of the permanent pool volume is covered by emergent wetland vegetation. Wetland basins without open water are inundated with water during runoff events, but do not maintain a significant permanent pool. Wetland basins of this type, also known as a wetland meadow, support a variety of wetland plants adapted to saturated soil conditions and tolerant of periodic inundation by runoff.

Pollutant removal in wetlands can occur through a number of mechanisms including sedimentation, filtration, volatilization, adsorption, absorption, microbial decomposition and plant uptake. In addition, wetlands can provide for significant water storage during runoff events, thus supplying water quantity control as well. A diagram of a typical storm water wetland system is included below.

Figure 5-6. Constructed Wetland System



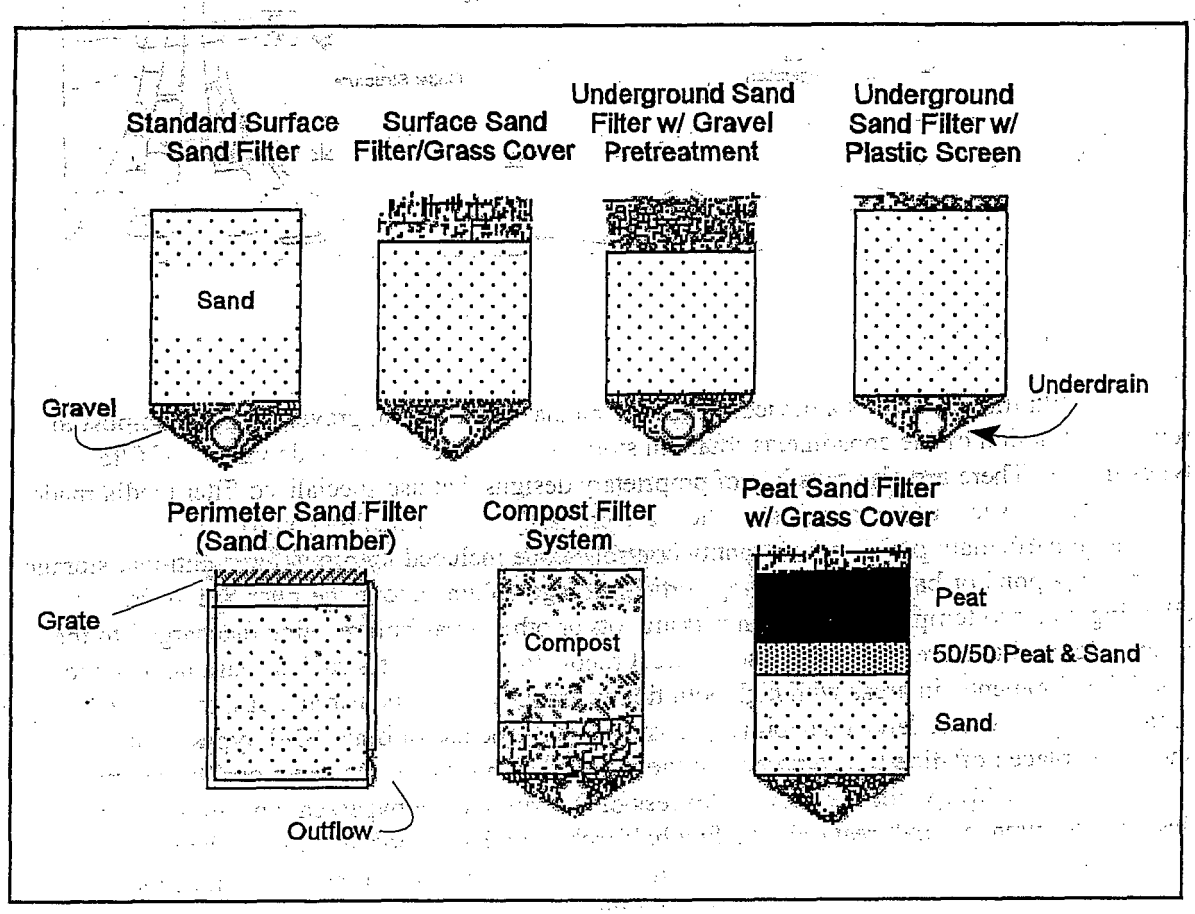
5.2.1.5 Filtration Systems

A filtration system is a device that uses a media such as sand, gravel, peat or compost to remove a fraction of the constituents found in storm water. There are a wide variety of filter types in use. There are also a variety of proprietary designs that use specialized filter media made from materials such as leaf compost. Filters are primarily a water quality control device designed to remove particulate pollutants. Quantity control can be included by providing additional storage volume in a pond or basin, by providing vertical storage volume above the filter bed, or by allowing water to temporarily pond in parking lots or other areas before being discharged to the filter. Media filters are commonly used to treat runoff from small sites such as parking lots and small developments, in areas with high pollution potential such as industrial areas, or in highly urbanized areas where land availability or costs preclude the use of other BMP types. Filters should be placed off-line (i.e., a portion of the runoff volume, called the water quality volume, is diverted to the BMP, while any flows in excess of this volume are bypassed) and are sometimes designed to intercept and treat only the first half inch or inch of runoff and bypass larger storm water flows. A benefit of using filters in highly urbanized areas is that the filter can be placed under parking lots or in building basements, limiting or eliminating costly land requirements. However, placing filters "out of sight" may have implications for continued maintenance and performance. Media filters should use a forebay or pre-settling chamber to remove a portion of the settleable solids prior to filtration. This helps to extend the life of the filter run and prevent clogging of the filter media by removing a portion of the coarse sediment. Also, care must be

taken to prevent construction site sediments and debris such as fines washed off of newly paved areas from entering the filter, as these can cause premature clogging of the filter.

Filter types in common use include surface sand filters such as the "Austin" sand filter and underground vault filters such as the "D.C." sand filter and the "Delaware" sand filter. There are a number of variations of these basic designs in common use. In addition, there are a number of proprietary filtering systems in use. There are also a number of variations in the types of filtration media that are in use in media filters. Designs may incorporate features such as a layer of filter cloth or a plastic screen, a gravel layer, a peat layer, a compost layer, a layer of peat or a peat/sand mixture. Typical variations in filtration media are shown below.

Figure 5-7. Filter Media



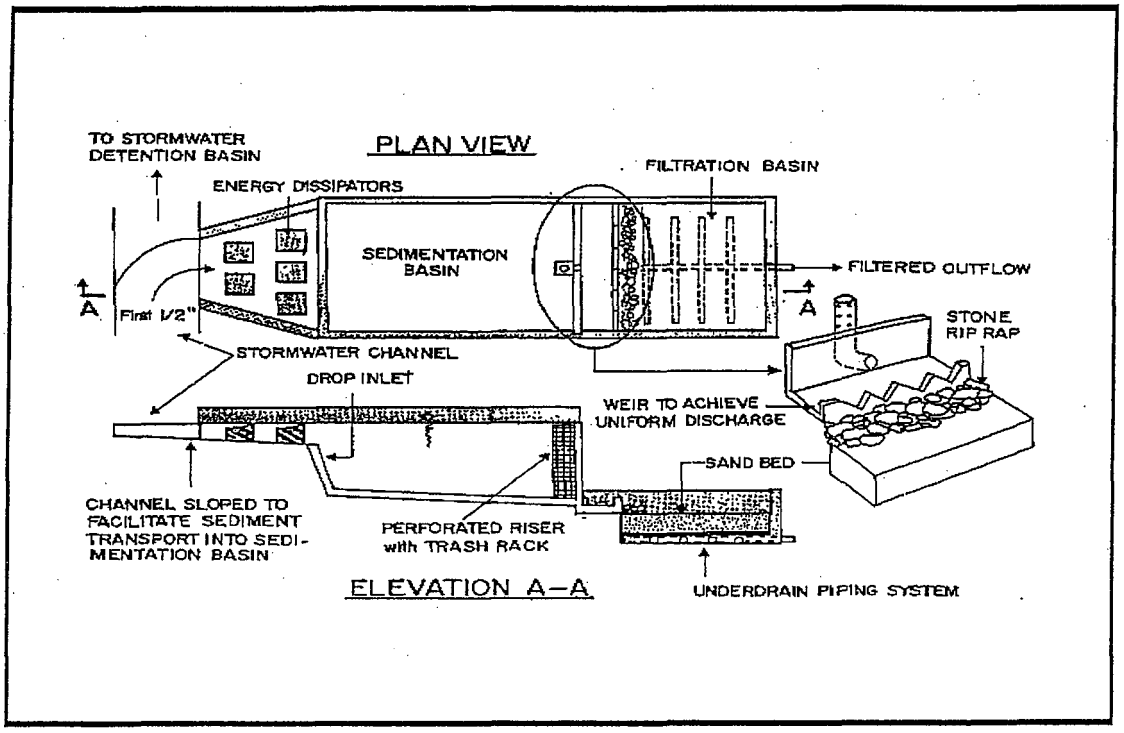
Source: Claytor and Schueler, 1996

Surface Sand Filter

The surface sand filter was developed in Florida in 1981 for sites that could not infiltrate runoff or were too small for effective use of detention systems. The city of Austin, Texas took the development of filter technology further in the mid-1980's. The surface sand filter system

usually incorporates two basins. Runoff first enters a sedimentation basin where coarse particles are removed by gravity settling. This sedimentation basin can be either wet or dry. Water then flows over a weir or through a riser into the filter basin. The filter bed consists of sand with a gravel and perforated pipe under-drain system to capture the treated water. The surface of the filter bed may be planted with grass. Additional storage volume is provided above the filter bed to increase the volume of water that can be temporarily ponded in the system prior to filtration. This two-basin configuration can help to limit premature clogging of the filter bed due to excessive sediment loading. There are several design variations of the simple surface sand filter. Austin uses two variations, termed the partial and the full sedimentation-filtration systems. A diagram of the Austin surface sand filter is shown in Figure 5-8.

Figure 5-8. Austin Full Sedimentation-Filtration System



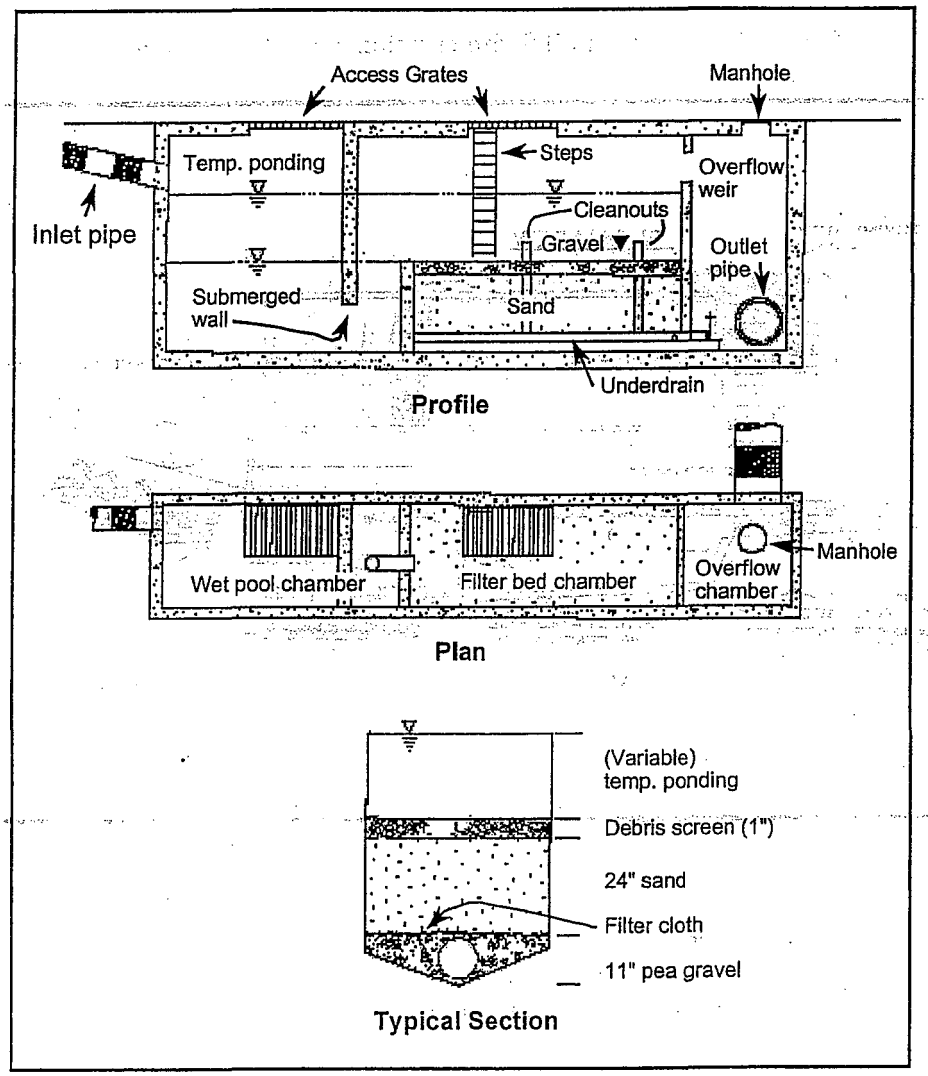
Source: Bell, 1998

Underground Vault Sand Filter

The underground vault sand filter was developed by the District of Columbia in the late 1980's. This filter design incorporates three chambers. The first chamber and the throat of the second chamber contain a permanent pool of water and functions as a sedimentation chamber and an oil and grease and floatables trap, as well as provides for temporary runoff storage. A submerged opening or inverted elbow near the bottom of the dividing wall connects the two chambers. This submerged opening provides a water seal that prevents the transfer of oil and

floatables to the second chamber which contains the filter bed. During a storm event, water flows through the opening into the second chamber and onto the filter bed. Additional runoff storage volume is provided above the filter bed. Filtered water is collected by a gravel and perforated pipe under-drain system and flows into the third chamber, which contains a clearwell and a connection to the storm drain system. Overflow protection can be provided by placing the filter off-line, or by providing a weir at the top of the wall connecting the filter chamber with the clearwell chamber to serve as an overflow. A schematic of the "D.C. Sand Filter" is shown below.

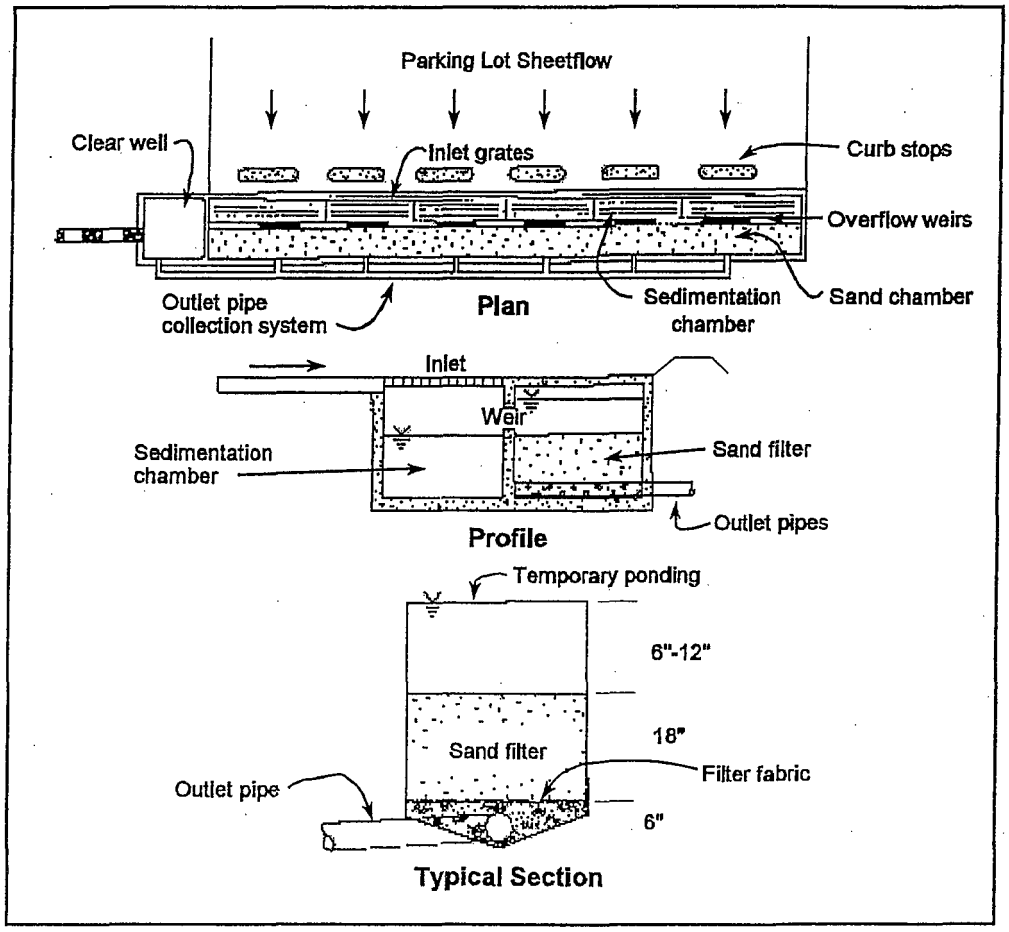
Figure 5-9. Underground Vault Sand Filter



Source: Claytor and Schueler, 1996.

Another underground vault sand filter, also termed a "perimeter" sand filter because it is particularly suited for use around the perimeter of parking lots, was developed in Delaware by Shaver and Baldwin and is known as the "Delaware Sand Filter." This system contains two chambers and a clearwell. Storm water runoff enters the first chamber, which serves as a sedimentation chamber. Water then flows over a series of weirs and into the second chamber which contains the filter media. Additional storage volume is provided by water temporarily ponding in both chambers. Filtered water is collected by a series of gravel and perforated pipe under-drains, and flows into a clearwell that contains a connection to the storm drain system. A schematic of the Delaware Sand Filter is shown below.

Figure 5-10. Delaware Sand Filter

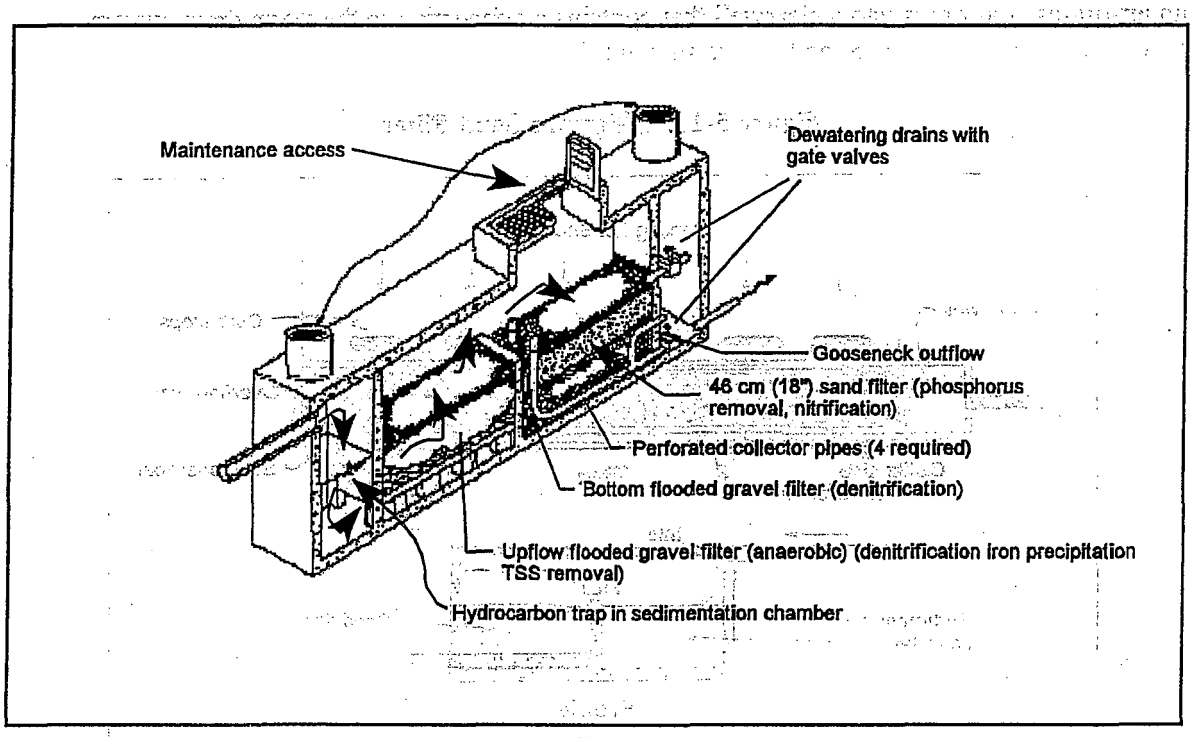


Source: Shaver and Baldwin, 1991

In addition to the three basic filtering systems (D.C., Austin, and Delaware), there are a number of variations in use. The city of Alexandria, Virginia has developed a compound storm water filtering system (Bell, 1998). This design incorporates an anoxic filtration zone in a

permanently flooded gravel layer in the filter. This anoxic zone aids in nitrogen removal by anoxic denitrification. Another configuration uses an upflow anaerobic filter upstream of the sand filter to enhance phosphorus removal by precipitating more iron on the sand filter. A diagram of the Alexandria Compound Filtration System is shown below.

Figure 5-11. Alexandria Compound Filter



Source: Bell, 1998.

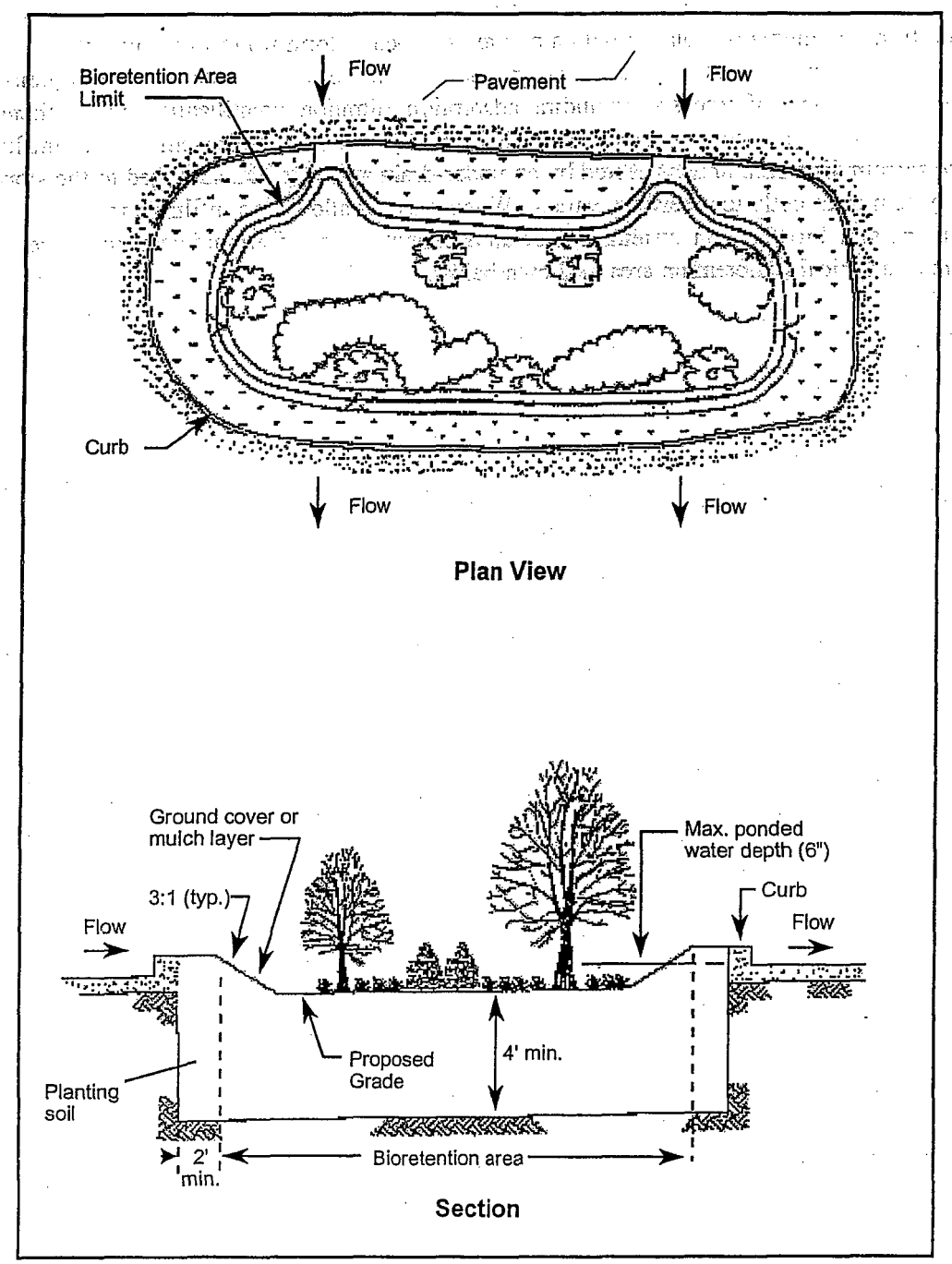
Filters that use an organic filtration media, such as peat or leaf compost, are useful in areas where additional nutrient or metal control is desirable due to the adsorptive capacity, its ion-exchange capability, and is ability to serve as a medium for the growth of a variety of microorganisms. However, peat must be carefully selected (fibric and/or hemic peat should be used, not sapric) and one must question the environmental consequences of destroying peat bogs to obtain filtration media when other technologies are available.

There are a number of references available that contain information on the design and selection of filtering systems for storm water treatment (Urbonas, 1999; Bell, 1998; Claytor and Schueler, 1996; Galli, 1990b; MDE, 1998; NVPDC, 1996a).

Biofiltration/Bioretention Systems

Bioretention systems are designed to mimic the functions of a natural forest ecosystem for treating storm water runoff. Bioretention systems are a variation of a surface sand filter, where the sand filtration media is replaced with a planted soil bed. Storm water flows into the bioretention area, ponds on the surface, and gradually infiltrates into the soil bed. Pollutants are removed by a number of processes including adsorption, filtration, volatilization, ion exchange and decomposition (Prince George's County, MD, 1993). Treated water is allowed to infiltrate into the surrounding soil, or is collected by an under-drain system and discharged to the storm sewer system or directly to receiving waters. When water is allowed to infiltrate into the surrounding soil, bioretention systems can be an excellent source of groundwater recharge. A diagram of a typical bioretention area is shown below.

Figure 5-12. Bioretention System
Traffic Island



Source: Prince George's County, 1993.

The components of a bioretention system include:

- *Grass Buffer Strips* - runoff enters the bioretention area as sheet flow through the grass buffer strips. The buffers reduce the velocity of the runoff and filter particulates from the runoff.

- *Ponding Area* - The ponding area provides for surface storage of storm water runoff before it filters through the soil bed. The ponding area also allows for evaporation of ponded water as well as allows for settling of sediment in the runoff.

- *Organic Mulch Layer* - The organic mulch layer has several functions. It protects the soil bed from erosion, retains moisture in the plant root zone, provides a medium for biological growth and decomposition of organic matter, and provides some filtration of pollutants.

- *Planting Soil Bed* - The planting soil bed provides water and nutrients to support plant life in the bioretention system. Storm water filters though the planting soil bed where pollutants are removed by the mechanisms of filtration, plant uptake, adsorption and biological degradation.

- *Sand Bed* - the sand bed underlies the planting soil bed and allows water to drain from the planting soil bed through the sand bed and into the surrounding soil. The sand bed also provides additional filtration and allows for aeration of the planting soil bed.

- *Plants* - Plants are an important component of a bioretention system. Plants remove water though evapotranspiration and remove pollutants and nutrient through uptake. The plant species selected are designed to replicate a forested ecosystem and to survive stresses such as frequent periods of inundation during runoff events and drying during inter-event periods.

In addition to providing for treatment of storm water, bioretention facilities, when properly maintained, can be aesthetically pleasing. Bioretention facilities can be placed in areas such as parking lot islands, in landscaped areas around buildings, the perimeter of parking lots, and in other open spaces. Since local regulations frequently require site plans to incorporate a certain percentage of open landscaped area, additional land requirements for bioretention facilities are often not required. The layout of bioretention facilities can be very flexible, and the selection of plant species can provide for a wide variety of landscape designs. However, it is important that a landscape architect with proper experience in designing bioretention areas be consulted prior to construction to insure that the plants selected can tolerate the growing conditions present in bioretention facilities. Bioretention facilities can be adapted easily for use on individual residential lots. Prince George's County, MD has developed the concept of "rain gardens" which are small bioretention systems for use in single or multi-lot residential areas. They provide an easily maintainable, aesthetically pleasing, and effective means of controlling runoff from residential

Vegetated Swales

Vegetated swales are broad, shallow channels with a dense stand of vegetation covering the side slopes and channel bottom. Vegetated swales are designed to slowly convey storm water runoff, and in the process trap pollutants, promote infiltration and reduce flow velocities. Vegetated swales can be either wet or dry. Dry swales are used in areas where standing water is not desired, such as in residential areas. Wet swales can be used where standing water does not create a nuisance problem and where the groundwater level is close enough to the surface to maintain the permanent pool in inter-event periods. Wet swales provide the added benefit of being able to include a range of wetland vegetation to aid in pollutant removal.

5.2.1.7 Minimizing Directly-Connected Impervious Surfaces

Minimizing directly-connected impervious surface areas involves a variety of practices designed to limit the amount of storm water runoff that is directly connected to the storm drainage system. Runoff is instead directed to landscaped areas, grass buffer strips, and grassed swales to reduce the velocity of runoff, reduce runoff volumes, attenuate peak flows, and encourage filtration and infiltration of runoff (UDFCD, 1992). By incorporating these principles into site designs, the size and number of conventional BMPs such as ponds and constructed wetland systems can be significantly reduced.

Minimizing directly connected impervious surfaces incorporates both non-structural and structural control measures. Discussions in this section address the structural measures that can be incorporated into existing urbanized or newly developed areas to minimize the amount of runoff discharged to the storm drain system. Additional discussion on non-structural practices that can be used to minimize runoff generation in new developments is included in Section 5.2.3 "Low Impact Development Practices."

The Denver *Urban Storm Drainage Criteria Manual* (UDFCD, 1992) identifies the following three levels of minimizing directly connected impervious areas:

- *Level 1*: Runoff generated from impervious surfaces such as rooftops, driveways and parking lots is directed to flow over vegetated areas before flowing to a storm sewer system. This increases the travel time of runoff and promotes the removal of suspended solids by sedimentation and filtration.
- *Level 2*: Street curb-and-gutter systems are replaced by grassed swales and pervious street shoulders. Conveyance systems and storm sewer inlets are still used to collect runoff at downstream intersections and crossings.
- *Level 3*: In addition to incorporating Levels 1 and 2, swales are oversized and driveway and street crossing culverts are configured to use the grassed swales as detention basins having the capacity to capture runoff volume for a design storm (2-, 5-, 10- or 100-year runoff).

Practices that reduce the amount of directly connected impervious surfaces can easily be incorporated into site design plans during the planning stages of development projects. Using these practices can result in significant development cost savings due to the decreased need for drainage infrastructure and large end-of-pipe structural BMPs such as ponds and constructed wetlands. These practices can also limit secondary impacts from structural BMPs, such as temperature increases from retention ponds. Minimizing directly connected impervious areas can also be applied to existing urbanized areas through retrofit. Practices that can be used in retrofit instances include disconnecting rooftop downspouts from the storm drain system, use of on-site retention and infiltration to limit the amount of runoff leaving the site and replacing traditional curb-and-gutter systems with grassed swales and wetland channels. Additional discussion on practices that minimize runoff generation is included in Section 5.2.3.

5.2.1.8 Miscellaneous and Vendor-Supplied Systems

There are a wide variety of miscellaneous and proprietary devices that are used for urban storm water management. Many of these systems are "drop-in" systems, and incorporate some combination of filtration media, hydrodynamic sediment removal, oil and grease removal, or screening to remove pollutants from storm water. A few of the systems available include:

- BaySaver
- CDS Technologies
- Hydrasep®
- Storm*ceptor*®
- StormFilter™
- StormTreat™ System
- Vortechs™.

A thorough evaluation of vendor-supplied systems was not conducted in this report. Readers are encouraged to contact the product vendors to obtain information regarding these systems.

One of the main problems facing the use of proprietary devices is the lack of peer-reviewed performance data for these systems. Several vendor-supplied storm water treatment systems are being evaluated through EPA's Environmental Technology Verification (ETV) program. With financial assistance from the ETV program, the Civil Engineering Research Foundation (CERF) established the Environmental Technology Evaluation Center, commonly known as "EvTEC, " in 1998. EvTEC is a private sector program designed to utilize networks of experts, testing facilities and stakeholders to evaluate technologies dealing with a variety of environmental problems. One of the EvTEC projects is a collaborative effort with the Washington Department of Transportation (WSDOT) to verify the performance of innovative storm water BMPs under field operating conditions. These evaluations, which are scheduled to begin in 1999, are expected to provide comparable, peer-reviewed data on the performance of these systems (CERF, 1998).