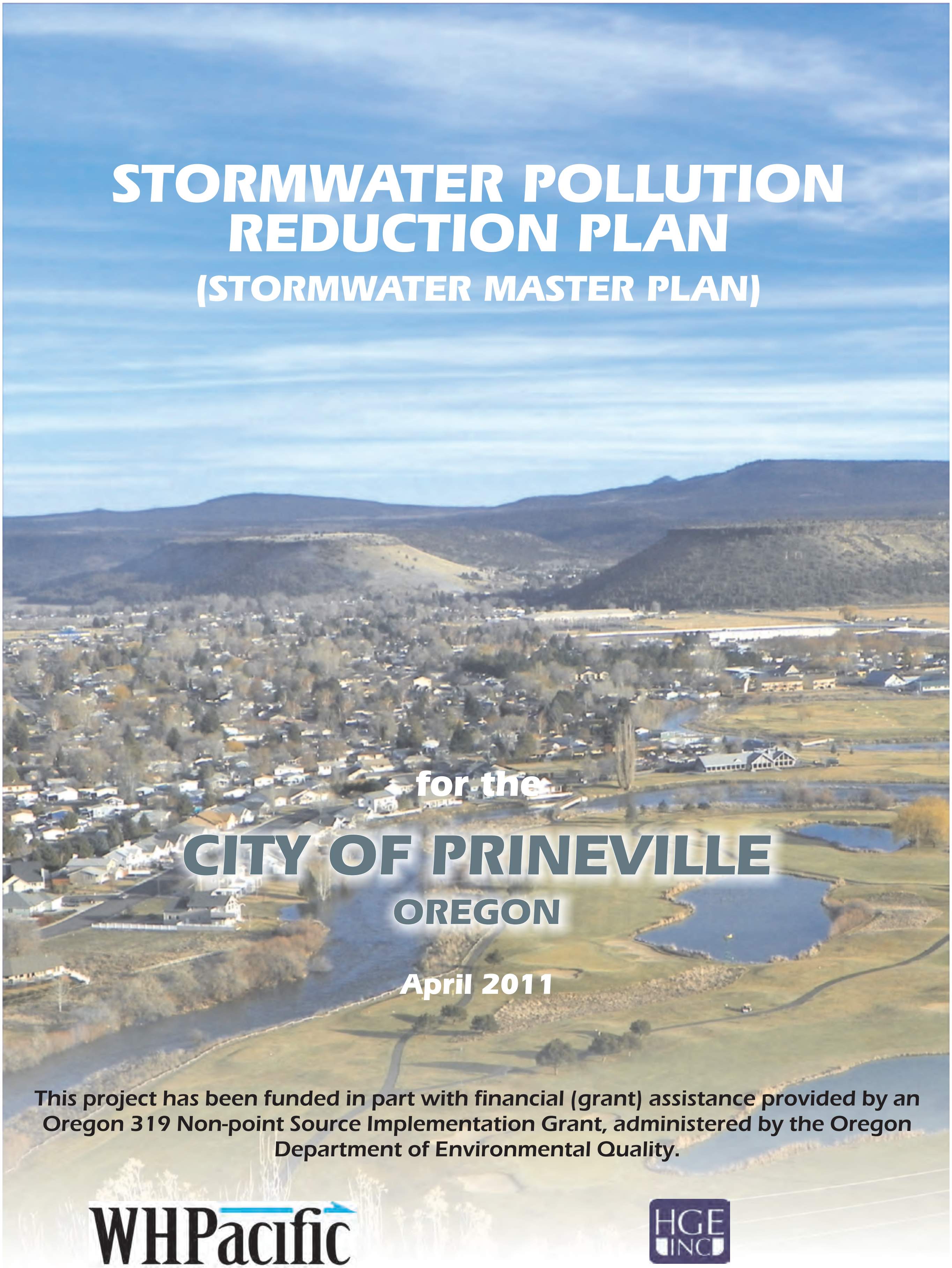

STORMWATER POLLUTION REDUCTION PLAN

(STORMWATER MASTER PLAN)

for the

CITY OF PRINEVILLE

OREGON

April 2011

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STORMWATER POLLUTION REDUCTION PLAN
(STORMWATER MASTER PLAN)

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City of Prineville, Oregon
Stormwater Pollution Reduction Plan

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SUMMARY

S.1 BACKGROUND

The City of Prineville is located in a high desert valley basin that includes the confluence of the Crooked River and Ochoco Creek. Other natural drainways and manmade irrigation canals are also prevalent in the area. The area is noted for having a very high water table that is influenced by local hydrology. Until recently area growth was extremely rapid, thereby exacerbating concerns that local, largely untreated stormwater discharges, could further degrade water quality in the Crooked River and Ochoco Creek.

Water quality data has been collected in the area, but local mapping and stormwater system documentation is lacking; consequently, no local comprehensive stormwater plan (master plan, pollution reduction plan, etc.) exists. Much of the existing infrastructure, to the extent present, was developed in the 1940s and 1950s.

Development within the Urban Growth Boundary (UGB) is extensive; and significant future growth, notwithstanding the current recession, is anticipated. Potential impacts on downstream infrastructure, properties, water quality, and groundwater levels have raised concerns and highlight the need for a comprehensive stormwater plan.

S.2 STUDY AREA

The study area includes the entire current UGB but focuses on core problem areas identified by City staff.

S.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.

During the project kickoff meeting, which was attended by DEQ, all parties agreed that the primary purpose of this Plan is to quantify the amount of stormwater, identify capacity issues in the system, and provide solutions for those capacity related issues. With this Plan in place, stormwater flows and volumes will be estimated, allowing for future study of water quality problems and solutions.

The Plan provides a general overview of the relevant physical environment (climate, geology, and soils), socio-economic environment (population, demographics, and regulatory considerations). The PSU population estimate for 2009 was 10,370 persons. Official 2010 Census data for Prineville is not currently available.

S.4 EXISTING DRAINAGE SYSTEM MAPPING

While constructed storm drainage infrastructure is 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 catch basin locations. Area drainage is currently accommodated by a combination of streams, ditches, culverts, catch basins, and pipes, UICs, and surface infiltration. Detention/sedimentation facilities are limited. Much of the hydraulic conveyance system is old and undersized (according to current design standards).

The base map was prepared using Crook County GIS as a primary source. GIS layers include: aerial photography, 5-foot and 25-foot elevation contours, property and right-of-way boundaries, soil surveys, zoning, City and UGB limits, street and street names, 100 and 500-year flood plains, water courses, and sewer manhole locations and elevations. Consistent with the proposed scope of work, emphasis and focus has been placed on the core urban area. Mapping was created, for various purposes, at scales of: 1"=400', 1"=500', 1"=600', and 1"=2,500'. Numerous modifications of the base mapping were necessary to accommodate the identified stormwater infrastructure, additional street and stream names, offsetting of text for clarity, and modifications of line weights. The base map was created using AutoCAD software. A LIDAR survey was provided by the City and incorporated as a GIS layer. This was used in conjunction with the GIS contours to construct a surface model to assist in evaluating the feasibility of potential hydraulic modifications to the stormwater system.

City of Prineville staff provided additional information on stormwater features to be added to the maps. Information was checked and extensively supplemented through field work conducted by City staff. Field work activities focused on the more densely developed areas of the City.

The overall mapping effort was iterative: base maps were provided to the City, Staff marked up the maps and returned them to the Consultant, the base map was updated with the information provided to the Consultant, and revised copies were sent back to the City for review and comment. Because of the extent of the area involved, the lack of existing documentation, the practical limits on Staff and Consultant availability for more extensive field work, 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.

S.5 BASIN DELINEATION

Where possible, roadways and mapped stormwater infrastructure were used to help determine basin extent, since this more truly represents the basin's tributary area of surface water flow. Overall, the study area is characterized by having a very large number of independent basins which are tributary to Ochoco Creek, the Crooked River, or the Ryegrass (irrigation) Canal. There are also isolated basins that drain via percolation from the surface or from constructed subsurface infrastructure. Overall, approximately 74 basins have been delineated. Additional subbasins have been created for detailed analysis of selected basins. 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 basin(s) in order to more accurately model flows in an area of interest.

S.6 PROBLEM AREAS

Problem areas and associated deficiencies were identified for the Consultant by City staff based on their experience and knowledge of the system. All of the identified problem areas were within the Prineville city limits. Most of these are very local in effect. Twelve (12) problem areas were identified.

S.7 HYDROLOGIC / HYDRAULIC ANALYSIS

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.

Hydrologic and hydraulic modeling was performed using HydroCAD Version 9.10 software. The Santa Barbara Urban Hydrograph (SBUH) method was used to determine runoff for this study.

A total of 17 basins were modeled for existing conditions and the 2-year 24-hour, 50-year 24-hour, and 100-year 24-hour storm events. The selected basins were divided into subbasins as needed to create a workable model; a total of 60 basins and subbasins were utilized in the modeling effort. The areas to be modeled reflected priorities identified by City staff in discussions with representatives of WH Pacific. Model output for existing conditions included 211 pages of printout, including a detailed routing map, that documents details of the model layout, parameters, and results. These have been presented to the City along with supplemental mapping to identify subbasin locations.

S.8 RECOMMENDATIONS

S.8.1 Potential Constructed Improvements

Representatives of WH Pacific met with City staff to discuss hydraulic modeling results and existing problem areas in order to develop improvement projects that addressed City needs and concerns. Nine projects were identified – one of which was developed into two project alternatives. The improvement recommendations were modeled and the proposed designs refined. Pipes were sized using two modeled events. The first event excluded stream tailwater effects in order to evaluate capacity during a summer thunderstorm; the second event utilized tailwater effects from a 50-year flood event. Copies of the modeling results have been provided to the City. Opinions of probable cost associated with the various projects are preliminary in nature and should be refined as part of the financing and pre-design process. The proposed improvements are primarily upgrades or replacements of existing drainage facilities; consequently, O & M costs associated with these improvements should not increase.

Most of the projects involve upgrades that significantly increase the hydraulic capacity. While this facilitates drainage and alleviates problems associated with backups and ponding, it does constitute an increased impact on the receiving water body in terms of peak flows. Some projects include consideration of a treatment/detention pond that would reduce peaking effects. Projects involving ODOT or other agencies may, as part of the environmental process, require mitigation for the impact.

Most of the projects also include manholes and allowances for miscellaneous construction. It is anticipated, that some of the budget associated with these items can be utilized in pre-design to modify selected manholes, or for additional facilities, to provide for sedimentation, grease and oil collection, or other water quality related improvements consistent with site specific physical constraints. Lastly, the identified pipeline projects can be constructed in phases, as long as construction commences at the most downstream location and proceeds upstream.

The potential improvement projects are recommendations only and reflect the City's and Engineer's perceived need at the time of plan preparation. As the City's understanding of local stormwater issues becomes more detailed and refined, other opportunities or improvement alternates may be developed. Implementation will ultimately require City discretion to balance stormwater management requirements with political and financial realities.

S.8.2 Capital Improvement Plan

Actual scheduling of improvements will be dependent on the City's perception of need relative to affordability. Projects should be pursued according to the following schedule:

Priority	Timeline
Urgent	As soon as possible
High	Within next 2 years
Medium	Within next 5 years
Low	Within next 10+ years

The timeline is not intended to be an inflexible schedule, but rather a guide based on current perception of problem areas and needs. Some low priority projects, because of perceived benefits relative to cost, may be constructed prior to higher priority projects. Also, street improvement projects should incorporate recommended storm drainage improvements regardless of priority classification because of the cost effectiveness of coordinated design and construction.

Proposed projects and associated priorities are summarized in Table S.1. See Section 7 for a detailed discussion of each of the recommended projects.

Table S.1: Stormwater Capital Improvement Summary

Project Number	Construction Total	Project Total	Priority
1A [1]	$1,192,000	$1,659,000	Low
1B [1]	$4,224,000	$5,712,000	Low
2	$458,000	$633,000	High
3	$1,163,000	$1,670,000	Medium
4	$112,000	$157,000	Urgent
5	$110,000	$154,000	Low
6	$56,000	$81,000	Low
7	$157,000	$221,000	High
8	$225,000	$300,000	Urgent
9	$297,000	$411,000	Medium
Total	**$3,770,000 - $6,802,000**	**$5,286,000 - $9,339,000**	---

Project Priority	Construction Totals	Project Totals
Urgent	$337,000	$457,000
High	$615,000	$854,000
Medium	$1,460,000	$2,081,000
Low	$1,358,000-$4,390,000	$1,894,000-$5,947,000

[1] *Note: Projects 1A and 1B are alternative approaches.*

S.8.3 Design and Development Standards

The City of Prineville is currently developing new standards and approaches for stormwater management. WH Pacific has been working with the City and has provided them with materials for consideration and comment. Emphasis has been placed on the development of a simplified methodology to determine stormwater rates and volumes associated with small site (less than one acre) development. The methodology utilizes the rational method and, as such, should result in conservative estimates.

The City also intends to require all new development and redevelopment to manage all stormwater, created by the development, onsite. Some developed lots in the urban core may not be practicably developed in accordance with this requirement. The City could develop, perhaps as a zoning overlay, an exemption area in which the requirement would not be applicable; or it could implement a mitigation program whereby the “exempt” properties could pay a (to be determined) fee that would either go directly to a mitigation project or to a City-established stormwater fund; the monies of which could be used, at the City's discretion, for stormwater related projects, programs, or maintenance. The latter approach would preserve the intent of having *all* development or redevelopment participate in managing stormwater.

The Central Oregon Stormwater Manual (COSM) is an excellent resource and should be adopted by the City. COSM takes into account that stormwater management facilities need to be designed for site specific requirements and subject to good engineering judgment. In Prineville, areas with high groundwater will limit the range of stormwater management alternatives, best management practices, and constructed facilities considered; however, these limitations will arise during the planning and review process. Adoption of the document does not preclude the City from modifying provisions of the manual or from developing additional or alternate criteria. Specifically, the City may decide to develop a stormwater ordinance, in which the COSM is adopted, that includes the more stringent requirements, other stormwater planning or design standards developed by the City, and a statement that reserves the right for the City, or the City's Engineer, to determine if any specified stormwater planning or design effort is adequate or sufficient, and if any additional work is needed to protect the City's interests.

S.8.4 Water Quality

The sample locations and potential analytes of concern for the water quality testing performed by various entities over the last 20 years within the Crooked River Watershed on the Crooked River and Ochoco Creek near Prineville was evaluated. As a result of this evaluation, we have concluded that the identified locations are useful for the intended watershed use, but are not directly useful for the specific urban stormwater testing requirements of this project. Numerous anomalies were identified within the data sets; however, the primary issue with the data is related to the intended use of the data. The data collected is to be used to assess the quality and health of the rivers and watershed, but the data needed going forward and for the purpose of the assessing the stormwater quality as it enters the river system is different and very specific.

The purpose of the City of Prineville's preliminary municipal stormwater sampling will be to initially identify parameters of concern currently present in the stormwater. This will give the City information to establish priorities for selecting, sighting, and installing municipal control measures and best management practices as the Stormwater Pollution Reduction Plan is implemented. Additionally, it will provide baseline stormwater quality data to build a Municipal Stormwater Sampling Plan around.

The uncertainty of storm events and rain fall volume are two of the greatest challenges to obtaining stormwater samples. Staff will need to be prepared and available to sample once the necessary rain volume threshold has been met. City staff will also need to identify the amount of rainfall necessary during different seasons to create sufficient flow to the specific outfalls. For example, drainage basins that drain larger areas will likely require a lesser volume of precipitation to have stromwater flow at the outfall than drainage basins draining smaller areas. This will be identified over time and should be noted for use by future employees.

Immediate implementation of stormwater monitoring for Prineville will utilize the collection of stormwater samples at the river outfalls (preferable) or from collection facilities such as catch basins as close to the rivers as possible. Sampling from catch basins should only be performed as a last resort and if sufficient flow is actively coming into the catch basin so that it has been thoroughly flushed. Sampling from catch basins is not preferable due to stagnant water and concentrated collection of contaminants. It is ill-advised to have only catch basin samples acquired during any sampling event. Outfall sampling will be the most representative, but may not always be possible due to the elevation of some of the outfalls. It appears that many of the outfalls are under water much of the year. This will need to be identified during each storm event as to whether a given stormwater outfall is accessible due to the river level. In the future, as Best Management Practices are put into place, easily accessible and safe sampling locations should be added to the design.

Monitoring results may be used to assess current water quality conditions, evaluate changes in water quality throughout different seasons or over a period of years. The monitoring results may also be used to identify significant sources of pollution or times of year when water quality is considerably worse. Trends may correlate with land use changes or implementation of BMPs. The City of Prineville has 20+ stormwater outfalls to the Crooked River and Ochoco Creek. This should allow for numerous outfall locations to be sampled during a precipitation event. Depending on the number of samples taken per event and the number of events monitored in a year, a long-term stormwater sampling plan can be established from the data assuming good sampling protocols and quality assurance/quality control (QA/QC) procedures are utilized.

Due to the lack of information regarding current municipal stormwater quality for the City of Prineville numerous samples should be acquired prior to formalizing a municipal stormwater sampling plan. 20-25% of the outfalls should be tested per stormwater event in at least two events in a year. Typical protocol is to acquire twice as many samples in the first year of sampling as compared to the subsequent sampling years. If this is not possible then 8-10 samples should be acquired as precipitation volume allows. The stormwater sampling budget will dictate how many samples can be taken and from which sampling parameter list (see above), but the more analytical data available for review, the higher the degree of confidence in choosing the appropriate stormwater sampling parameters for subsequent sampling events. This analytical data should be reviewed for sampling protocols and QA/QC. This amount of quality stormwater sampling data will likely lead to a sound, defendable municipal sampling program.

S.9 FINANCING AND IMPLEMENTATION

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 and management of stormwater runoff. If funds are not made available to address existing problems, the risk of stormwater related damage or pollution 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 stormwater 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.

S.9.1 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. 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.

As an initial, practicable alternative, the City could implement a flat fee of $4.00 per sewer billing. This could be added directly to the sewer billing, thereby adding nominal administrative costs. Because of the simplicity of this approach, it can be implemented without detailed study. Based on the approximate 3,600 active sewer connections, this would yield $172,800 per year. Monies from the stormwater utility fee can also be used to supplement and expand current public works efforts devoted to stormwater development.

Dedicated efforts by the City to inform and involve the public will be needed to obtain support for the establishment of a stormwater utility.

S.9.2 System Development Charges (SDCs)

The Prineville Code of Ordinances includes: “Chapter 40: System Development Charges” which was passed as Ordinance 1111 on May 5, 2004. The ordinance was specifically worded for sewer, water, and transportation. Since SDCs are for capacity building, stormwater SDCs are probably not consistent with the City's intent to have all new development manage stormwater so as not to exceed pre-development conditions. To the extent that the intent is realized, there will be no increase in capacity needs that would otherwise provide the basis for the SDC.

S9.3 Funding Programs

There are relatively few state or federal funding programs that provide financial assistance for municipal stormwater 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 stormwater improvement projects that address simple hydraulic conveyance (pipes, intakes, culverts, etc.) do not qualify for grant or low interest loan funding.

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. Project 3 may be eligible for funding through this program. The City should contact ODOT regarding current policies and program requirements.

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

> *Flood Mitigation Assistance (FMA) Grant Program.* This program provides grant funding 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. 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. 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 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.

S.10 IMPLEMENTATION

The City will need to consider the recommendations of this Plans in the context of its many other goals and obligations. Prioritizing, budgeting, and constructing the recommended capital improvements will take several years – at least. Implementation of water quality sampling and testing, as well as data acquisition and analysis, will also be implemented over the next several years in accordance with perceived need and available budget. The most immediate and effective measure the City can implement, with minimal effort and cost, is a simple, flat rate of $4.00 per month per sewer billing stormwater utility fee; this is similar to Bend and the national average. Since this is estimated to yield $172,800 in annual revenue, implementation as soon as possible can generate the revenues to fund much of the stormwater related work (water quality sampling, funding applications, environmental studies, preliminary design work, ongoing and expanded O & M, etc.). In general, monies generated by the stormwater utility can assist in implementing other recommendations of this Plan.

S.11 PUBLIC INFORMATION

Dissemination of information to the public regarding stormwater 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

The City of Prineville is located in a high desert valley basin that includes the confluence of the Crooked River and Ochoco Creek. Other natural drainways and manmade irrigation canals are also prevalent in the area. The area is noted for having a very high water table that is influenced by local hydrology. Until recently area growth was extremely rapid, thereby exacerbating concerns that local, largely untreated stormwater discharges, could further degrade water quality in the Crooked River and Ochoco Creek.

Water quality data has been collected in the area, but local mapping and stormwater system documentation is lacking; consequently, no local comprehensive stormwater plan (master plan, pollution reduction plan, etc.) exists. Much of the existing infrastructure, to the extent present, was developed in the 1940s and 1950s.

Development within the Urban Growth Boundary (UGB) is extensive; and significant future growth, notwithstanding the current recession, is anticipated. Potential impacts on downstream infrastructure, properties, water quality, and groundwater levels have raised concerns and highlight the need for a comprehensive stormwater plan.

1.2 STUDY AREA

The study area includes the entire current UGB but focuses on core problem areas identified by City staff. Areas uphill and tributary to the UGB are also included as warranted because of current and potential future impacts from these areas on the UGB. The study area is located in northwestern Crook County. The Prineville UGB included approximately 9,500 acres (approximately 15 square miles).

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.

During the project kickoff meeting, which was attended by DEQ, all parties agreed that the primary purpose of this Plan is to quantify the amount of stormwater, identify capacity issues in the system, and provide solutions for those capacity related issues. With this Plan in place, stormwater flows and volumes will be estimated, allowing for future study of water quality problems and solutions.

1.4 FUNDING ACKNOWLEDGMENT

This project has been funded in part with financial (grant) assistance provided by an Oregon 319 Non-point Source Implementation Grant, administered by the Oregon Department of Environmental Quality. Matching funds (cash) have been provided by the City of Prineville; "In-kind" matches have also been provided by the City of Prineville, the Crooked River Watershed Council, and the Crook County School District.

1.5 AUTHORIZATION

The City of Prineville retained WH Pacific, Inc., on March 30, 2010. HGE Inc., Architects, Engineers, Surveyors & Planners was retained as a subconsultant by WH Pacific, Inc. on April 9, 2010.

1.6 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 News 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 August 2010, ENR Construction Cost Index value of 8837. 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 2006, construction costs have increased an average of 3.06 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 8837; 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, environment and geology, and soils) of the study area that directly bear on hydrologic analyses and designs.

2.2 CLIMATE

The study area has an arid to semiarid climate. Precipitation averages 10.74 inches annually with a lowest, summer, monthly average of 0.44 inches (September) and a highest, winter, monthly average of 1.36 inches (November). Summers tend to be warm to hot and winters cool to cold. Daily high temperatures in excess of 100°F have been recorded in each month June - September; daily minimum temperatures have been subzero (°F) in each month November - March. An extreme high temperature of 119°F was recorded on July 29, 1898; an extreme low temperature of -35°F was recorded on January 21, 1930.

Table 2.1 includes monthly climate data for the period 1971 - 2000, and maximum day precipitation for each month based on data from the period 1897 - 2009.

Table 2.1: Temperature and Precipitation - Climate Summary
City of Prineville
(NCDC 1971 - 2000 Data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	43.3	48.8	55.3	61.6	69.3	77.6	86.2	86.1	78.1	66.0	49.0	42.7	63.9
Average Min. Temperature (F)	22.1	24.9	26.4	29.2	35.2	40.3	43.5	42.3	35.9	30.0	25.7	21.7	31.5
Average Total Precipitation (in.)	1.17	0.99	0.88	0.85	1.06	0.87	0.63	0.46	0.44	0.80	1.36	1.24	10.74
Highest Precipitation (in.)	2.78	2.96	2.00	2.57	4.40	2.00	3.96	4.30	1.88	1.85	3.21	4.08	---
Lowest Precipitation (in.)	0.05	0.01	0.22	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.25	0.02	---
Maximum Day[1] Precipitation (in.)	1.35	1.80	0.96	1.19	1.73	1.54	1.62	1.51	1.53	1.50	1.87	1.67	---

[1] *Maximum Day Precipitation From Year 1897 to Year 2009 data.*

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.

---

[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.

Frequency Events	Rainfall Accumulated Depth
2-yr, 24-hour	1.2 inches
5-yr, 24-hour	1.5 inches
10-yr, 24 hour	1.7 inches
25-yr, 24 hour	2.0 inches
50-yr, 24-hour	2.2 inches
100-yr, 24-hour	2.4 inches

The highest 24-hour rainfall recorded since 1897 was 1.87 inches on November 18, 1996. This would appear to be somewhere between a "10-year" and a "25-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 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. In Prineville, if a rainfall event started later on Day 1 and terminated early on Day 2 with 1.0 inches recorded on Day 1 and 1.2 inches recorded on Day 2, it would appear that a 2-year, 24-hour event occurred on Day 2; however, if rainfall on both days fell within a continuous 24-hour period, then a 50-year, 24-hour event would have occurred. The NOAA statistics are used as a basis for hydrologic modelling in this study.

2.3 ENVIRONMENT AND GEOLOGY

The City of Prineville Comprehensive Plan includes an excellent summary of the local environment and geology. The summary is reproduced below.

> "Prineville is located at the base of high plateaus and traversed by many natural drainage ways. Ochoco Creek and the Crooked River run through the center of the community. Various greenbelts and wildlife-rich riparian areas exist within the community. This situation offers opportunities to develop additional preservation greenbelts and multipurpose areas that can buffer these sensitive lands from the negative impacts of urban development.
>
> The 100-year floodplains near the rivers are potential hazard areas for development. The land area within the Prineville UGB includes over 320 acres within the floodplain.
>
> Many small drainage tributaries of the major streams have high flood hazard and erosion potential within localized areas. However, these localized flash flood conditions do not contribute significantly to flood conditions when channeled into the larger drainages. Many hazard areas can or have been partially, or totally, reclaimed through adequate engineering, especially where drainage can be provided within areas of high water tables. Seasonally high water table problems are caused by spring runoff of snow melt, by flood and sprinkler irrigation, and by soils with high enough clay content to make them impervious to ground water flow. The general soil boundaries indicating ground water problems have been further modified by engineering practices such as diversion canals, drainage ditches, and interceptor drain tiles.

The areas indicated as having extreme or moderate high water tables present problems for foundations, underground utilities, septic tanks, wells and adequate drainage. Engineering techniques may solve these problems. Consequently, increased development costs can be expected. There are approximately 760 acres of soils poorly suited for foundations in the Prineville Urban Area. These soils, also located within areas of high water tables, create additional limitations for sewers, water systems, and other underground utilities. Severe limitations also exist for roadways because of the soils' high shrink swell characteristics. Problems associated with these soils include foundation cracking, settling, and water damage to structures, and underground utility systems that may result in pollution of groundwater.

The general geology of Crook County is almost entirely volcanic in origin. The Clarno and John Day Formations are the most extensive with Columbia River Basalts, Dansforth Mascal Rim Basalts, Deschutes Formations and unconsolidated materials (i.e. alluvial valleys and terraces, etc.) following in decreasing order. The steepest slopes (in excess of 30%) generally pose higher development and maintenance costs for structures and utilities, although modern engineering technology and design may alleviate some or all of these limitations. Shallow rocky soils, high erosion potential, mass movement, septic tank limitations and low agricultural potential commonly characterize steep slopes." [2]

2.4 SOILS

The study area has been mapped by the Natural Resources Conservation Service (NRCS)[3] Extensive mapping and soil characteristic data is available through the agency's website:

http://websoilsurvey.nrcs.usda.gov

Soils maps for the study area are included in Exhibits 5.0 - 5.4.

Approximately 33 different soil classifications occur across the study area. Soils identified are included in Table 2.2.

Table 2.2**:** NRCS Soil Classifications (for Urban Growth Boundary)

Map Symbol	Soil Name	Hydrologic Group	Drainage Class	Depth to Water Table	Frequency of Ponding	Frequency of Flooding
012	Dryck Loam	B	Well Drained	48" - 72"	None	Rare
013	Dryck Loam	B	Well Drained	48" - 72"	None	Rare
014	Powder Silt Loam	B	Well Drained	> 80"	None	Rare
015	Metolius Ashy Sandy Loam	B	Well Drained	> 80"	None	Rare

2 City of Prineville, Urban Area Comprehensive Plan, April 2007.

3 Formerly known as the Soil Conservation Service (SCS).

Map Symbol	Soil Name	Hydrologic Group	Drainage Class	Depth to Water Table	Frequency of Ponding	Frequency of Flooding
016	Crooked-Stearns Complex	D	Somewhat Poorly Drained	> 80"	None	Rare
017	Metolius Ashy Sandy Loam	B	Moderately Well Drained	> 80"	None	Rare
020	Boyce Silt Loam	D	Poorly Drained	6" - 12"	None	Rare
021	Wingdale Silt Loam	D	Poorly Drained	0" - 18"	None	Rare
023	Dryck Gravely Loam	B	Well Drained	48" - 72"	None	Rare
031	Swartz Silt Loam	D	Somewhat Poorly Drained	0"	Frequent	None
036	Argentia - Era Complex	B	Well Drained	> 80"	None	None
037	Meadowridge Ashy Loam	B	Well Drained	> 80"	None	None
038	Meadowridge-Argentia - Era Complex	B	Well Drained	> 80"	None	None
80 Em	Lickskillet-Redmond Complex	D	Well Drained	> 80"	None	None
81 Fm	Lickskillet-Rock Outcrop Complex	D	Well Drained	> 80"	None	None
99	Era Ashy Sandy Loam	B	Well Drained	> 80"	None	None
100	Homehollow Ashy Sandy Loam	B	Well Drained	> 80"	None	None
101	Homehollow Stony Ashy Sandy Loam	B	Well Drained	> 80"	None	None
109	Meadowridge-Era Complex	B	Well Drained	> 80"	None	None
115	Tristan Meadowridge-Era Complex	B	Well Drained	> 80"	None	None
120	Powellbutte-Skullhollow Complex	C	Well Drained	> 80"	None	None

Map Symbol	Soil Name	Hydrologic Group	Drainage Class	Depth to Water Table	Frequency of Ponding	Frequency of Flooding
121	Era Ashy Sandy Loam	B	Well Drained	> 80"	None	None
122	Era Ashy Sandy Loam	B	Well Drained	> 80"	None	None
123	Ochoco-Prineville Complex	C	Well Drained	> 80"	None	None
124	Powder Loam	B	Well Drained	> 80"	None	Rare
130	Aridic Haploxerolls Complex	B	Well Drained	> 80"	None	None
133	Ochoco-Prineville Complex	C	Well Drained	> 80"	None	None
143	Stukmond-Lickskillet-Redmond Complex	B	Well Drained	> 80"	None	None
144	Redmond-Stukmond Complex	B	Well Drained	> 80"	None	None
163	Era Complex	B	Well Drained	> 80"	None	None
208	Meadowridge-Era-Tristam Complex	B	Well Drained	> 80"	None	None
226	Slayton Channery Ashy Sandy Loam	C	Well Drained	> 80"	None	None
227	Slayton Ashy Sandy Loam	C	Well Drained	> 80"	None	None

2.5 MAJOR STREAMS AND RECENT FLOODING

Major streams in the study area include the Crooked River and its tributary, Ochoco Creek. Both streams flow east to west through the study area and merge just west of the UGB. Historically, as a natural stream, the Crooked River existed as a meandering channel that took up the entire valley floor and flooded annually. Approximately 75 percent of the river's average flow occurred during the months of March, April, and May.

Natural flow patterns ceased with the construction of dams upstream on both Ochoco Creek and the Crooked River. Ochoco Dam was constructed after World War I and significantly rehabilitated in 1949. The Arthur R. Bowman Dam was constructed on the Crooked River in 1961. The dams and associated reservoirs provide flood control water to maintain downstream summer flows, water for irrigation, and recreation. Flood control goals are: less than 500 cubic feet per second (cfs) below the Ochoco Dam and less than 3,000 cfs below the Arthur R. Bowman Dam.

Major flooding occurred in 1964. Afterwards, the Crooked River, as well as some other streams, were straightened and channelized. The approach can increase a stream's hydraulic efficiency and, presumably, reduce the incidence of local flooding; however, it does so at a cost. Higher flow velocities result in increased erosion (bank and bed), loss of riparian habitat, poorer water quality, and increased downstream flooding.

Major flooding also occurred in 1998 when the Ochoco Dam was releasing 2,500 cfs. Many homes were flooded.

The Federal Emergency Management Agency (FEMA) National Flood Insurance Program has recently issued revised (Preliminary - April 30, 2010) flood insurance rate maps that include Prineville and surrounding areas. Selected panels are included in Appendix 2.1. Perusal of the panels indicate that much of the core Prineville area is affected by either the 100-year or 500-year floodplains, with Ochoco Creek being the major source of flooding in the developed areas.

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 Prineville and Crook County. 2010 Census data is not yet available.

Table 3.1: 2000 Census Demographic Characteristics

	City of Prineville	Crook County
Population:		
Total:	7,356	19,182
Median Age (years):	32.9	38.6
65 years and over:	1,140 (15.5%)	2,818 (14.7%)
Housing:		
Housing Units (Total):	3,022	8,264
Occupied:	2,817 (93.2%)	7,354 (89.0%)
Vacant:	205 (6.8%)	910 (11.0%)
Owner Occupied:	1,786 (63.4%)	5,464 (74.3%)
Renter Occupied:	1,031 (36.6%)	1,890 (25.7%)
Housing Structures Constructed Since 1970:	1,337	4,546
Housing Structures Constructed Since 1990:	661	2,506
Average Household Size (persons per household):	2.55	2.57
Median Housing Value:	$88,600	$100,000
Median Rent per Unit:	$511	$538
Education:		
High School Graduate or Higher:	74.1%	80.5%
Employment:		
Persons in Labor Force:	3,126	8,764
Employed:	2,888	8,090
Unemployed:	238	674
Persons Not in Labor Force:	2,266	5,989
Mean Travel Time to Work (minutes)	16.2 min.	18.7 min
Income:		
Median Household Income	$30,435	$40,746
Poverty Status (% of Population)	14.3%	11.3%

3.2 POPULATION

3.2.1 Historic Population

Decennial census populations figures for Prineville and Crook County are presented in Table 3.2.

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 Prineville	5,276	5,355	7,358	0.15%	3.23%	1.68%
Crook County	13,091	14,111	19,184	0.75%	3.12%	1.93%

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. Recent population estimates are presented in Table 3.3.

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

Year	July 1 Population Estimates			
	Prineville		Crook County	
	Population	Percent Increase Over Previous Year	Population	Percent Increase Over Previous Year
2001	7,750	---	19,850	---
2002	8,150	5.16%	20,200	1.76%
2003	8,500	4.29%	20,300	0.50%
2004	8,640	1.65%	20,650	1.72%
2005	9,080	5.09%	22,775	10.29%
2006	9,990	10.02%	24,525	7.68%
2007	10,190	2.00%	25,885	5.55%
2008	10,370	1.77%	26,845	3.71%
2009	10,370	0.00%	27,185	1.27%

	July 1 Population Estimates			
	Prineville		Crook County	
Year	Population	Percent Increase Over Previous Year	Population	Percent Increase Over Previous Year
AAGR (2001-2009)		3.71%		4.01%

During the period April 1, 2000 to July 1, 2009, Prineville added 753 persons as a result of annexations. Subtracting 753 persons in Table 3.3 above would result in an estimated average annual growth rate (AAGR) of approximately 2.7% rather than that 3.71% indicated. The annexations, while having real impacts on City growth, nevertheless skew the computed and perceived natural area growth rate.

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 20,300 persons as a base, the forecast indicates a 2040 Crook County population of 38,553 persons, an increase of 18,253 persons and an AAGR of 1.75%.

The OEA forecasts are for counties. There is no uniform methodology for allocating county forecasts to individual municipalities or areas. Average growth in Crook County was higher than in Prineville for the period 2001 - 2009 (Table 3.3). If this relative rate continues, long-term growth in Prineville will reflect a reate (AAGR) of 1.75% or less. Crook County has incorporated the OEA forecast in the *Crook County Coordinated Transportation Plan* (approved 2007; update approved 2009).

Notwithstanding the OEA forecast and possible interpretations, recent development in the area suggest a potential for higher future population growth rates. Much will depend on resolution of the current economic downturn and marketing of the City and area benefits to prospective businesses, developers, and home buyers. The City is currently preparing a wastewater facilities plan in which detailed population and growth forecasts will be made. The City has directed HGE and WH Pacific to not develop growth forecasts for the Stormwater Plan.

The City's recent Water System Master Plan Update[1] estimated an ultimate buildout capacity of the 2006 UGB of approximately 36,000 persons.

[1] City of Prineville Water System Master Plan Update, Ace Consultants, Inc., March 2006.

3.3 LAND USE

3.3.1 Current Land Use and Development

The City of Prineville Comprehensive Plan includes an excellent summary of local land use and development. The information is reproduced below:

"Prineville is a small rural community. It provides both shopping and employment for City and Crook County residents. The City was built along the rivers and railroad tracks, using the rail to ship the lumber and agricultural products that came into the town from the nearby farms. As the rest of Central Oregon grew, so did Prineville, but at a much-reduced rate given its distance from regional centers like Bend. State highways improved vehicular access routes allowed for improved transportation to needed goods and services not readily available in Prineville. Today new residents come to Prineville because of its small-town character and current low housing prices, locating their families in this community though their jobs; service and shopping needs may be elsewhere.

"Prineville's street patterns and subdivisions testify to a value of open spaces and easy vehicular and large transport access. As time passed, there was a transition from the older streets lying parallel to the old railroad line to the newer ones paralleling section lines. Over time, orientation to the railroad gradually became less important. Subdivisions rotated to match section lines, accommodating rural land ownership patterns as surrounding farmland converted to residential and urban uses.

"Prineville has historically attracted people for two primary reasons: one for its natural resource and recreation based heritage and another for its emergence as a small town within Central Oregon. Although previous traditional industries are rapidly diminishing, as illustrated by the reduction in the lumber and agricultural industries, new community construction is taking place on lands that were formerly farmed for many years or had a history of underdevelopment. Historic buildings do remain evident in the central business district and nearby neighborhoods. Longstanding businesses, with original facades and signage, are adjacent to newer establishments. Industrial areas are continuing to develop with needed businesses and manufacturing offering much needed jobs for the community.

"The community has been making significant public investments in expanding hospital facilities, a new high school, a new public library, a new public park and extensive playground, and fully serviced industrial park.

"Prineville also has a high concentration of trucking/ground transport companies. With seven regional firms based in the town, businesses in the region have excellent service and rates for transport to and from major markets. Outside the manufacturing and distribution sectors, agriculture still plays an important economic and cultural role for residents of the town and Crook County. Annually, the industry contributes more that $40 million to the local economy in commodities sold." [2]

[2] City of Prineville, *Urban Area Comprehensive Plan*, April 2007.

3.3.2 Current Zoning

Both Crook County and the City of Prineville have highly developed zoning ordinances: the Crook County Code (Title 18) and Prineville Code of Ordinances (Title XV: Land Usage, Chapter 153: Land Development). Crook County maintains a website (http://www.co.crook.or.us/) that includes an interactive GIS map with zoning layers and keys for both the City of Prineville and Crook County.

3.3.3 Future Development

Future development in Prineville is difficult to forecast given the current economic recession and impacts to the housing market; nevertheless, it is likely, for all the reasons that attracted high growth to the area previously, that once the economy stabilizes, significant growth will resume. Ongoing development includes IronHorse, a mixed-use community that plans to include a school, retail stores, and 3,000 housing units. The City completed a multi-modal, trans-load, warehouse and distribution center (The Prineville Freight Depot) thereby creating a first-rate transportation hub. Facebook, Inc., is constructing a 300,000 square foot data storage farm that is estimated to cost approximately $200 million and will directly employ 35 engineering, maintenance, and information technology positions with potential for future expansion.

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)** has implemented 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 100,000 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 $745 for the initial application and $765 for each year of coverage under the permit.

DEQ is currently in the initial scoping and data collection phase for a total maximum daily load (TMDL) study for the Lower and Upper Crooked River Subbasins. Its purpose is to establish water quality goals within the Crooked River Subbasins. 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 Crooked River include: bacteria, pH, temperature, and flow modification. Temperature is the only parameter of particular concern (under Section 303d) in Ochoco Creek.

Prineville 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 and result in discharges to surface water, 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 $745 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 CROOK COUNTY ORDINANCES AND REQUIREMENTS

The Crook County Code includes some direct references and provisions for stormwater and related issues; however, overall discussion is limited. Some key provisions for subdivision development include:

- From 17.36.030 Subdivision roads and public ways:

> "(6) Drainage. Adequate drainage for the main roadbed and all approach roads shall be provided by utilization of proper and necessary size culverts. Culvert size shall be a minimum of 15 inches. All culverts shall extend a minimum of three feet beyond the roadbed. Drainage plans shall comply with all applicable standards required by the State of Oregon Department of Environmental Quality Central Oregon Stormwater Plan or as specified by the planning department.
>
> "(10) The Developer... The developer shall provide proof of compliance with stormwater drainage and erosion control requirements as may be imposed by the State of Oregon Department of Environmental Quality, Central Oregon Stormwater Manual or the county."

- From 17.40.030 Improvements in subdivisions:

> "(2) Surface Drainage and Storm Sewer System. Drainage facilities as required within the subdivision and to connect the subdivision drainage to drainage ways or storm sewers outside the subdivision. Design of drainage within the subdivision shall take into account the capacity and grade necessary to maintain unrestricted flow from areas draining throughout the subdivision and to allow extension of the system to serve such area and shall provide proof of compliance with stormwater drainage requirements as may be imposed by the State of Oregon Department of Environmental Quality or the county roadmaster."

Note that detail is provided by reference to requirements of the Department of Environmental Quality, "the planning department," the county roadmaster, "the county," and the Central Oregon Stormwater Manual.

The Crook County Code is available through the County's website: http://co.crook.or.us/

Floodplain related requirements are discussed, primarily in the following sections of the Crook County Code:

- Chapter 15.08 Flood Damage Prevention
- Chapter 18.84 Flood Plain Combining Zone, FP

The Code reflects floodplain policies adopted by the County and incorporated in the Crook County Comprehensive Plan (adopted 1978, codified January 2003). The section on floodplain policies is reproduced below:

"**FLOODPLAIN POLICIES**

It shall be the policy of Crook County to recognize the 100-year floodplain areas as the minimum areas which could be inundated by flood, and to require strict controls for development near, or presently within them. The following shall be considered in relation to development in floodplain areas:

1. High density development shall occur as far from the floodplain as possible.

2. Building and engineering requirements such as drainage systems, minimum floor elevations, and diking as set forth by federal regulations shall be required within areas that could potentially have high water problems.

3. Construction standards established by the Federal Insurance Agency for Emergency Program Aid shall be observed; these include:

   (a) Proper anchoring of structures.

   (b) Use of construction materials that will minimize flood damage.

   (c) Adequate drainage of new subdivisions.

   (d) New or replacement utility systems are to be located and designed to preclude flood loss.

   (e) All new construction or improved/repaired structures in flood hazard areas are to be elevated or flood-proofed to the 100-year elevation.

It shall be the policy of Crook County to identify and maintain floodways in their natural undeveloped condition in order to:

1. Minimize meander and bank erosion damage.

2. Provide an unobstructed channel for flood waters to provide conditions for minimum velocity and stream flow.

3. To reduce flood damage in areas not protected by flood control structures.

The portion of the floodplain nearest the stream channel shall be considered best suited for:

1. Grazing, hay and grain fields, orchards, truck gardens, nurseries, or other open space agriculture.

2. Parks, playgrounds, golf courses, ball fields, or other recreation not involving structures.

3. Locations of utility lines.

4. Storage during non-floor seasons."

4.8 CITY OF PRINEVILLE

Like the Crook County Code, the Prineville Code of Ordinances includes some direct references and provisions for stormwater and related issues; and also like the Crook County Code, overall discussion is limited. Notable sections include:

- Section 153.157: Subdivisions - applications. Required information on existing conditions including: pipelines, irrigation canals and ditches, waterways, marshes, wetlands, location and direction of water courses, high water tables, areas subject to erosion, stormwater runoff, and flooding. Information concerning a proposed subdivision is to include "stormwater and other drainage plans."

- Section 153.089: Cutting and Filling. This section includes: "That the proposed grading and/or filling will not have an adverse impact on the drainage on adjacent properties or other properties down slope;" and, "filling of wetlands shall only be permitted after a permit has been issued by the Division of State Lands (DSL) and U.S. Army Corps of Engineers (if applicable), and where the City Planning Official, the Building Official, and City Public Works Superintendent find that the filling will not cause flooding of adjacent properties or public street or drainage systems, and that drainage systems are adequate to handle actual or projected storm run-off."

- Chapter 155: Natural Features Overlay District (NFOD). This chapter provides for the protection of significant natural features including surface water features and wildlife habitat areas. Surface water features include: the Crooked River, Ochoco Creek, Hudspeth Drainage, and Ryegrass Ditch and their riparian corridors, including associated wetlands and floodplain areas. Hudspeth Reservoir, isolated wetlands, and dry washes area also covered.

- Section 153.088: Riparian Habitat. This section also provides riparian habitat protections for identified areas associated with Ochoco Creek and the Crooked River

- Chapter 151: Flood Damage Prevention. This chapter includes 20 sections and numerous provisions to achieve its purpose "to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions..." Section 151.21 includes specific standards for construction. Section 151.22 and 151.23 include provisions that prohibit or limit encroachments on the floodway.

- Section 51: Sewers. This section focuses primarily on sanitary sewers and is notable primarily from its requirement for any building or dwelling within 100 feet of a sanitary sewer to connect to it; and for the prohibition against any connection that directs surface water or groundwater to the sanitary sewer system.

The City of Prineville Public Works Standards and Specifications (revised July 2008). Chapter II includes requirements for drainage control and storm sewer design. These are provided below:

DRAINAGE CONTROL
GENERAL

Street runoff shall be controlled by means of a catch basin and retention pond/drainage swale. Note that special construction techniques are used in pavement areas. Double catch basins are normally required for inlets. A single catch basin is acceptable for the collection of water where special situation apply. Curb inlet catch basins shall be installed in arterial and major collector streets.

In areas known to be impervious material, such as cemented volcanic tuft, a storm sewer system should be used to carry runoff to a site where disposal is practicable.

Inlets shall be provided at intersections of collectors or arterials. Inlets should be provided at intersections of local streets, especially continuous local streets. These inlets shall be so arranged that water is not directed through the intersection or, in certain cases, around a curb return. Inlets should be provided in any area where icing could create hazard. Valley gutter intersections should be specified with caution and only at the intersections of short Cul-de-sacs with local streets.

A drainage swale/retention pond shall be provided for every 20,000 SF of ultimate service area unless exception is granted by City Engineer that meets the criteria in Storm Sewer Design below. For example (see drawing 2.2, page VI-57), a 36-foot wide road with a sidewalk on one side will have an ultimate service area of sidewalks on both sides; hence the width to be used for determining the service area is as follows:

Street	36'
Curb	1"
Sidewalks	10'
Pavement width	47'

STORM SEWER DESIGN

Except as modified or amended by these Standards and Specifications, storm sewers shall be designed according to the current ODOT Hydraulics Manual (2005). Storm sewers shall conform to the same specifications as sanitary sewers.

In the ODOT specifications, any references to “mainline” shall apply to all storm sewers serving City streets. All references to “highway” shall also mean City streets.

The responsibility for the design shall be borne by the developer and shall provide for the control of all upstream development whether existing or undeveloped. The design shall be reviewed and approved by the City. Inlets shall be designed for a 25-year storm, except sag inlets shall be designed for a 50-year storm.

The cost for the approved system shall be wholly borne by the developer, including any offsite system that is required.

The Prineville Urban Area is located in zone 10. The following five-minute rainfall intensities over a 24-hour period shall apply:

25-year	2.14 inches
50-year	3.2 inches

The runoff coefficient for streets, curb tops and sidewalks shall be 0.85.

In lier of the Kinematic Wave Equation, the designer may use the following formulas to determine time of concentration:

Average Slope	T_c
<2%	2L+2
2%-4%	1.5L+2
>4%	L+2

where: L is in stations
T_c shall not be less than 5 minutes

Flanking inlets at sags shall not be required provided that the primary inlet is adequate to capture the design flow.

A City standard single catch basin corresponds to an ODOT type G inlet. A City standard double catch basin corresponds to an ODOT type G-2 inlet.

The Public Works Standards include, in Chapter VII Sewer Facilities, specific requirements for culvert and storm water related materials and construction.

4.9 CENTRAL OREGON STORMWATER MANUAL

The Central Oregon Stormwater Manual (COSM) was developed specifically for Central Oregon by the Central Oregon Intergovernmental Council (COIC) and sponsored by Deschutes and Crook counties and the cities of Bend, Redmond, Prineville, Madras, and Sisters. The goal of the COSM "is to provide local engineers, developers, builders, and agencies clear guidance and design standards on stormwater conveyance and treatment systems that are appropriate to our climate, hydrogeology and geology." The foreword to the COSM includes the following general statement in regard to applicability of the document:

> "The COSM contains minimum local requirements and standards for designing stormwater management systems within Central Oregon. The requirements apply to land development and municipal road and drainage projects in both urban and rural settings. The COSM contains procedures and assistance in the design of stormwater management facilities. It is not intended to be a textbook on hydrology or hydraulic engineering, nor is it an attempt to cover every scenario that may arise. It is intended to be sufficiently comprehensive so that its contents, along with good engineering judgment, will address the myriad drainage concerns in Central Oregon."

The COSM was recently updated in August 2010. The full document, 404 pages, is available through the City of Bend's website:

http://www.ci.bend.or.us/dept/public_works/stormwater/docs/COSM_201008.pdf

A copy of the COSM Table of Contents is included in Appendix 4.1.

SECTION 5: EXISTING DRAINAGE SYSTEM

5.1 BACKGROUND

While constructed storm drainage infrastructure is 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 catch basin locations. Area drainage is currently accommodated by a combination of streams, ditches, culverts, catch basins, and pipes, UICs, and surface infiltration. 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 Base Map

The base map was prepared using Crook County GIS as a primary source. GIS layers include: aerial photography, 5-foot and 25-foot elevation contours, property and right-of-way boundaries, soil surveys, zoning, City and UGB limits, street and street names, 100 and 500-year flood plains, water courses, and sewer manhole locations and elevations. As reported by Crook County, the GIS incorporates the following technical standards:

Horizontal Datum:	NAD 83
Vertical Datum:	NGVD 29
Grid Coordinate System:	State Plan Coordinate System 1983
Units:	International Feet

Extent of the base map was determined by using topography to outline the overall study area tributary to the UGB. This was further refined by utilizing drainway and irrigation canal locations as natural boundaries that intercept and reroute flows. Consistent with the proposed scope of work, emphasis and focus has been placed on the core urban area. Mapping was created, for various purposes, at scales of: 1"=400', 1"=500', 1"=600', and 1"=2,500'. The 1"=400' maps incorporate aerial photography and were utilized to record stormwater infrastructure and related features identified by City staff. The 1"=2,500' scale is used for the "key" maps and the 1"=600' scale is used for the individual maps referenced on the key map. Numerous modifications of the base mapping were necessary to accommodate the identified stormwater infrastructure, additional street and stream names, offsetting of text for clarity, and modifications of line weights. The base map was created using AutoCAD software. A LIDAR survey was provided by the City and incorporated as a GIS layer. This was used in conjunction with the GIS contours to construct a surface model to assist in evaluating the feasibility of potential hydraulic modifications to the stormwater system.

5.2.2 Existing Drainage Features

As noted in Section 5.1 above, existing stormwater infrastructure mapping was limited to catch basin locations. City of Prineville staff provided additional information on stormwater features to be added to the maps. Details were transcribed on to 1"=400' scale maps with aerial photography backgrounds. Information was checked and extensively supplemented through field work conducted by City staff. The Consultant reviewed ODOT mapping for the Madras-Prineville Highway and conducted (limited) field work associated with the stormwater outfalls to the Crooked River and Ochoco Creek. Field work activities focused on the more densely developed areas of the City.

The overall mapping effort was iterative: base maps were provided to the City, Staff marked up the maps and returned them to the Consultant, the base map was updated with the information provided to the Consultant, and revised copies were sent back to the City for review and comment. Because of the extent of the area involved, the lack of existing documentation, the practical limits on Staff and Consultant availability for more extensive field work, 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 Existing Drainage System Maps and Descriptions

Existing drainage system infrastructure is shown in Exhibits 1.0 - 1.5. Map scale is 1"=2,500' for the key map (EX1.0) and 1"=600' for each of the referenced plates (exhibits).

5.2.4 Basin Delineation

Where possible, roadways and mapped stormwater infrastructure were 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[1]. 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 Ochoco Creek, the Crooked River, or the Ryegrass (irrigation) Canal. There are also isolated basins that drain via percolation from the

[1] With the exception of any water migrating via pipe trenches to another basin.

surface or from constructed subsurface infrastructure. Overall, approximately 74 basins have been delineated. Additional subbasins have been created for detailed analysis of selected basins. 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 basin(s) in order to more accurately model flows in an area of interest.

5.2.5 Existing Drainage System Maps and Descriptions

Existing drainage system infrastructure, and mapped basins, are shown in Exhibits 2.0 - 2.5. Map scale is 1"=2,500' for the key map (EX2.0) and 1"=600' for each of the referenced plates (exhibits). Table 5.1 includes a general description and summary of the mapped drainage basins.

Table 5.1 Drainage Basin Summary

Basin [1]	**Approximate Acreage**	**Outfall/Discharge Description**	**Basin Description**
CR-1	1,418	Non-point	Area mainly consisting of agriculture lands, and areas around the river which are not developed. Also includes the Meadowlakes Golf Course.
CR-2	12	Piped Outfall	Served by catch basins and pipe to the river, this area includes a portion of the Les Schwab site west of the Madras Highway as well as portions of NW 6th Street and the Ochoco Elementary School. **No existing treatment.**
CR-3	7	Swale Overflow	Area north of 2nd Street is collected in catch basins and piped to a storm water infiltration pond located near the Crooked River banks. Designed to overflow to the river during heavy events. **Detention pond treatment.**
CR-4	22	Piped Outfall	Residential runoff, including the Queen's Garden Mobile Home Park is collected in catch basin and pipe to the river. **No existing treatment.**
CR-5	8	Piped Outfall	Residential runoff is collected in catch basin and pipe to the river. **No existing treatment**.
CR-6	244	Piped Outfall	Large basin, mainly consisting of residential areas, collected in catch basin and pipe to the River near the Meadowlakes Golf Course. Large portions of the basin are connected to the collection system through a series of 'bubbler' catch basin system and intersections and rely on curb flow. **No existing treatment.**

Basin [1]	Approximate Acreage	Outfall/Discharge Description	Basin Description
CR-7	59	Piped Outfall	Basin consists of residential areas and Highway runoff. A portion of the residential area is not curbed. The highway is curbed and utilizes catch basins and piping to outfall to the river. The outfall pipe is located approximately 400 feet east of the river and utilized a natural vegetated ditch. **Potential bio-treatment along ditch.**
OC-1	1,273	Non-point	Area consists of industrial, residential agriculture lands, and areas around the creek which are not developed. Surface runoff to the creek.
OC-2	11	Swale Overflow	Residential development uses catch basins piped to three separate drainage swales for infiltration along the creek. Appear to be able to overflow to the creek during heavy events. **Potential bio-treatment in swales.**
OC-3	11	Swale Overflow	Residential development uses catch basins piped to a drainage swales for infiltration along the creek. Appear to be able to overflow to the creek during heavy events. **Potential bio-treatment in swale.**
OC-4	103	Surface Overflow	Basin includes residential, industrial, and vacant lads which drain to the creek. No pipe drainage system in place.
OC-5	7	Swale Overflow	Portion of basin is piped to surface swale for infiltration and treatment. Portion is piped to Basin OC-4.
OC-6	21	Surface Overflow	A mix of residential, industrial, and vacant lands drains overland to the creek. No piped drainage system in place.
OC-7	1	Swale Overflow	Small basin collects drainage from 9th Street. Piped to a bio-swale swale along the creek. **Potential bio-treatment in swale.**
OC-8	7	Swale Overflow	Small basin collects drainage from 9th Street and a small portion of residential and industrial lands. Piped to a bio-swale swale along the creek. **Potential bio-treatment in swale.**
OC-9	3	Pipe Outfall	Small basin collects drainage from residential lands west of Harwood Ave. and piped to the creek. **No existing treatment.**
OC-10	9	Pipe Outfall	Mainly residential lands drainage collected in catch basins and pipe to the creek. No existing treatment.
OC-11	80	Pipe Outfall	Basin includes residential, industrial, and vacant lads which drain into catch basins and a collection system. Main is constructed under 9th Street. Main is perforated and is continually moving groundwater to the creek.

Basin [1]	Approximate Acreage	Outfall/Discharge Description	Basin Description
OC-12	3	Swale Overflow	Small residential basin collects surface drainage into a catch basin and discharges to a bio-swale at the creek. **Potential bio-treatment in swale.**
OC-13	2	Swale Overflow	Small residential basin collects surface drainage into a catch basin and discharges to a bio-swale at the creek. **Potential bio-treatment in swale.**
OC-14	8	Pipe Outfall	Small residential basin collects surface drainage into catch basins and discharges by pipe to the creek. Portions of the basin are connected to the collection system through a series of 'bubbler' catch basin system and intersections and rely on curb flow. **No existing treatment.**
OC-15	146	Pipe Outfall	Large basin includes a major portion of downtown, residential and commercial areas. The highway system connects to this outfall. Collection system is connected to the old 'Mill Race' system. Large diameter pipe, but if very poor condition. Potential plugging. Homes have been constructed on top of the 'Mill Race' pipe. No easements. **No existing treatment.**
OC-15A	24	Surface Infiltration	Residential area pipe to existing PUE east of Queen's Garden Mobile Home Park. Appears to be part of the old 'Mill Race' system. Potentially connected to the 'Mill Race' pipe?
OC-16	22	Surface Overflow	Residential basin relies on a series of 'bubbler' catch basin system at intersections and relies on curb flow. **No existing treatment.**
OC-17	1	Surface Overflow	Basin isolated to Deer St. north of the creek. Relies on a series of 'bubbler' catch basin system at intersections and relies on curb flow. **No existing treatment.**
OC-18	3	Pipe Outfall	Small residential basin is collected in catch basins and piped to the creek. **No existing treatment.**
OC-19	6	Surface Overflow	Residential basin relies on a series of 'bubbler' catch basin system at intersections and relies on curb flow. **No existing treatment.**
OC-20	6	Pipe Outfall	Area of downtown collected along Beaver St., including areas to the east, are collected in catch basin and pipe to the creek. **No existing treatment.**
OC-21	6	Pipe Outfall	Area of downtown, including commercial and industrial, collected along Main St., including areas to the east, are collected in catch basin and pipe to the creek. **No existing treatment.**
OC-22	4	Pipe Outfall	Area north of the creek, including residential, commercial, and industrial, collected along Main St., including areas to the east, are collected in catch basin and pipe to the creek. **No existing treatment.**

Basin [1]	Approximate Acreage	Outfall/Discharge Description	Basin Description
OC-23	4	Pipe Outfall	Commercial area collected in catch basin and piped to the creek. Basin relies on a series of 'bubbler' catch basin system at intersections and relies on curb flow. **No existing treatment.**
OC-24	3	Pipe Outfall	Commercial area collected in catch basin and piped to the creek. Pipe outfalls to bio-swale near the back of the Fire Department. Potential bio-treatment in swale.
OC-25	6	Pipe Outfall	Residential area collected in catch basin and piped to the creek. Basin relies on a series of 'bubbler' catch basin system at intersections and relies on curb flow. Minimal existing curb in basin. Outfall pipe just above existing path. No existing treatment.
OC-26	4	Pipe Outfall	Basin includes a portion of the highway and City Hall area. Outfalls to bioswale in the park. **Potential bio-treatment in swale.**
OC-27	24	Pipe Outfall	Residential area collected in catch basin and piped to the creek. Basin relies on a series of 'bubbler' catch basin system at intersections and relies on curb flow. No existing treatment.
OC-28	9	Surface Overflow	Residential and park areas rely on a series of 'bubbler' catch basin system at intersections and relies on curb flow. **No existing treatment.**
OC-29	4	Pipe Outfall	Residential area collected in catch basin and piped to the creek. Basin relies on a series of 'bubbler' catch basin system at intersections and relies on curb flow. No existing treatment.
OC-30	3	Pipe Outfall	Residential and park areas, as well as a small portion of the highway, are collected in catch basins and piped to the creek. **No existing treatment.**
OC-31	5	Pipe Outfall	Basin mainly consists of Highway right of way and runoff. Outfalls at the new bridge. **No existing treatment.**
OC-32	15	Pipe Outfall	Basin contains a portion of the highway right of way and the shopping center parking lot. Piped through residential streets to the creek. **No existing treatment.**
OC-33	16	Pipe Outfall	Residential development uses catch basins piped to a drainage swales for infiltration along the creek. Appear to be able to overflow to the creek during heavy events. **Potential bio-treatment in swale.**
OC-34	48	Pipe Outfall	Residential development uses catch basins piped to a drainage swales for infiltration along the creek. Appear to be able to overflow to the creek during heavy events. **Potential bio-treatment in swale.**

Basin [1]	**Approximate Acreage**	**Outfall/Discharge Description**	**Basin Description**
RG-1	140	Non-point	Large agricultural basin overland flows to the Rye Grass Canal. Mainly located outside UGB.
RG-2	170	Non-point	Large agricultural basin overland flows to the Rye Grass Canal. Mainly located outside UGB.
RG-3	565	Non-point	Large agricultural and residential basin overland flows to the Rye Grass Canal.
RG-4	495	Non-point	Large basin including agricultural, residential, and industrial land flows overland to the canal.
RG-5	13	Pipe Outfall	Mainly residential area collected in catch basin and piped to the canals. **No existing treatment.**
RG-6	657	Pipe Outfall	Large basin mainly consisting of the wetland area below Barnes Butte Reservoir as well as residential and industrial areas, and agricultural lands. Existing overflow is piped to the canal. Basins RG-7 through RG-17 are either piped to the wetland or have facilities which can overflow to this basin. **Potential treatment for water flowing through wetland.**
RG-7	59	Pipe Outfall	Mainly residential area collected in catch basin and piped to the wetland. **No existing treatment prior to wetland flow.**
RG-8	4	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
RG-9	8	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
RG-10	4	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
RG-11	12	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
RG-12	5	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
RG-13	14	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**

Basin [1]	Approximate Acreage	Outfall/Discharge Description	Basin Description
RG-14	3	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
RG-15	13	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
RG-16	2	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
RG-17	1	Swale Overflow	Residential area collected in catch basin and piped to bio-swales. Potential overflow to the wetland area during heavy events. **Potential bio-treatment in swale.**
IS-1	8	Pond Infiltration	Highway runoff to grassy infiltration area with Highway right of way at the West Wye.
IS-2	28	UIC	Residential neighborhood with drywells. **Treatment unknown.**
IS-3	16	Pond Infiltration	Residential neighborhood piped to infiltration bar ditch.
IS-4	26	Pond Infiltration	Residential neighborhood piped to infiltration pond.
IS-5	7	Outfall Descriptions	Residential neighborhood piped to infiltration pond.
IS-6	254	Non-point to Canal	Residential neighborhood is piped to infiltration facilities along existing canal. Areas of surface flow may reach the canal.
IS-7	37	UIC	Residential neighborhood with drywells. **Cartridge filters for treatment.**
IS-8	46	Pond Infiltration	Residential and park area drains to park graded for drainage collection and infiltration.
IS-9	17	Pond Infiltration	Residential and park area drains to park graded for drainage collection and infiltration.
IS-10	52	Pond Infiltration	Agricultural area drains to existing irrigation pond drainage collection and infiltration.
IS-11	119	Non-point to Canal	Agricultural area drains to existing irrigation canal. Portion lies outside UGB.
IS-12	671	Non-point to Canal	Agricultural area drains to existing irrigation canal.
IS-13	979	Non-point to Canal	Native area drains to existing irrigation canal. Portion lies outside UGB.

Basin [1]	Approximate Acreage	Outfall/Discharge Description	Basin Description
IS-14	211	Non-point to Canal	Agricultural area drains to existing irrigation canal.
IS-15	91	Sewerage Pond	City sewerage Ponds.

1 Basin numbers are assigned, in part, to reflect the stream to which the basin is tributary: CR (Crooked River), OC (Ochoco Creek), RG (Rye Grass Canal), and IS (isolated, not tributary to a stream).

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 Prineville are included in Section 5.4.2; and for areas outside the City, in Section 5.4.3. In general, stormwater issues arise with the advent and progress of warmer winter storms (especially in the case of combined warmer temperatures, rainfall, and existing/melting snowpack) and thunderstorms. Leaf drop during the fall/winter period can result in local catch basin or culvert obstructions with consequent back-ups or flooding — even under moderate rainfall events. 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.

5.4.2 City of Prineville

Problem areas and associated deficiencies were identified for the Consultant by City staff based on their experience and knowledge of the system. All of the identified problem areas were within the Prineville city limits. Most of these are very local in effect. Twelve (12) problem areas were identified; these are referenced by letter, described below, and indicated on Exhibits Ex 3.0 - 3.5. Photographs are included in Appendix 5.1.

Problem Area A.

Location: East side of NW Harwood Street between 12th Street and Lamonta Road.

Basin: OC-5

Description: Extensive ponding in right-of-way and on private property. Ponding extends around storage buildings and is associated with heavy rainfall events. Area is relatively flat and it appears the storage buildings should have been constructed with a higher base elevation.

Problem Area B.

Location: West side of Locust Avenue at NW 12th Street.

Basin: OC-4

Description: Some ponding occurs in the intersection during heavy rainfall events.

Problem Area C.

Location: At 5th Street and Claypool Street.

Basin: OC-18, OC-19

Description: Extensive ponding occurs across south side of intersection during heavy rainfall events. There is a surface intake (south) and line that extends to a "bubbler" catch basin (north) on both sides of the intersection. It appears that the area and roadway north of the intersection is higher and not allowing drainage to flow north toward Ochoco Creek.

Problem Area D.

Location: East side of Main Street, near 5th Street.

Basin: OC-21

Description: The storm sewer is only 6" diameter and has inadequate capacity. The small diameter contributes to maintenance issues.

Problem Area E.

Location: Intersection at 6th Street and Elm Street.

Basin: OC-27

Description: Back-ups cause ponding on SE corner, and flow off NE corner and down a private driveway. Problem thought to be caused by relatively flat grade and capacity limitations associated with 6" (or 8") storm sewer that drains south to Ochoco Creek.

Problem Area F.

Location: Main Street and 3rd Street.

Basin: OC-15

Description: Backups and ponding occur during heavy rainfall events and are attributed to capacity limitations associated with a downstream storm sewer transition from a 12" line to a 10" line. Ponding reaches the museum doors.

Problem Area G.

Location: In alley on north side of 3rd Street between Main Street and Beaver Street.

Basin: OC-15

Description: The adjacent (bank) parking lot drainage system is plugged causing water to pond on the lot and flow to the alley where it can, in turn, flow into adjacent basements.

Problem Area H.

Location: South off High Desert Drive near Cesna Drive.

Basin: (Not located in a mapped basin.)

Description: Constructed pond (on private property) overflows to the public right-of-way. There is no constructed overflow channel.

Problem Area I.

Location: North side of Empire Drive, just west of Tom McCall Road.

Basin: (Not located in a mapped basin.)

Description: Ponding occurs, after heavy rain, in the drainage swale and on the north side of the roadway.

Problem Area J.

Location: North side of 4th Street between Harwood Street and Deer Street (at house #545).

Basin: OC-15

Description: There is a grated intake with a 4" pipe in the bottom that drops to the 24" (reported) storm sewer (also known as the "Mill race pipe"). The 4" pipe is easily obstructed causing ongoing maintenance issues. The 24" storm sewer runs under the house, as well as across several properties, without an easement.

Problem Area K.

Location: 3rd Street, approximately 200' east of Maple Street.

Basin: OC-15

Description: The 24" line (noted in Problem Area J description above) runs under the corner of the existing gas station. Sediment and "potential VOC and hydrocarbons" were reported found in the pipe under the highway.

Problem Area L.

Location: At the Les Schwab facility, west from 6th Street and Prineville Highway No. 360.

Basin: CR-2

Description: Private catch basins and roof drains at the facility are reported to be connected to the storm sewer. There is no known easement for the public storm sewer.

5.4.3 Surrounding Areas

No specific problem areas were identified in areas outside the Prineville city limits as part of this study.

5.5 WATER QUALITY

For a general discussion of water quality data and issues as it pertains to this stormwater plan, refer to Section 7.3.

5.5.1 Crooked River and Ochoco Creek Water Quality

The Oregon Department of Environmental Quality (DEQ) notes in the Oregon Water Quality Index Report for Deschutes and Hood Basins, for water years 1986 - 1995, for the Crooked River at Highway 126 (Prineville), at river mile 47.9, average water quality scores of 72 (October - May) and 78 (June - September). A score of 60 -79 indicates poor water quality. The report goes on to note:

> pH and dissolved oxygen supersaturation were detected as early as April. High water temperatures were detected during the summer months. High concentrations of biochemical oxygen demand, total phosphates, and total solids were detected throughout the year. Spikes in total phosphate levels, related to heavy precipitation, were seen simultaneously with total phosphate spikes at Conant Basin Road. Generally, OWQI values for the Crooked Rive at Hwy 126 in Prineville were poor throughout the year...."

In accordance with requirements of Section 3.3(d) of the Clean Water Act, the State of Oregon maintains a list of water quality limited water bodies. Oregon's 303(d) list (year 2004/2006) for the Crooked River (river mile 0 - 51), includes water quality parameters for year-round pH (exceeds, at times, pH of 6.5 - 8.5) and summer temperature (exceeds, at times, pH of 6.5 - 8.5) and summer temperature (exceeds, at times, 64°F fish rearing temperature). Prineville is located at approximately river mile 48. Temperature and pH are not listed for the upstream stream segment, river miles 51 - 70; this segment is listed for exceedence of the 110% total dissolved gas criteria.

Ochoco Creek, for river mile 0 - 36.4, also appears on the 303(d) for temperature and pH.

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. 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 desired 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.

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 Prineville owns and operates a municipal wastewater collection and treatment system. Prineville's wastewater collection system includes 38.7 miles of gravity sewers. On-site (septic) systems are present in parts 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 Prineville's 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 waterfowl and resident or transient herds of deer or elk. Dogs are likely the most prevalent and problematic source of pet/domestic animal waste.

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 2 years, 50 years, and 100 years for a 24-hour event were modeled for selected basins. 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 50-year event is recommended for general drainage planning. 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 modeling was performed using HydroCAD Version 9.10 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 basin that is equal to the time of concentration.

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. Prineville has a Type I 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.
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 soils predominate in the study area. Generally, basins include a mix of soil groups; however, some basins or areas are almost exclusively one or the other. For modeling, soil group selection can markedly affect the curve number selected.

The modeling 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 basin. 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 larger lot sizes and densities that are less than the permissible maximum; these areas are less likely to change because of the established nature of the area. The City is moving in the direction of requiring new developments to restrict post-development flows so as not

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

to adversely impact downstream infrastructure. Based on these considerations, modeling 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

Land Use Category	**Curve Numbers for Hydrologic Soil Group** [2]			
	A	**B**	**C**	**D**
Paved parking lots	98	98	98	98
Paved street with curbs and storm sewers	98	98	98	98
Urban Industrial (72% Impervious)	81	88	91	93
Urban Commercial (85% Impervious)	89	92	94	95
Residential				
(1/8 Ac. average lot)	77	85	90	92
(1/4 Ac. average lot)	61	75	83	87
(1/3 Ac. average lot)	57	72	81	86
>75% grass cover in good condition	39	61	74	80

For each basin, the relative proportion (in decimal fractions) of each soil group was estimated from soil mapping. For each land use category of the basin, a curve number (CN) was determined by multiplying each CN by the corresponding decimal fraction of each soil group present in the basin. 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 basin acreage. Summing the results yield the basin curve number that is incorporated in the hydraulic model.

6.3.4 Time of Concentration

Other input parameters for HydroCAD include (for each basin): 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

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

number) method was used to determine T_C for all basins. It is generally applicable for basins of 2000 acres or less. The T_C equations are:

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

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

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

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 basins 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) or more precise information if available. 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. Manning numbers varied according to the pipe or channel type and condition. Generally, n = 0.015 was used for smooth pipe, and n = 0.025 or 0.030 for corrugated metal pipe.

6.4 MODEL RESULTS

A total of 17 basins were modeled for existing conditions and the 2-year 24-hour, 50-year 24-hour, and 100-year 24-hour storm events. The selected basins were divided into subbasins as needed to create a workable model; a total of 60 basins and subbasins were utilized in the modeling effort. The areas to be modeled reflected priorities identified by City staff in discussions with representatives of WH Pacific. Model output for existing conditions included 211 pages of printout, including a detailed routing map, that documents details of the model layout, parameters, and results. These have been presented to the City along with supplemental mapping to identify subbasin locations. A sample printout is included in Appendix 6.1

Model results for each basin are summarized in Table 6.2.

Table 6.2: Basin Modeling Summary
(SBUH Model, Existing Conditions)

Basin	Modeled Area (Ac.)	Percent Impervious Surface	Outlet Characteristics (Pipe size)	Outlet Invert Elevation (ft.)	Full Pipe Capacity (rfs)	2-year 24-hour event		50-year 24-hour event		100-year 24-hour event	
						Peak Flow (cfs)	Total Volume (Ac.ft.)	Peak Flow (cfs)	Total Volume (Ac.ft.)	Peak Flow (cfs)	Total Volume (Ac.ft.)
CR-6	206.3	38.0	36"	55.74	31.66	6.73	7.313	11.99	16.671	14.28	20.246
OC-9	2.9	38.0	12"	45.00	2.93	0.27	0.083	0.99	0.241	1.27	0.301
OC-10	9.8	38.0	6"	51.60	0.21	0.06	0.060	0.21	0.352	0.22	0.484
OC-11	50.1	43.1	15"	49.50	1.84	1.96	2.410	1.97	4.920	1.97	5.858
OC-14	7.8	38.0	6"	64.12	0.21	0.05	0.048	0.21	0.279	0.21	0.383
OC-15	81.2	63.6	18"	48.39	6.84	7.66	4.432	8.07	9.025	8.28	10.666
OC-18	1.5	38.0	6"	57.37	0.23	0.23	0.043	0.24	0.124	0.24	0.154
OC-20	4.5	85.0	6"	60.25	0.18	0.19	0.276	0.19	0.583	0.19	0.683
OC-21	5.3	72.0	6"	64.12	0.21	0.22	0.272	0.21	0.625	0.22	0.718
OC-22	11.3	38.0	6"	65.83	0.21	0.22	0.319	0.22	0.675	0.22	0.684
OC-23	3.0	100	6"	64.12	0.21	0.22	0.242	0.22	0.452	0.22	0.522
OC-24	2.0	30.0	6"	64.12	0.21	0.21	0.055	0.21	0.167	0.21	0.210
OC-25	2.2	30.0	6"	64.12	0.21	0.22	0.056	0.22	0.169	0.21	0.213
OC-26	56.6	63.7	12"	60.55	2.35	2.41	3.196	2.37	6.635	2.36	7.856
OC-27	13.5	38.0	6"	65.83	0.21	0.21	0.380	0.22	0.677	0.22	0.687
OC-29	6.5	38.0	6"	71.00	0.62	0.04	0.040	0.65	0.234	0.65	0.322
OC-32	15.1	38.0	18"	80.00	4.55	0.09	0.093	3.03	0.543	4.81	0.748

SECTION 7: RECOMMENDATIONS

7.1 POTENTIAL CONSTRUCTED IMPROVEMENTS

Representatives of WH Pacific met with City staff to discuss hydraulic modeling results and existing problem areas in order to develop improvement projects that addressed City needs and concerns. Nine projects were identified – one of which was developed into two project alternatives. Consistent with the City's requirement for a 2-year, 24-hour storm basis for treatment related improvements and a 50-year, 24-hour storm basis for hydraulic related improvements, the improvement recommendations were modeled and the proposed designs refined. Pipes were sized using two modeled events. The first event excluded stream tailwater effects in order to evaluate capacity during a summer thunderstorm; the second event utilized tailwater effects from a 50-year flood event. Copies of the modeling results have been provided to the City. Proposed improvements are shown in Exhibits 4.0 - 4.4 and discussed in the following subsections. Opinions of probable cost associated with the various projects are preliminary in nature and should be refined as part of the financing and pre-design process. The proposed improvements are primarily upgrades or replacements of existing drainage facilities; consequently, O & M costs associated with these improvements should not increase.

Most of the projects involve upgrades that significantly increase the hydraulic capacity. While this facilitates drainage and alleviates problems associated with backups and ponding, it does constitute an increased impact on the receiving water body in terms of peak flows. Some projects include consideration of a treatment/detention pond that would reduce peaking effects. Projects involving ODOT or other agencies may, as part of the environmental process, require mitigation for the impact.

Most of the projects also include manholes and allowances for miscellaneous construction. It is anticipated, that some of the budget associated with these items can be utilized in pre-design to modify selected manholes, or for additional facilities, to provide for sedimentation, grease and oil collection, or other water quality related improvements consistent with site specific physical constraints. Lastly, the identified pipeline projects can be constructed in phases, as long as construction commences at the most downstream location and proceeds upstream.

The potential improvement projects are recommendations only and reflect the City's and Engineer's perceived need at the time of plan preparation. As the City's understanding of local stormwater issues becomes more detailed and refined, other opportunities or improvement alternates may be developed. Implementation will ultimately require City discretion to balance stormwater management requirements with political and financial realities.

7.1.1 Project 1 (Basin CR-6) Alternative A

Location and Description. Project 1, Alternative A, is located in Basin CR-6. The project consists of a general upgrade and replacement of the existing drainage system from: SE Idlewood Street and SE 4th Street, then west along SE 4th Street to SE Belknap Street, then south to connect to the new line on SE 5th Street; and from SE Knowledge Street and SE 5th Street, then west along SE 5th Street beyond SW Claypool Street, and south to the Crooked River. 1,185 lineal feet of the existing 36" storm drain will be lined rather than replaced. See Exhibits 4.3 and 4.4.

Existing Flows.

2-year, 24-hour flow: 6.73 cfs, 7.313 Ac-ft.
50-year, 24-hour flow: 11.99 cfs, 16.671 Ac-ft.

Design Flows.

2-year, 24-hour flow: 17.51 cfs, 7.313 Ac-ft.
50-year, 24-hour flow: 39.66 cfs, 16.71 Ac-ft.

Preliminary Opinion of Probable Cost (OPC). A preliminary opinion of probable cost for Project 1, Alternative A is provided in Table 7.1.

Table 7.1: Project 1 (Basin CR-6) Alternative A, Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$75,000	$75,000
18" Storm Drain	1,252	LF	$80	$100,160
21" Storm Drain	3,370	LF	$95	$320,150
24" Storm Drain	975	LF	$120	$117,000
36" Storm Drain	265	LF	$190	$50,350
36" Storm Drain Liner	1,185	LF	$100	$118,500
Manholes	20	EA	$5,000	$100,000
Headwall and Grate	1	LS	$10,000	$10,000
Misc. Construction	1	LS	$100,000	$100,000
Misc. Resurfacing	1	LS	$176,000	$176,000
Traffic Control	1	LS	$25,000	$25,000
		Construction Subtotal		**$1,192,160**
	Contingencies @10%			$119,216
	Engineering @20%			$238,432
	Legal and Administration @5%			$59,608
	Permitting and Easements (allowance)			$50,000
	Project Total			$1,659,416
		Project Total (rounded)		**$1,659,000**

7.1.2 Project 1 (Basin CR-6) Alternative B

Location and Description. For general location information, see Section 7.1.1 above. The project entails the partial replacement of existing asphalt roadways in the project area with permeable surfacing (see Appendix 7.1). Areas to be provided with permeable surfacing are indicated on Exhibits 4.3 and 4.4. Alternative B results in significant capture and percolation of surface water to groundwater with a substantial reduction in both peak and total flow to the Crooked River.

The benefits of Alternative B are proportionate to the total square footage constructed. Alternative B can be constructed in multiple phases, to accommodate budget realities, without compromising the effectiveness of the solution.

Existing Flows.

2-year, 24-hour flow:	6.73 cfs, 7.313 Ac-ft.
50-year, 24-hour flow:	11.99 cfs, 16.671 Ac-ft.

Design Flows.

2-year, 24-hour flow:	1.12 cfs, 0.364 Ac-ft.
50-year, 24-hour flow:	2.82 cfs, 0.852 Ac-ft.

Preliminary Opinion of Probable Cost (OPC). A preliminary opinion of probable cost for Project 1, Alternative B is provided in Table 7.2.

Table 7.2: Project 1 (Basin CR-6) Alternative B, Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$200,000	$200,000
Sawcut Asphalt	40,950	LF	$1.50	$61,425
Surfacing Removal	22,000	SY	$10	$220,000
Excavation	18,333	CY	$20	$366,660
Backfill	18,333	CY	$15	$274,995
Flush Curb	18,330	LF	$15	$274,950
Permeable Pavers[1]	198,000	SF	$12	$2,376,000
Misc. Construction	1	LS	$200,000	$200,000
Misc. Resurfacing	1	LS	$200,000	$200,000
Traffic Control	1	LS	$50,000	$50,000
		Construction Subtotal		**$4,224,030**
	Contingencies @10%			$422,403
	Engineering @20%			$844,806
	Legal and Administration @5%			$211,202
	Permitting and Easements (allowance)			$10,000
	Project Total			$5,712,441
		Project Total (rounded)		**$5,712,000**

[1] *Permeable asphalt (at $9/sf) results in a $594,000 construction cost savings. Total OPC for a permeable asphalt alternative is $4,911,000.*

7.1.3 Project 2 (Basin OC-11)

Location and Description. Project 2 is located in Basin OC-11. The project consists of a general upgrade and replacement of the existing drainage system from: N Main Street and NW 9th Street, then west along NW 9th Street to NW Harwood Avenue, then south to Ochoco Creek. See Exhibit 4.1.

Existing Flows.

2-year, 24-hour flow: 1.96 cfs, 2.410 Ac-ft.
50-year, 24-hour flow: 1.97 cfs, 4.920 Ac-ft.

Preliminary Opinion of Probable Cost (OPC). A preliminary opinion of probable cost for Project 2 is provided in Table 7.3.

Table 7.3: Project 2 (Basin OC-11) Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$40,000	$40,000
18" Storm Drain	960	LF	$80	$76,800
21" Storm Drain	320	LF	$95	$30,400
24" Storm Drain	1,290	LF	$120	$154,800
Manholes	8	EA	$5,000	$40,000
Headwall and Grate	1	LS	$8,000	$8,000
Misc. Construction	1	LS	$50,000	$50,000
Misc. Resurfacing	1	LS	$48,000	$48,000
Traffic Control	1	LS	$10,000	$10,000
		Construction Subtotal		**$458,000**
	Contingencies @10%			$45,800
	Engineering @20%			$91,600
	Legal and Administration @5%			$22,900
	Permitting and Easements (allowance)			$15,000
	Project Total			$633,300
		Project Total (rounded)		**$633,000**

7.1.4 Project 3 (Basin OC-15)

Location and Description. Project 3 is located primarily in Basin OC-15; but as a result of hydraulic modifications, Project 3 also incorporates flow from Basin OC-10 and Basin OC-14. The project consists of a general upgrade and replacement of the existing drainage system along W 3rd Street between SE Court Street and SE Harwood Avenue. A new line will route flows north along Harwood Avenue to Ochoco Creek, thereby replacing the "Mill race pipe," associated with Problem Areas J and K, as the basin's outfall line. An additional line will be extended from the new line on Harwood, along NW 4th Street, to the "Mill race pipe." 3rd Street is an ODOT highway; consequently, permitting and construction costs will likely be higher than in other parts of the City. The project addresses issues associated with Problem Area F and J. Problem Area G issues will likely be resolved or alleviated in pre-design. Problem Area K is addressed as Project 8 (Section 7.1.9). See Exhibits 4.1, 4.3, and 4.4.

Existing Flows.

2-year, 24-hour flow: 7.66 cfs, 4.432 Ac-ft.
50-year, 24-hour flow: 80.7 cfs, 9.025 Ac-ft.

Design Flows.

2-year, 24-hour flow: 15.33 cfs, 3.982 Ac-ft.
50-year, 24-hour flow: 29.75 cfs, 8.016 Ac-ft.

Preliminary Opinion of Probable Cost (OPC). A preliminary opinion of probable cost for Project 3 is provided in Table 7.4.

Table 7.4: Project 3 (Basin OC-15) Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$75,000	$75,000
15" Storm Drain	270	LF	$70	$18,900
18" Storm Drain	1,020	LF	$80	$81,600
21" Storm Drain	320	LF	$95	$30,400
24" Storm Drain	640	LF	$120	$76,800
27" Storm Drain	350	LF	$140	$49,000
36" Storm Drain	715	LF	$190	$135,850
42" Storm Drain	1,025	LF	$220	$225,500
Manholes	17	EA	$5,000	$85,000
Headwall and Grate	1	LS	$15,000	$15,000
Misc. Construction	1	LS	$100,000	$100,000
Misc. Resurfacing	1	LS	$220,000	$220,000
Traffic Control	1	LS	$50,000	$50,000
		Construction Subtotal		**$1,163,050**
	Contingencies @10%			$116,305
	Engineering @20%			$232,610
	Legal and Administration @5%			$58,153
	Permitting and Easements (allowance)			$100,000
	Project Total			$1,670,118
		Project Total (rounded)		**$1,670,000**

An alternate project is shown in Exhibits 4.1, 4.3, and 4.4 where the 42" line is routed west on NW 6th Street to NW Locust Street, then north on Locust, then west to a vacant parcel (141631CD02000) adjacent to Ochoco Creek, where the system will discharge. The 2010 RMV is $62,400. The parcel is currently outside the City limits and is zoned Suburban Residential. Specifics for a treatment/detention facility have not been identified at this time; consequently, the budget will need to be adjusted if this alternative is pursued. The project adds 200 LF of the 42" storm drain to Project 3, as well as site acquisition, and the treatment/detention facilities. An order of magnitude estimate for the additional (to Project 3) costs to implement this alternate is $300,000 - $400,000.

7.1.5 Project 4 (Basin OC-18)

Location and Description. Project 4 is located in Basin OC-18. The project consists of a general upgrade and replacement, with a new extension to eliminate, or alleviate, issues associated with Problem Area C, from: 5th Street and Claypool Street, west to Deer Street, then north to Ochoco Creek. See Exhibit 4.3.

Existing Flows.

2-year, 24-hour flow: 0.23 cfs, 0.043 Ac-ft.
50-year, 24-hour flow: 0.24 cfs, 0.124 Ac-ft.

Design Flows.

2-year, 24-hour flow: 1.85 cfs, 0.225 Ac-ft.
50-year, 24-hour flow: 6.42 cfs, 0.654 Ac-ft.

Preliminary Opinion of Probable Cost (OPC). A preliminary opinion of probable cost for Project 4 is provided in Table 7.5.

Table 7.5: Project 4 (Basin OC-18) Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$10,000	$10,000
18" Storm Drain	580	LF	$80	$46,400
Manholes	3	EA	$5,000	$15,000
Headwall and Grate	1	LS	$7,000	$7,000
Misc. Construction	1	LS	$15,000	$15,000
Misc. Resurfacing	1	LS	$14,000	$14,000
Traffic Control	1	LS	$5,000	$5,000
		Construction Subtotal		**$112,400**
	Contingencies @10%			$11,240
	Engineering @20%			$22,480
	Legal and Administration @5%			$5,620
	Permitting and Easements (allowance)			$5,000
	Project Total			$156,740
		Project Total (rounded)		**$157,000**

7.1.6 Project 5 (Basin OC-21)

Location and Description. Project 5 is located in Basin OC-21. The project consists of a general upgrade of the existing storm drainage system from: NW 4th Street and Main Street, north along Main Street to Ochoco Creek. This project addresses capacity issues associated with Problem Area D. See Exhibit 4.2.

Existing Flows.

2-year, 24-hour flow: 0.22 cfs, 0.272 Ac-ft.
50-year, 24-hour flow: 0.21 cfs, 0.625 Ac-ft.

Design Flows.

2-year, 24-hour flow: 2.23 cfs, 0.272 Ac-ft.
50-year, 24-hour flow: 5.61 cfs, 0.625 Ac-ft.

Preliminary Opinion of Probable Cost (OPC). A preliminary opinion of probable cost for Project 5 is provided in Table 7.6.

Table 7.6: Project 5 (Basin OC-21) Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$10,000	$10,000
18" Storm Drain	550	LF	$80	$44,000
Manholes	3	EA	$5,000	$15,000
Headwall and Grate	1	LS	$7,000	$7,000
Misc. Construction	1	LS	$15,000	$15,000
Misc Resurfacing	1	LS	$14,000	$14,000
Traffic Control	1	LS	$5,000	$5,000
		Construction Subtotal		**$110,000**
	Contingencies @10%			$11,000
	Engineering @20%			$22,000
	Legal and Administration @5%			$5,500
	Permitting and Easements (allowance)			$5,000
	Project Total			$153,500
		Project Total (rounded)		**$154,000**

7.1.7 Project 6 (Basin OC-22)

Location and Description. Project 6 is located in Basin OC-22. The project consists of a general upgrade and replacement of the existing drainage system from: N Main Street and NE 7th Street, south along N Main Street to Ochoco Creek. See Exhibit 4.2.

Existing Flows.

2-year, 24-hour flow: 0.22 cfs, 0.319 Ac-ft.
20-year, 24-hour flow: 0.22 cfs, 0.675 Ac-ft.

Design Flows.

2-year, 24-hour flow: 1.05 cfs, 0.319 Ac-ft.
50-year, 24-hour flow: 3.86 cfs, 0.926 Ac-ft.

Preliminary Opinion of Probable Cost (OPC). A preliminary opinion of probable cost for Project 6 is provided in Table 7.7.

Table 7.7: Project 6 (Basin OC-22) Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$5,000	$5,000
15" Storm Drain	235	LF	$70	$16,450
Manholes	2	EA	$5,000	$10,000
Headwall and Grate	1	LS	$7,000	$7,000
Misc. Construction	1	LS	$7,000	$7,000
Misc Resurfacing	1	LS	$6,000	$6,000
Traffic Control	1	LS	$5,000	$5,000
		Construction Subtotal		**$56,450**
	Contingencies @10%			$5,645
	Engineering @20%			$11,290
	Legal and Administration @5%			$2,823
	Permitting and Easements (allowance)			$5,000
	Project Total			$81,208
		Project Total (rounded)		**$81,000**

7.1.8 Project 7 (Basin OC-27)

Location and Description. Project 7 is located in Basin OC-27. The project consists of a general upgrade and replacement of the existing drainage system from: NE 7th Street to NE Elm Street, then south along Elm to Ochoco Creek. The project addresses capacity and grade issues associated with Problem Area E. See Exhibit 4.2.

Existing Flows.

2-year, 24-hour flow: 0.21 cfs, 0.380 Ac-ft.
50-year, 24-hour flow: 0.22 cfs, 0.677 Ac-ft.

Design Flows.

2-year, 24-hour flow: 1.22 cfs, 0.380 Ac-ft.
50-year, 24-hour flow: 4.52, cfs, 1.104 Ac-ft.

Preliminary Opinion of Probable Cost (OPC). A preliminary opinion of probable cost for Project 7 is provided in Table 7.8

Table 7.8: Project 7 (Basin OC-27) Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$10,000	$10,000
15" Storm Drain	943	LF	$70	$66,010
Manholes	6	EA	$5,000	$30,000
Headwall and Grate	1	LS	$7,000	$7,000
Misc. Construction	1	LS	$15,000	$15,000
Misc Resurfacing	1	LS	$18,500	$18,500
Traffic Control	1	LS	$10,000	$10,000
		Construction Subtotal		**$156,510**
	Contingencies @10%			$15,651
	Engineering @20%			$31,302
	Legal and Administration @5%			$7,826
	Permitting and Easements (allowance)			$10,000
	Project Total			$221,289
		Project Total (rounded)		**$221,000**

7.1.9 Project 8 (Basin OC-15)

Project 8 is located in Basin OC-15 and is associated with Project 3 and Problem Area 3. Specifically, the existing stormwater facilities ("Mill race pipe") is estimated to be 75% full of petroleum contaminated soil. The problem is estimated to extend to 300 lineal feet (LF) of 48" pipe, 560 LF of 24" pipe, and 1,100 LF of 18" pipe. The project entails sampling, testing, removal, and disposal of the contaminated sediments and water. An opinion of probable "construction cost" is $225,000; total cost is $300,000 including engineering, project observation, legal, and administrative costs.

7.1.10 Project 9 (Basin OC-4 and OC-5)

Location and Description. Project 9 is located in Basins OC-4 and OC-5. The project consists of a new storm drain that addresses ponding issues associated with Problem Areas A and B. The project starts near Lamonta Road and runs south on NW Harwood Street to 12th Street, then west on 12th Street, to Ochoco Creek. The discharge will be located on a parcel (141631CO12000). The 2010 RMV for the land is $75,000. Land cost is included in Table 7.9. Specifics for a treatment/detention facility have not been identified at this time; consequently, the budget will need to be adjusted if a treatment/detention facility is added to the project. An order of magnitude estimate for the treatment/detention facility is $100,000 - $200,000.

Preliminary Opinion of Probable Cost. A preliminary opinion of probable cost is provided in Table 7.9.

Table 7.9: Project 9 (Basin OC-4 and OC-5) Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
Mobilization	1	LS	$20,000	$20,000
18" Storm Drain	2,000	LF	$80	$160,000
Manholes	6	EA	$5,000	$30,000
Headwall and Grate	1	LS	$7,000	$7,000
Misc. Construction	1	LS	$25,000	$25,000
Misc Resurfacing	1	LS	$40,000	$40,000
Traffic Control	1	LS	$15,000	$15,000
		Construction Subtotal		**$297,000**
	Contingencies @10%			$29,700
	Engineering @20%			$59,400
	Legal and Administration @5%			$14,850
	Permitting and Easements (allowance)			$10,000
	Land Acquisition			$90,000
	Project Total			$410,950
		Project Total (rounded)		**$411,000**

7.1.11 Capital Improvement Plan

Actual scheduling of improvements will be dependent on the City's perception of need relative to affordability. Projects should be pursued according to the following schedule:

Priority	Timeline
Urgent	As soon as possible
High	Within next 2 years
Medium	Within next 5 years
Low	Within next 10+ years

The timeline is not intended to be an inflexible schedule, but rather a guide based on current perception of problem areas and needs. Some low priority projects, because of perceived benefits relative to cost, may be constructed prior to higher priority projects. Also, street improvement projects should incorporate recommended storm drainage improvements regardless of priority classification because of the cost effectiveness of coordinated design and construction.

Proposed projects and associated priorities are summarized in Table 7.10.

Table 7.10: Stormwater Capital Improvement Summary

Project Number	Construction Total	Project Total	Priority
1A [1]	$1,192,000	$1,659,000	Low
1B [1]	$4,224,000	$5,712,000	Low
2	$458,000	$633,000	High
3	$1,163,000	$1,670,000	Medium
4	$112,000	$157,000	Urgent
5	$110,000	$154,000	Low
6	$56,000	$81,000	Low
7	$157,000	$221,000	High
8	$225,000	$300,000	Urgent
9	$297,000	$411,000	Medium
Total	**$3,770,000 - $6,802,000**	**$5,286,000 - $9,339,000**	---

Project Priority	Construction Totals	Project Totals
Urgent	$337,000	$457,000
High	$615,000	$854,000
Medium	$1,460,000	$2,081,000
Low	$1,358,000-$4,390,000	$1,894,000-$5,947,000

[1] *Note: Projects 1A and 1B are alternative approaches.*

7.2 DESIGN AND DEVELOPMENT STANDARDS

The City of Prineville is currently developing new standards and approaches for stormwater management. WH Pacific has been working with the City and has provided them with materials (Appendix 7.2) for consideration and comment. Emphasis has been placed on the development of a simplified methodology to determine stormwater rates and volumes associated with small site (less than one acre) development. The methodology utilizes the rational method and, as such, should result in conservative estimates.

In Prineville, the standard stormwater design criteria generally follows the Central Oregon Stormwater Manual (COSM):

i) The Water Quality Storm shall be the 2 year 24 hour storm. Verify the facilities can hold the water quality storm without considering infiltration.

ii) The Detention Storm shalll be the 50 year 24 hour storm. Verify the facilities can hold the detention storm with infiltration factored in.

iii) The Overflow Storm shall be the 100 year 24 hour storm. Verify the facilities can hold the overflow storm with infiltration factored in. If the facilities overflow, verify the excess water is maintained onsite without causing any damage to the site. If the site overflows to the public right of way, verify the overflow does not impact existing facilities. If the overflow impacts the existing facilities, determine required upgrades to the existing public system.

Note that (i) and (ii) above are more conservative than that provided for by the COSM, but consistent with efforts in other areas (City of Redmond).

As an alternative, for simple sites, no infiltration testing will be required and the Detention Storm shall be the 25 year 24 hour storm. Approval to utilize the alternative approach is subject to the discretion of the City Engineer.

The City also intends to require all new development and redevelopment to manage all stormwater, created by the development, onsite. Some developed lots in the urban core may not be practicably developed in accordance with this requirement. The City could develop, perhaps as a zoning overlay, an exemption area in which the requirement would not be applicable; or it could implement a mitigation program whereby the "exempt" properties could pay a (to be determined) fee that would either go directly to a mitigation project or to a City-established stormwater fund; the monies of which could be used, at the City's discretion, for stormwater related projects, programs, or maintenance. The latter approach would preserve the intent of having *all* development or redevelopment participate in managing stormwater.

The Central Oregon Stormwater Manual (COSM) is an excellent resource and should be adopted by the City. COSM takes into account that stormwater management facilities need to be designed for site specific requirements and subject to good engineering judgment. In Prineville, areas with high groundwater will limit the range of stormwater management alternatives, best management practices, and constructed facilities considered; however, these limitations will arise during the planning and review process. Adoption of the document does not preclude the City from modifying provisions of the manual or from developing additional or alternate criteria. Specifically, the City may decide to develop a stormwater ordinance, in which the COSM is adopted, that includes the more stringent design event requirements noted above, other stormwater planning or design standards developed by the City, and a statement that reserves the right for the City, or the City's Engineer, to determine if any specified stormwater planning or design effort is adequate or sufficient, and if any additional work is needed to protect the City's interests.

7.3 WATER QUALITY

A basic program of water quality sampling and testing to determine general impacts of the City of Prineville on water quality in the Crooked River and Ochoco Creek is included below in Section 7.3.1 and 7.3.2. These sections represent a summary, and elaboration, of an August 13, 2010 letter from WH Pacific to the City. A copy of the original letter is included in Appendix 7.3.

7.3.1 Existing Water Quality Data Review

As part of the overall analysis of water quality data for the Crooked River Watershed, pertaining particularly to the quality of the City of Prineville's stormwater, available water quality data collected from numerous sources was reviewed. The data was reviewed primarily for timeframe, location, and analyses performed. The multi source data was reviewed to potentially supplement the City of Prineville's non-point source stormwater sampling as part of the preparation of this Stormwater Master Plan.

The sample locations and potential analytes of concern for the water quality testing performed by various entities over the last 20 years within the Crooked River Watershed on the Crooked River and Ochoco Creek near Prineville was evaluated. As a result of this evaluation, we have concluded that the identified locations are useful for the intended watershed use, but are not directly useful for the specific urban stormwater testing requirements of this project. Numerous anomalies were identified within the data sets; however, the primary issue with the data is related to the intended use of the data. The data collected is to be used to assess the quality and health of the rivers and watershed, but the data needed going forward and for the purpose of the assessing the stormwater quality as it enters the river system is different and very specific.

7.3.2 Stormwater Monitoring Criteria

The purpose of the City of Prineville's preliminary municipal stormwater sampling will be to initially identify parameters of concern currently present in the stormwater. This will give the City information to establish priorities for selecting, sighting, and installing municipal control measures and best management practices as the Stormwater Pollution Reduction Plan is implemented. Additionally, it will provide baseline stormwater quality data to build a Municipal Stormwater Sampling Plan around.

The uncertainty of storm events and rain fall volume are two of the greatest challenges to obtaining stormwater samples. Staff will need to be prepared and available to sample once the necessary rain volume threshold has been met. City staff will also need to identify the amount of rainfall necessary during different seasons to create sufficient flow to the specific outfalls. For example, drainage basins that drain larger areas will likely require a lesser volume of precipitation to have stromwater flow at the outfall than drainage basins draining smaller areas. This will be identified over time and should be noted for use by future employees.

Immediate implementation of stormwater monitoring for Prineville will utilize the collection of stormwater samples at the river outfalls (preferable) or from collection facilities such as catch basins as close to the rivers as possible. Sampling from catch basins should only be performed as a last resort and if sufficient flow is actively coming into the catch basin so that it has been thoroughly flushed. Sampling from catch basins is not preferable due to stagnant water and concentrated collection of contaminants. It is ill-advised to have only catch basin samples acquired during any sampling event. Outfall sampling will be the most representative, but may not always be possible due to the elevation of some of the outfalls. It appears that many of the outfalls are under water much of the year. This will need to be identified during each storm event as to whether a given stormwater outfall is accessible due to the river level. In the future, as Best Management Practices are put into place, easily accessible and safe sampling locations should be added to the design.

Monitoring results may be used to assess current water quality conditions, evaluate changes in water quality throughout different seasons or over a period of years. The monitoring results may also be used to identify significant sources of pollution or times of year when water quality is considerably worse. Trends may correlate with land use changes or implementation of BMPs. The City of Prineville has 20+ stormwater outfalls to the Crooked River and Ochoco Creek. This should allow for numerous outfall locations to be sampled during a precipitation event. Depending on the number of samples taken per event and the number of events monitored in a year, a long-term stormwater sampling plan can be established from the data assuming good sampling protocols and quality assurance/quality control (QA/QC) procedures are utilized.

The following is a listing of potential preliminary stormwater sampling parameters:

Basic Parameters $405 [1]

Benzo(a)pyrene
Antimony
Arsenic
Cadmium
Copper
Lead
Zinc
pH
bacteria- Coli form and e. Coli

Substantial Parameters $1525 [1]

NWPH-Dx
volatile organic compounds
Polyaromatic hydrocarbons (add phenols and phalates)
13 priority pollutant metals
herbicide screening
pesticide screening
cyanide

Due to the lack of information regarding current municipal stormwater quality for the City of Prineville numerous samples should be acquired prior to formalizing a municipal stormwater sampling plan. 20-25% of the outfalls should be tested per stormwater event in at least two events in a year. Typical protocol is to acquire twice as many samples in the first year of sampling as compared to the subsequent sampling years. If this is not possible then 8-10 samples should be acquired as precipitation volume allows. The stormwater sampling budget will dictate how many samples can be taken and from which sampling parameter list (see above), but the more analytical data available for review, the higher the degree of confidence in choosing the appropriate stormwater sampling parameters for subsequent sampling events. This analytical data should be reviewed for sampling protocols and QA/QC. This amount of quality stormwater sampling data will likely lead to a sound, defendable municipal sampling program.

7.3.3 NPDES Phase II MS4 Considerations

Prineville has not been required to have an NPDES Phase II MS4 permit. Should this be required, the City will need to undertake a more structured and costly sampling

[1] Estimated laboratory analytical prices are included, however, this will vary based on laboratory, sample method specified and turnaround time for the results. Shipping costs not included.

program. The previously described general monitoring program will allow the City, in consultation with the City's Engineer and DEQ, to better identify the sample locations for the more costly sampling, as well as minimize the overall cost of implementing the program. Note, the more costly sampling and testing is typically conducted a few times per year at pre-selected outfall locations. The number of sites, frequency of sampling, and parameters to be tested will be determined in consultation with DEQ.

The stormwater Phase II regulatory requirements also provide an excellent general outline of measures that can be implemented by the City 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. An EPA document describing and providing guidance on each measure can be found on the EPA website:

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Minimum Measure #1, "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.

Minimum Measures #2 and #3, "public education and outreach" and "public involvement / participation" should be implemented by the City. In general, the effort should be ongoing and evolving. The implicit goal is to maintain an awareness of stormwater issues as well as expand the level of understanding and participation.

Water quality issues are best addressed as close to the source as possible; consequently, the public education program is an important 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.

Minimum Measure #4, "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 staff involvement –

especially in areas requiring access across private property. The City should develop an illicit discharge detection and elimination program. Priority should be given to those basins most likely to have significant contaminant 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 Measures #5 and #6, "construction site stormwater runoff control" and "post construction runoff control," should be addressed by City Ordinances or by reference to COSM. The intent is to control erosion and reduce sediment laden runoff. Erosion is a natural process that exists everywhere to some extent. Erosion from, or stemming from, human activities, if not managed, 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 - at the initial source.

Since implementation of the minimum measures is not required at this time, the City can determine how vigorously it will pursue the recommendations and budget accordingly. Much of the work can be done in-house, with citizen task forces, and with the consultation and assistance of various organizations and agencies interested in stormwater related issues in Prineville. Development of a stormwater utility (see Section 8.2.2) could provide monies for implementation and ongoing work.

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 and management of stormwater runoff. If funds are not made available to address existing problems, the risk of stormwater related damage or pollution 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 stormwater 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 Bonds. 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 stormwater 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.

Stormwater Utility. See Section 8.2.2.

System Development Charges. See Section 8.2.3.

8.2.2 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. 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.

On June 20, 2001, the Bend City Council approved a Stormwater Utility Fee of $4.00 per equivalent residential unit (ERU).[1] This is consistent with what recent literature note as the approximate limit of political palatability. Bend determined that the average family residence in Bend has 3,800 square feet of impermeable surface coverage (roofs, driveways, walkways, patios, gravel, or other packed surfaces), where one ERU is equal to 3,800 square feet of impermeable surface. For non-residential development, the number of ERUs, and subsequent billings, can be determined by dividing the impermeable area by the 3,800 square feet per ERU figure. While this approach will undoubtedly work for Prineville, determining the average impermeable area per ERU and the number of ERUs associated with each non-residential development will take considerable time and effort to implement. As an initial, practicable alternative, the City could implement a flat fee of $4.00 per sewer billing. This could be added directly to the sewer billing, thereby adding nominal administrative costs. Because of the simplicity of this approach, it can be implemented without the detailed study required for the "ERU" approach. Based on the approximate 3,600 active sewer connections, this would yield $172,800 per year. Monies generated by the utility fee can be used, in part, to study the "ERU" approach. The ERU approach should yield additional monies; however, the study should also determine whether the increased complexity and administrative costs associated with the ERU approach are not so high as to offset the extra revenues generated. Monies from the stormwater utility fee can also be used to supplement and expand current public works efforts devoted to stormwater development.

Dedicated efforts by the City to inform and involve the public will be needed to obtain support for the establishment of a stormwater utility.

[1] ERUs are also known as EDUs (equivalent dwelling units).

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.

The Prineville Code of Ordinances includes: "Chapter 40: System Development Charges" which was passed as Ordinance 1111 on May 5, 2004. The ordinance was specifically worded for sewer, water, and transportation; consequently, a modification will be required to authorize SDCs for stormwater. SDCs require some basis, such as the ERU basis described in Section 8.2.2 above. Since SDCs are for capacity building, stormwater SDCs are probably not consistent with the City's intent to have all new development manage stormwater so as not to exceed pre-development conditions. To the extent that the intent is realized, there will be no increase in capacity needs that would otherwise provide the basis for the SDC.

8.2.4 Funding Programs

General. There are relatively few state or federal funding programs that provide financial assistance for municipal stormwater 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 stormwater 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.

Rural Development

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 stormwater 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.

Prinville's 2009 population has been estimated, by the Center for Population Research and Census (Portland State University), to be 10,370 persons. On the surface, this would appear to disqualify the City from receiving RD funds; however, the 10,370 figure is only an estimate. PSU will use the 2010 Census figures, when available, to provide a new basis for future population estimates. It is not uncommon for PSU figures to be adjusted significantly after a new Census is available. In short, Prineville's 2010 population may actually be below the 10,000 person threshold for RD funding, thereby making the City eligible.

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. Interest rates vary from 25% to 65% of the base rate depending on project category and term (5-year, 10-year, 15-year, or 20-year). The base rate is based on the weekly state and local government bond interest rates for the preceding quarter. This base rate is the "state and local bonds" entry reported in the "Federal Statistical Release, H.15." 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.

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.

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.

Project 3 may be eligible for funding through this program. The City should contact ODOT regarding current policies and program requirements.

Federal Emergency Management Agency

The Federal Emergency Management Agency (FEMA) has two programs that may be utilized for stormwater 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.

8.3 IMPLEMENTATION

The City will need to consider the recommendations of this Plans in the context of its many other goals and obligations. Prioritizing, budgeting, and constructing the recommended capital improvements will take several years – at least. Implementation of water quality sampling and testing, as well as data acquisition and analysis, will also be implemented over the next several years in accordance with perceived need and available budget. The most immediate and effective measure the City can implement, with minimal effort and cost, is a simple, flat rate of $4.00 per month per sewer billing stormwater utility fee; this is similar to Bend and the national average. Since this is estimated (Section 8.2.2) to yield $172,800 in annual revenue, implementation as soon as possible can generate the revenues to fund much of the stormwater related work (water quality sampling, funding applications, environmental studies, preliminary design work, ongoing and expanded O & M, etc.). In general, monies generated by the stormwater utility can assist in implementing other recommendations of this Plan.

8.4 PUBLIC INFORMATION

Dissemination of information to the public regarding stormwater 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.

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 it is 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.

[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.

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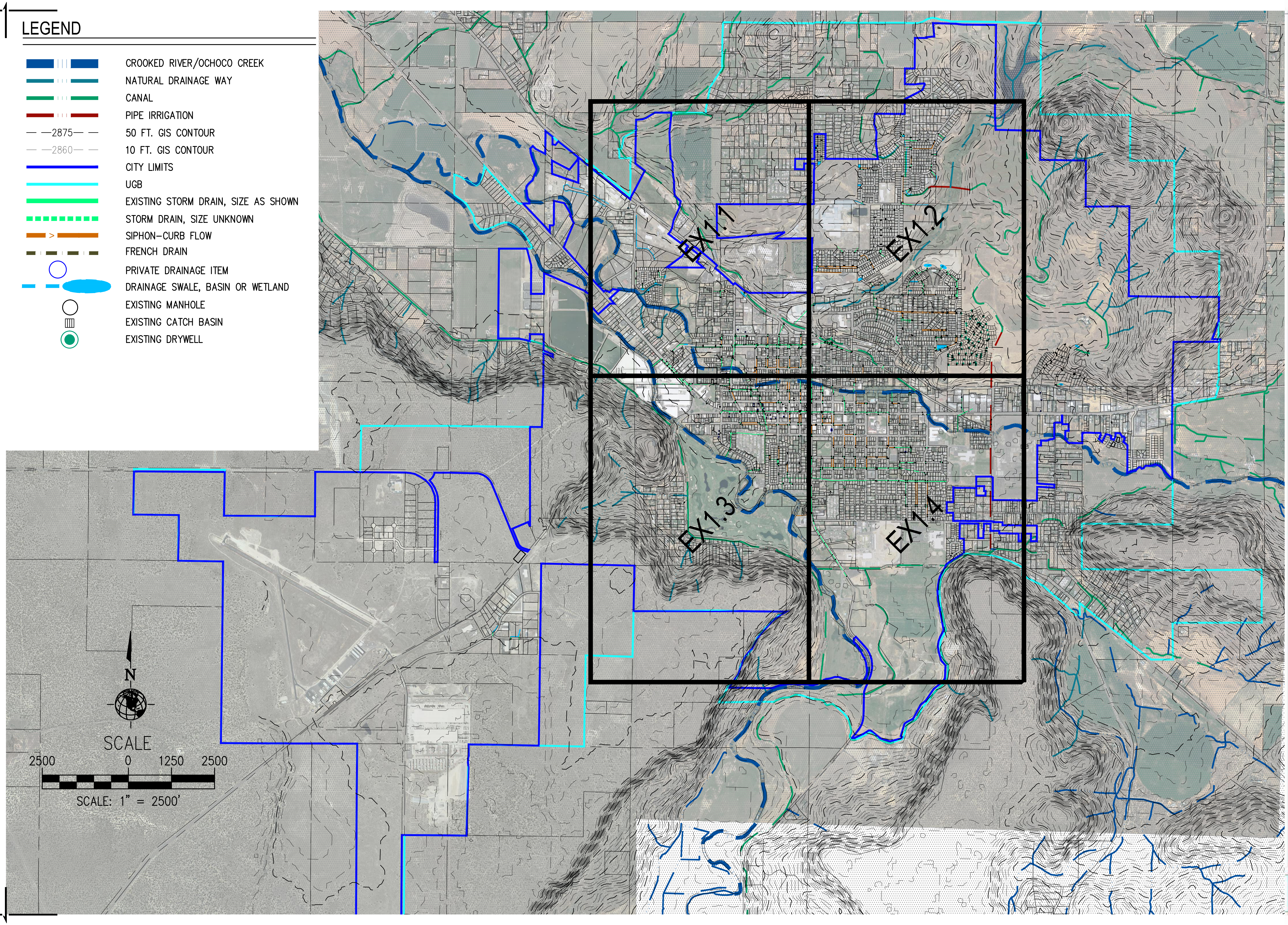
EXHIBIT 1.0 - 1.4

Existing Drainage System Infrastructure



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CITY OF PRINEVILLE

EXISTING CONDITIONS OVER ALL

CITY OF PRINEVILLE STORMWATER MASTER PLAN

PROJECT NUMBER 036612

DRAWING FILE NAME 036612-EC-EX1

SCALE 1" = 2500'

EX1.0

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LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- —2875— 50 FT. GIS CONTOUR
- —2860— 10 FT. GIS CONTOUR
- CITY LIMITS
- UGB
- EXISTING STORM DRAIN, SIZE AS SHOWN
- STORM DRAIN, SIZE UNKNOWN
- SIPHON–CURB FLOW
- FRENCH DRAIN
- PRIVATE DRAINAGE ITEM
- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL

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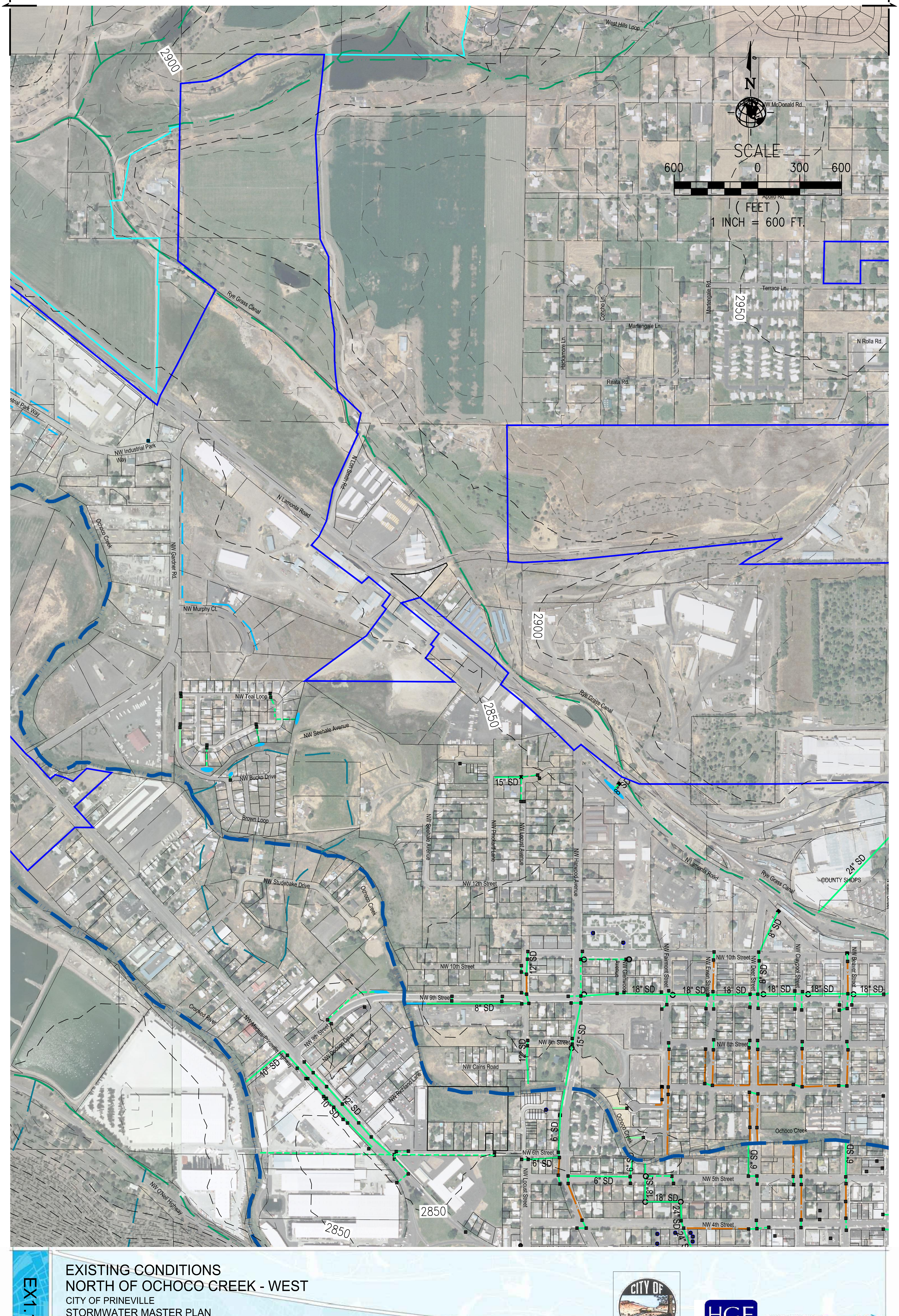


EXISTING CONDITIONS
NORTH OF OCHOCO CREEK - WEST
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-EC-EX1	1" = 600'

CITY OF PRINEVILLE
HGE INC
WHPacific

EX1.1

LEGEND

—2875—	50 FT. GIS CONTOUR
—2860—	10 FT. GIS CONTOUR

CROOKED RIVER/OCHOCO CREEK

NATURAL DRAINAGE WAY

CANAL

PIPE IRRIGATION

50 FT. GIS CONTOUR

10 FT. GIS CONTOUR

CITY LIMITS

UGB

EXISTING STORM DRAIN, SIZE AS SHOWN

STORM DRAIN, SIZE UNKNOWN

SIPHON–CURB FLOW

FRENCH DRAIN

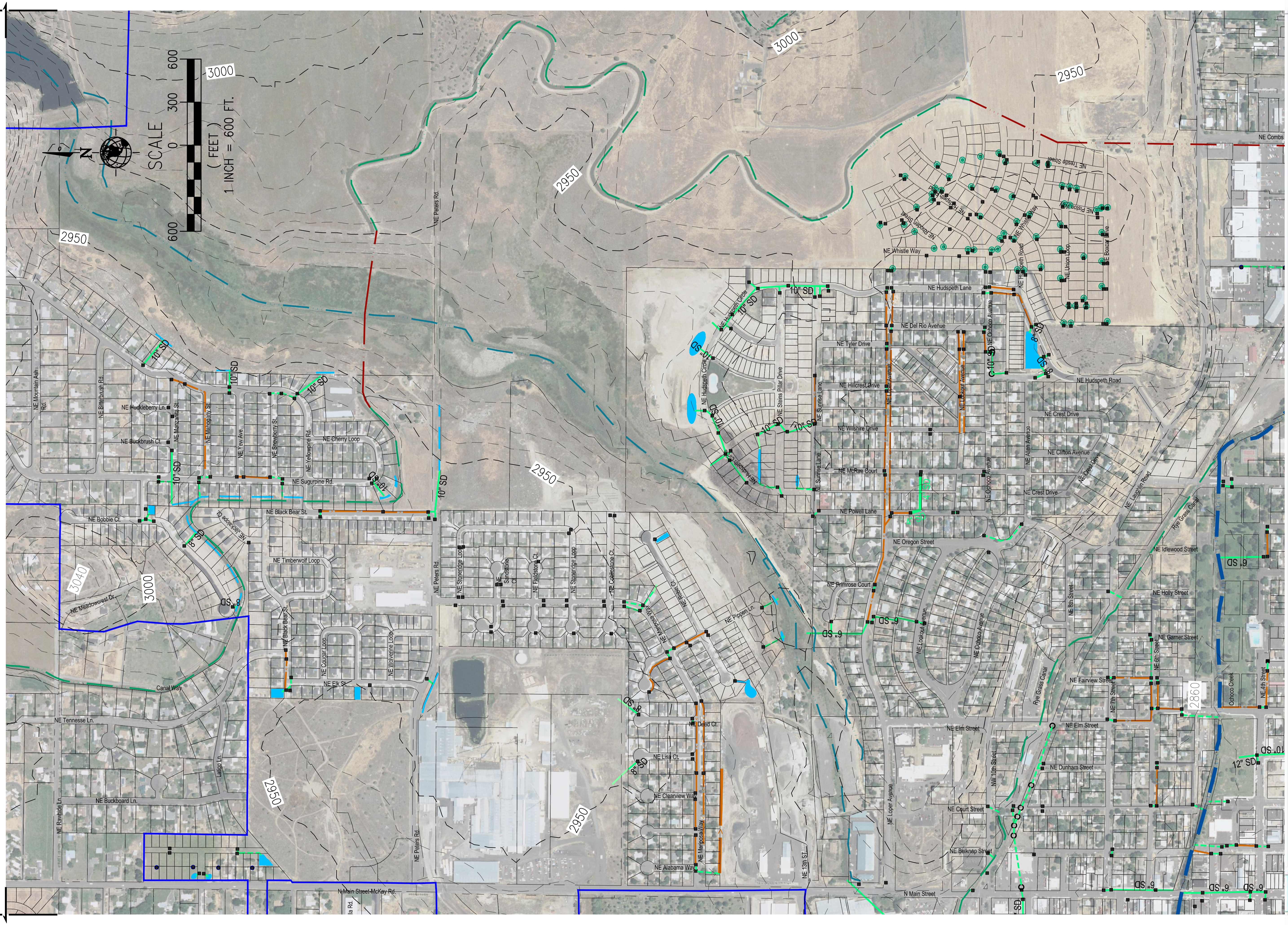
PRIVATE DRAINAGE ITEM

DRAINAGE SWALE, BASIN OR WETLAND

EXISTING MANHOLE

EXISTING CATCH BASIN

EXISTING DRYWELL



EXISTING CONDITIONS
NORTH OF OCHOCO CREEK - EAST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER 036612
DRAWING FILE NAME 036612-EC-EX1
SCALE 1" = 600'

EX1.2

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CITY OF PRINEVILLE

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LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- 2875 — 50 FT. GIS CONTOUR
- 2860 — 10 FT. GIS CONTOUR
- CITY LIMITS
- UGB
- EXISTING STORM DRAIN, SIZE AS SHOWN
- STORM DRAIN, SIZE UNKNOWN
- SIPHON–CURB FLOW
- FRENCH DRAIN
- PRIVATE DRAINAGE ITEM
- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL

[DATE: 4/13/2011 9:29 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
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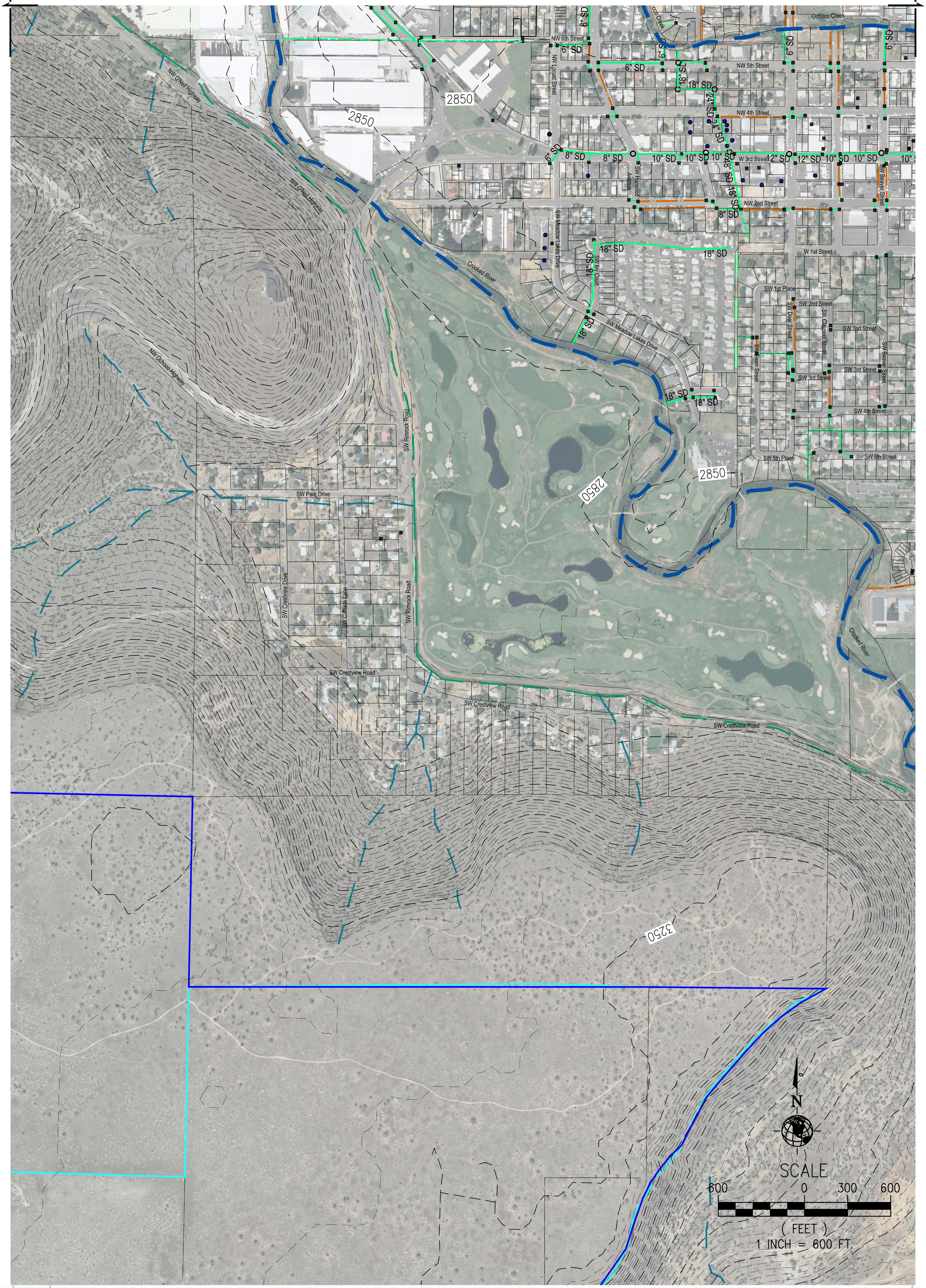

EX1.3

EXISTING CONDITIONS
SOUTH OF OCHOCO CREEK - WEST
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER 036612
DRAWING FILE NAME 036612-EC-EX1
SCALE 1" = 600'

CITY OF PRINEVILLE
HGE INC
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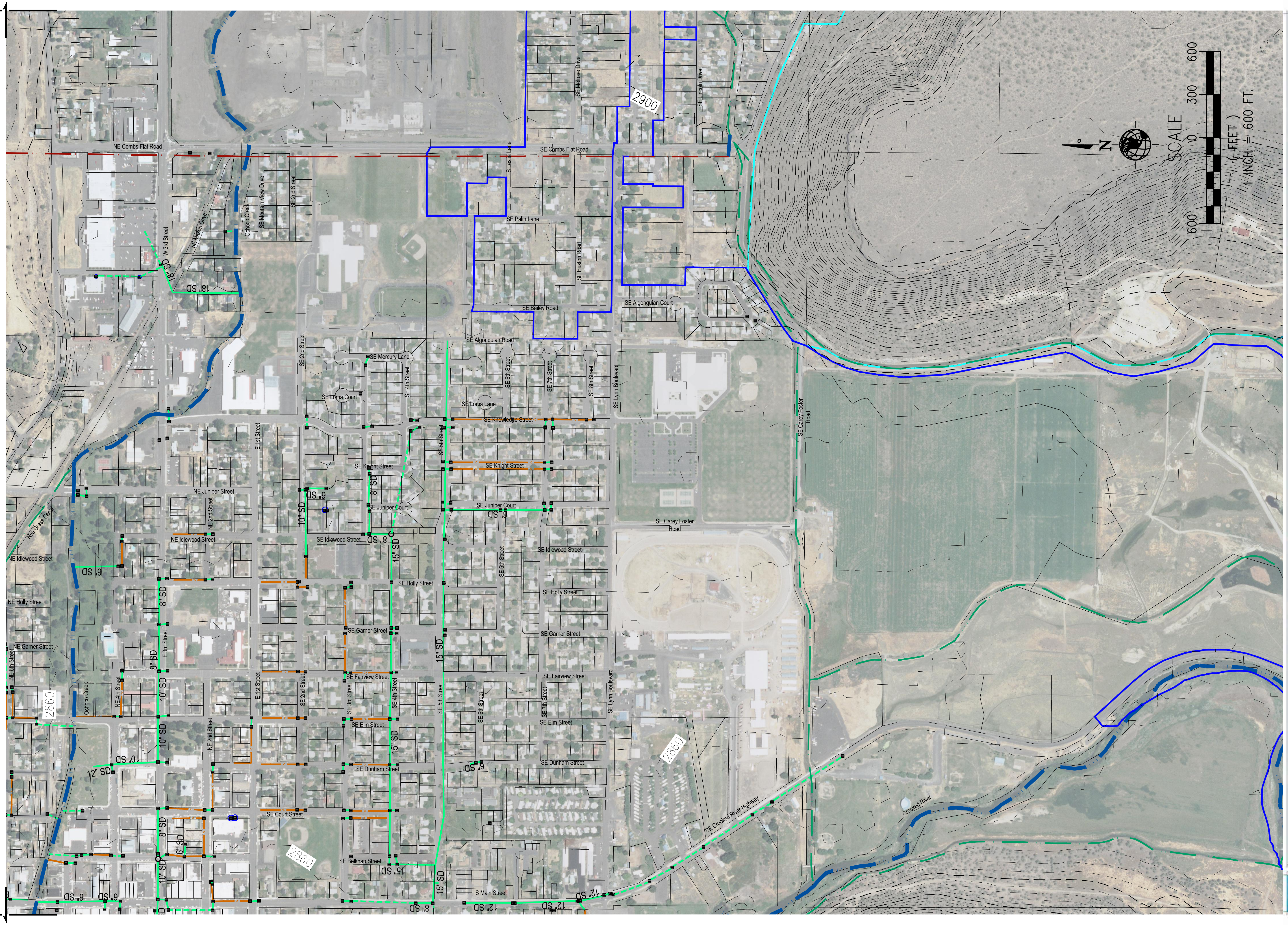
LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- 2875 — 50 FT. GIS CONTOUR
- 2860 — 10 FT. GIS CONTOUR
- CITY LIMITS
- UGB
- EXISTING STORM DRAIN, SIZE AS SHOWN
- STORM DRAIN, SIZE UNKNOWN
- SIPHON–CURB FLOW
- FRENCH DRAIN
- PRIVATE DRAINAGE ITEM
- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL



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CITY OF PRINEVILLE

EXISTING CONDITIONS SOUTH OF OCHOCO CREEK - EAST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER 036612
DRAWING FILE NAME 036612-EC-EX1
SCALE 1" = 600'

EX1.4

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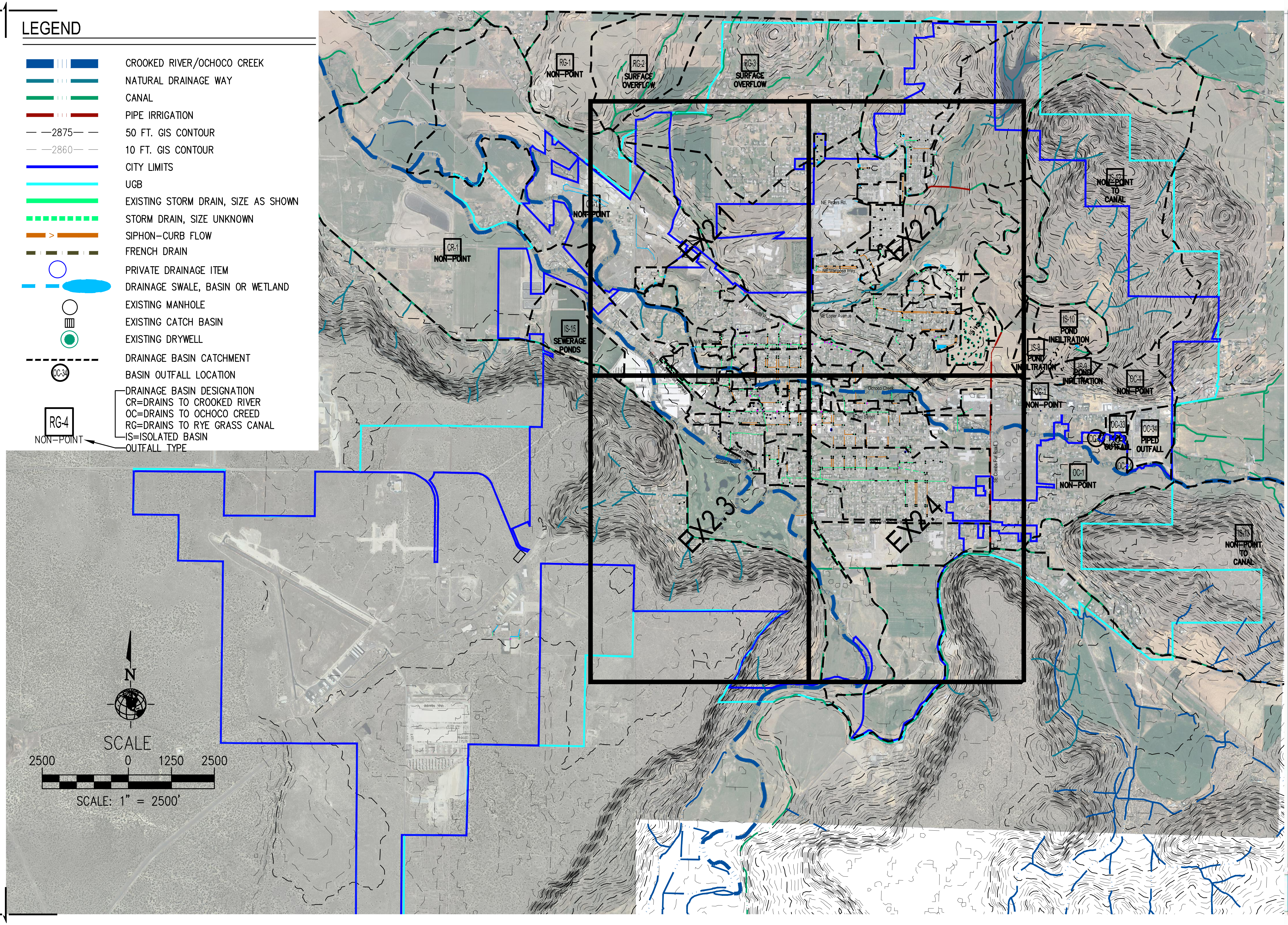
EXHIBIT 2.0 - 2.4

Mapped Drainage Basins



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CITY OF PRINEVILLE

EXISTING CONDITIONS - DRAINAGE BASINS
OVER ALL
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER 036612
DRAWING FILE NAME 036612-BA-EX2
SCALE 1" = 2500'

EX2.0

LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- 2875 — 50 FT. GIS CONTOUR
- 2860 — 10 FT. GIS CONTOUR
- CITY LIMITS
- UGB
- EXISTING STORM DRAIN, SIZE AS SHOWN
- STORM DRAIN, SIZE UNKNOWN
- SIPHON–CURB FLOW
- FRENCH DRAIN
- PRIVATE DRAINAGE ITEM
- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL
- DRAINAGE BASIN CATCHMENT
- OC-34 — BASIN OUTFALL LOCATION
- RG-4 — DRAINAGE BASIN DESIGNATION
  - CR=DRAINS TO CROOKED RIVER
  - OC=DRAINS TO OCHOCO CREED
  - RG=DRAINS TO RYE GRASS CANAL
  - IS=ISOLATED BASIN
- NON–POINT — OUTFALL TYPE

[DATE: 4/13/2011 9:59 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
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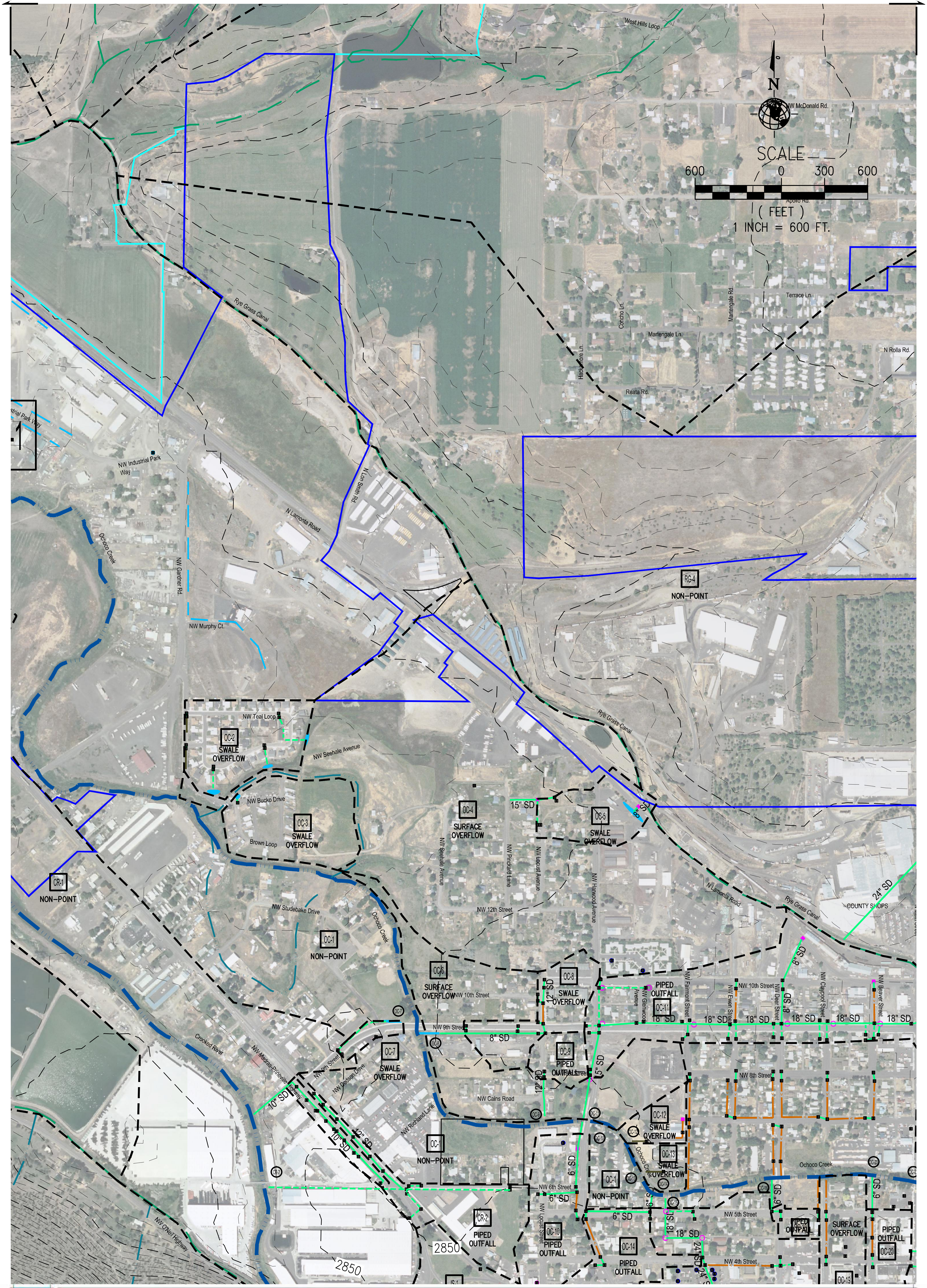

EXISTING CONDITIONS - DRAINAGE BASINS
NORTH OF OCHOCO CREEK - WEST
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-BA-EX2	1" = 600'

EX2.1

LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- —2875— 50 FT. GIS CONTOUR
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- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL
- DRAINAGE BASIN CATCHMENT
- OC-34 BASIN OUTFALL LOCATION

RG-4 — DRAINAGE BASIN DESIGNATION
CR=DRAINS TO CROOKED RIVER
OC=DRAINS TO OCHOCO CREED
RG=DRAINS TO RYE GRASS CANAL
IS=ISOLATED BASIN

NON–POINT — OUTFALL TYPE

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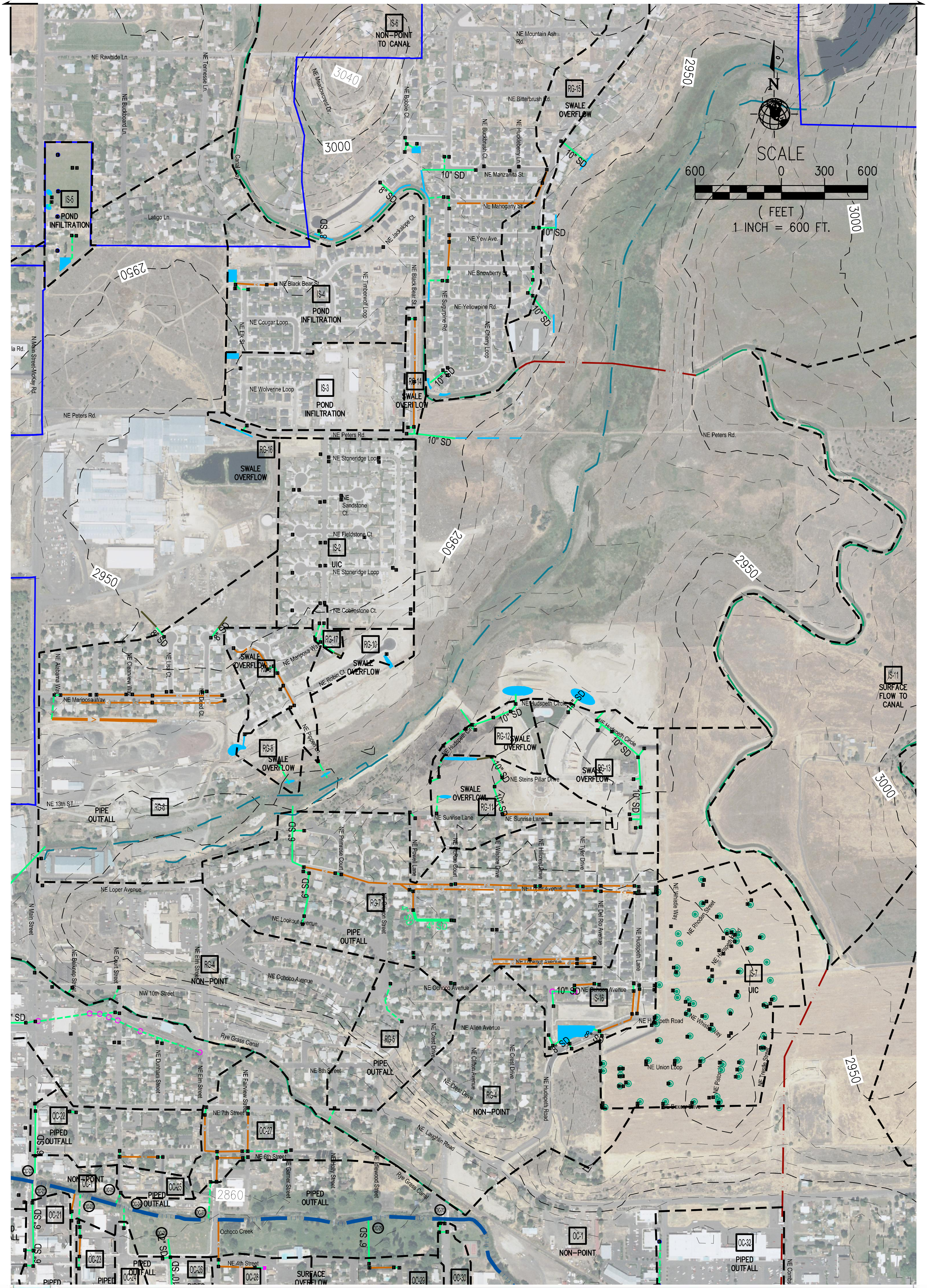

EXISTING CONDITIONS - DRAINAGE BASINS NORTH OF OCHOCO CREEK - EAST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-BA-EX2	1" = 600'

CITY OF PRINEVILLE

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EX2.2

LEGEND

	CROOKED RIVER/OCHOCO CREEK
	NATURAL DRAINAGE WAY
	CANAL
	PIPE IRRIGATION
2875	50 FT. GIS CONTOUR
2860	10 FT. GIS CONTOUR
	CITY LIMITS
	UGB
	EXISTING STORM DRAIN, SIZE AS SHOWN
	STORM DRAIN, SIZE UNKNOWN
>	SIPHON–CURB FLOW
	FRENCH DRAIN
	PRIVATE DRAINAGE ITEM
	DRAINAGE SWALE, BASIN OR WETLAND
	EXISTING MANHOLE
	EXISTING CATCH BASIN
	EXISTING DRYWELL
	DRAINAGE BASIN CATCHMENT
OC-34	BASIN OUTFALL LOCATION
RG-4	DRAINAGE BASIN DESIGNATION CR=DRAINS TO CROOKED RIVER OC=DRAINS TO OCHOCO CREED RG=DRAINS TO RYE GRASS CANAL IS=ISOLATED BASIN
NON–POINT	OUTFALL TYPE

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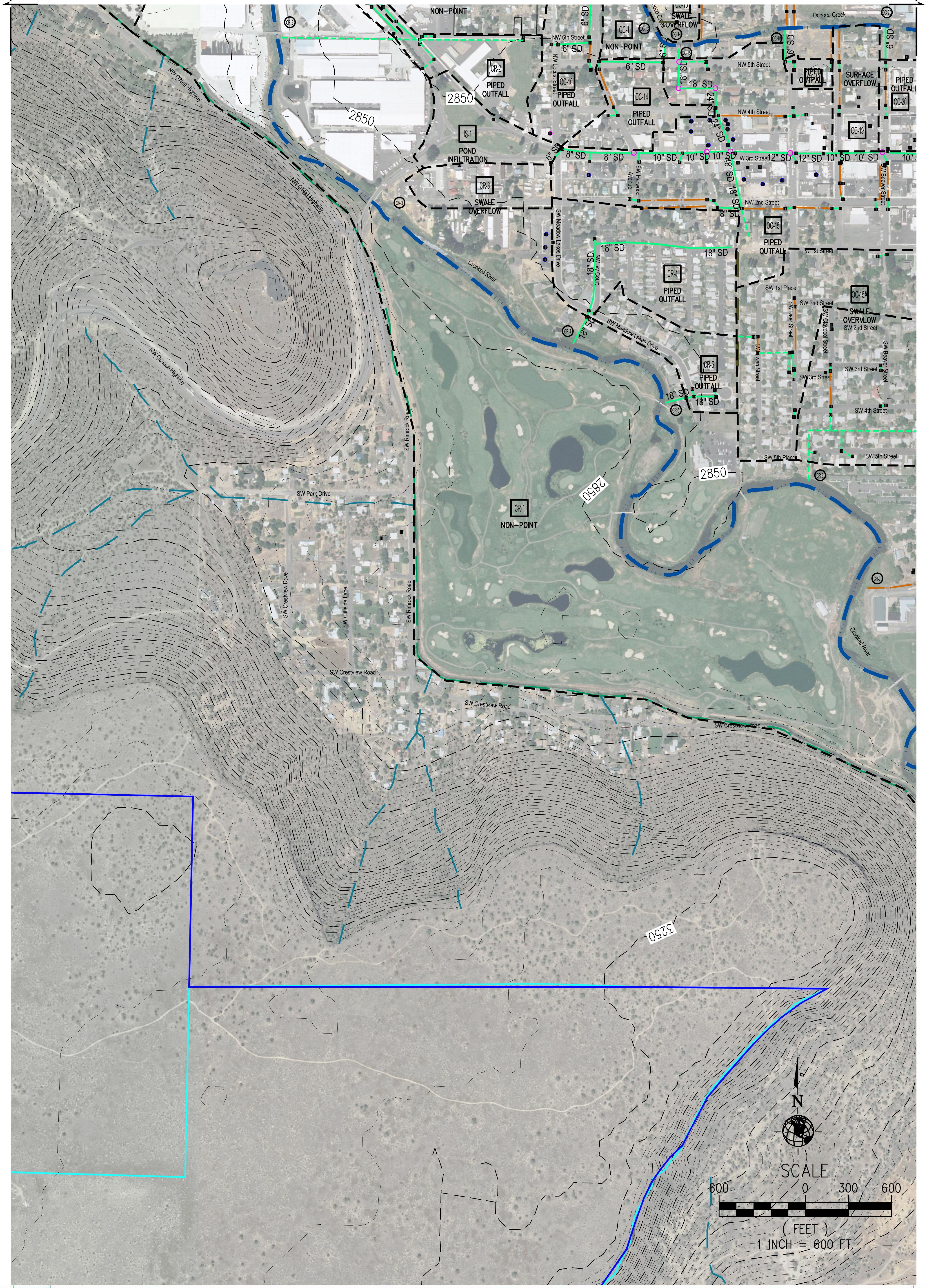

EX2.3

EXISTING CONDITIONS - DRAINAGE BASINS
SOUTH OF OCHOCO CREEK - WEST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-BA-EX2	1" = 600'

CITY OF PRINEVILLE

HGE INC

WHPacific

LEGEND

CROOKED RIVER/OCHOCO CREEK
NATURAL DRAINAGE WAY
CANAL
PIPE IRRIGATION
—2875— 50 FT. GIS CONTOUR
—2860— 10 FT. GIS CONTOUR
CITY LIMITS
UGB
EXISTING STORM DRAIN, SIZE AS SHOWN
STORM DRAIN, SIZE UNKNOWN
SIPHON–CURB FLOW
FRENCH DRAIN
PRIVATE DRAINAGE ITEM
DRAINAGE SWALE, BASIN OR WETLAND
EXISTING MANHOLE
EXISTING CATCH BASIN
EXISTING DRYWELL
DRAINAGE BASIN CATCHMENT
OC-34 BASIN OUTFALL LOCATION

RG-4
NON–POINT

DRAINAGE BASIN DESIGNATION
CR=DRAINS TO CROOKED RIVER
OC=DRAINS TO OCHOCO CREED
RG=DRAINS TO RYE GRASS CANAL
IS=ISOLATED BASIN
OUTFALL TYPE

[DATE: 4/13/2011 10:01 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
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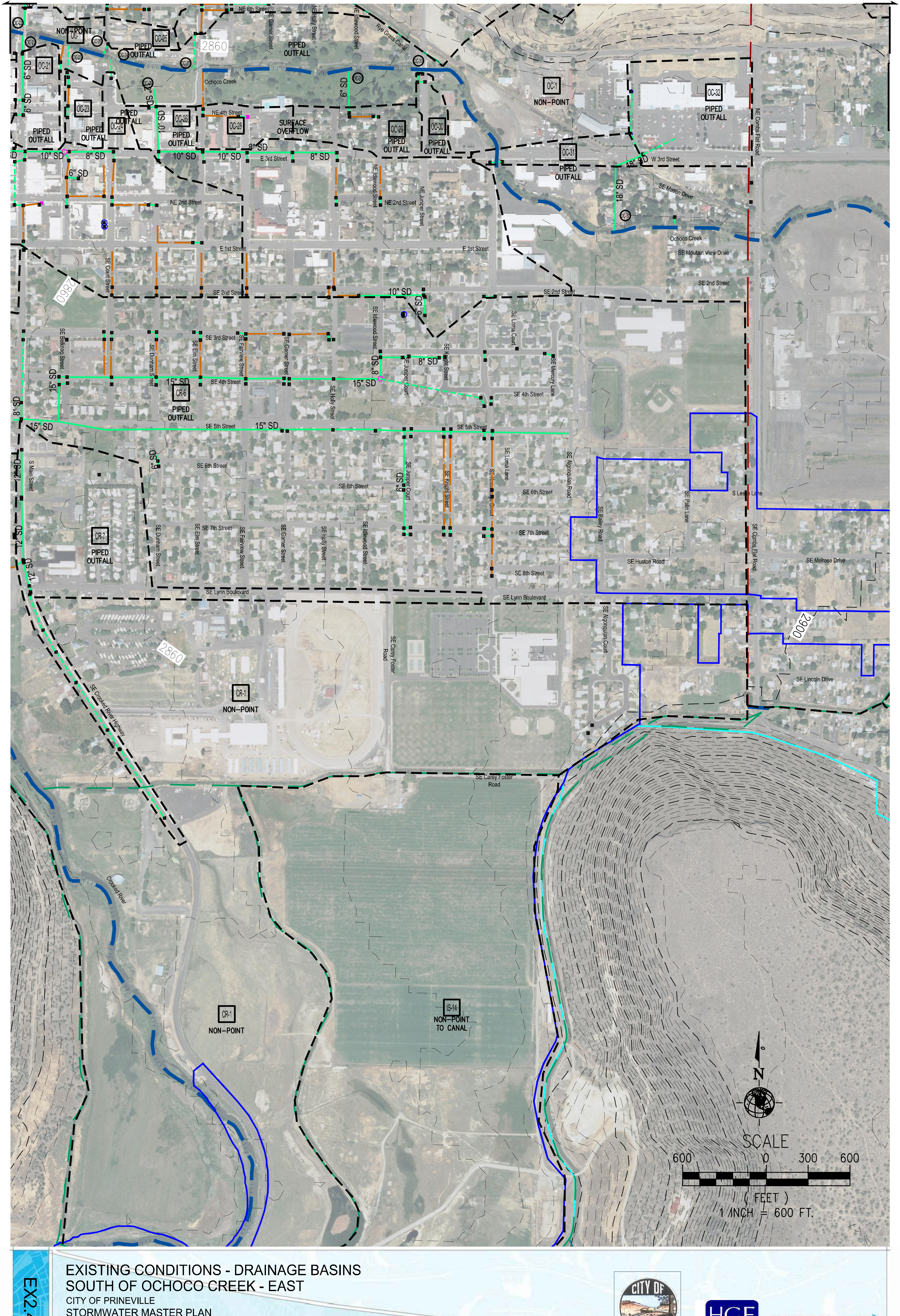

EX2.4

EXISTING CONDITIONS - DRAINAGE BASINS SOUTH OF OCHOCO CREEK - EAST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-BA-EX2	1" = 600'

CITY OF PRINEVILLE

HGE INC

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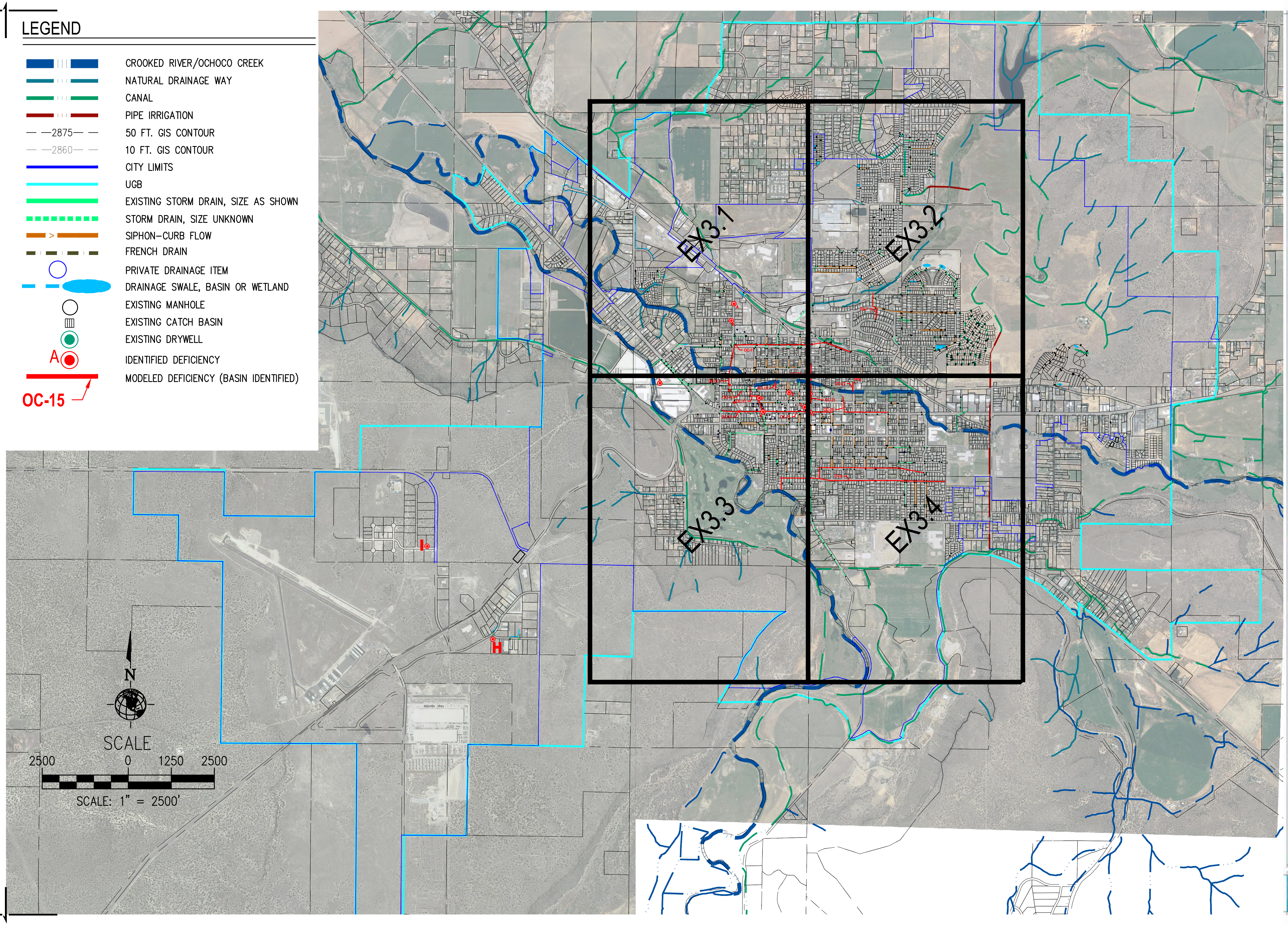
EXHIBIT 3.0 - 3.4
Problem Areas



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HGE INC

CITY OF PRINEVILLE

IDENTIFIED DEFICIENCIES
OVER ALL

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

SCALE 1" = 2500'

PROJECT NUMBER 036612

DRAWING FILE NAME 036612-IM-EX3

EX3.0

[DATE: 4/22/2011 10:27 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
[PATH: P:\City of Prineville\036612\Design\Drawings\Civil\036612-IM-EX3.dwg] [LAYOUT: EX3.0]

LEGEND

CROOKED RIVER/OCHOCO CREEK
NATURAL DRAINAGE WAY
CANAL
PIPE IRRIGATION
2875 — 50 FT. GIS CONTOUR
2860 — 10 FT. GIS CONTOUR
CITY LIMITS
UGB
EXISTING STORM DRAIN, SIZE AS SHOWN
STORM DRAIN, SIZE UNKNOWN
SIPHON–CURB FLOW
FRENCH DRAIN
PRIVATE DRAINAGE ITEM
DRAINAGE SWALE, BASIN OR WETLAND
EXISTING MANHOLE
EXISTING CATCH BASIN
EXISTING DRYWELL
A — IDENTIFIED DEFICIENCY
OC-15 — MODELED DEFICIENCY (BASIN IDENTIFIED)

[DATE: 4/22/2011 10:28 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
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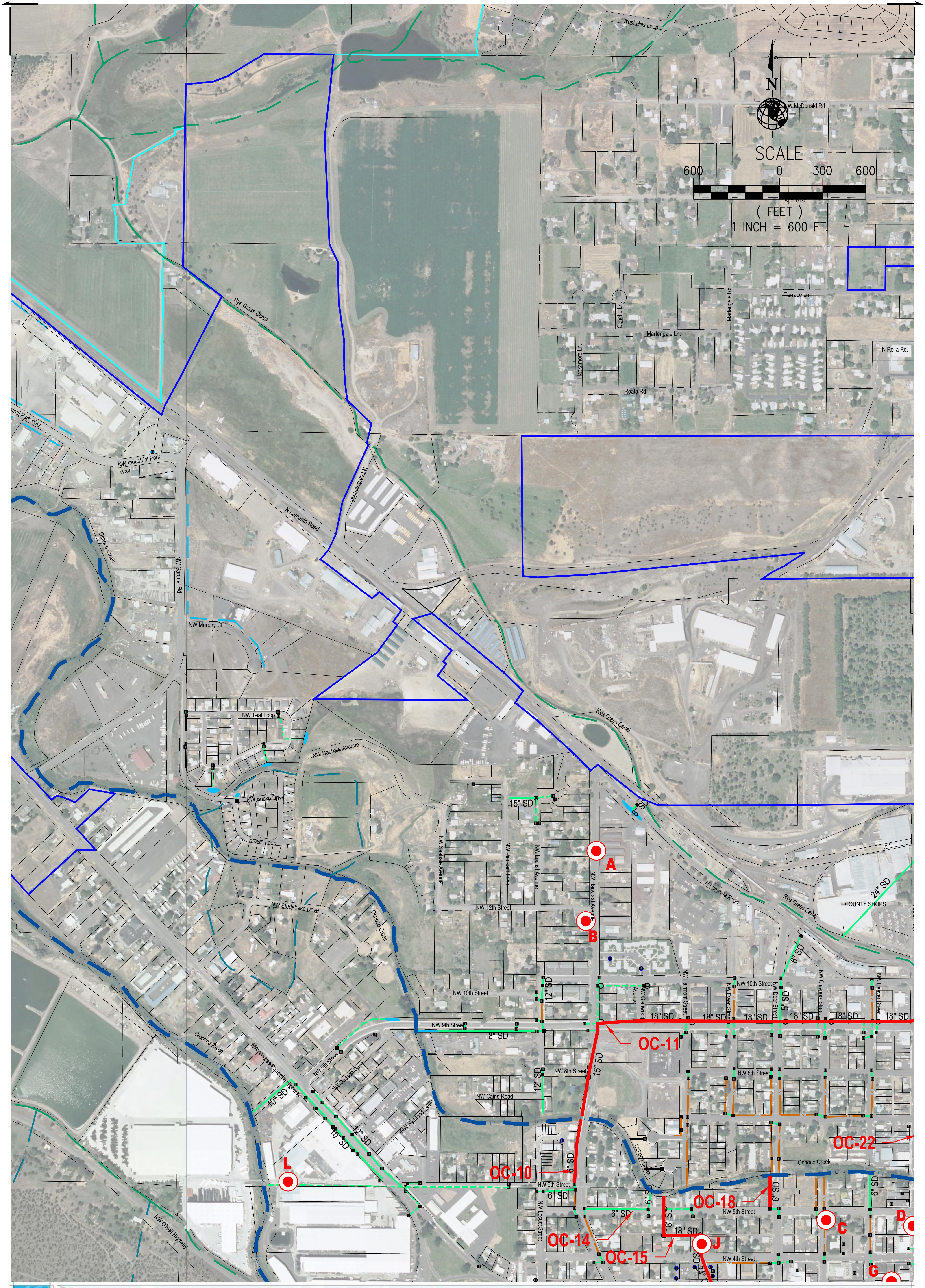

EX3.1

IDENTIFIED DEFICIENCIES
NORTH OF OCHOCO CREEK - WEST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-IM-EX3	1" = 600'

WHPacific

LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- 2875 — 50 FT. GIS CONTOUR
- 2860 — 10 FT. GIS CONTOUR
- CITY LIMITS
- UGB
- EXISTING STORM DRAIN, SIZE AS SHOWN
- STORM DRAIN, SIZE UNKNOWN
- SIPHON–CURB FLOW
- FRENCH DRAIN
- PRIVATE DRAINAGE ITEM
- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL
- A — IDENTIFIED DEFICIENCY
- MODELED DEFICIENCY (BASIN IDENTIFIED) — OC-15

[DATE: 4/22/2011 10:29 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
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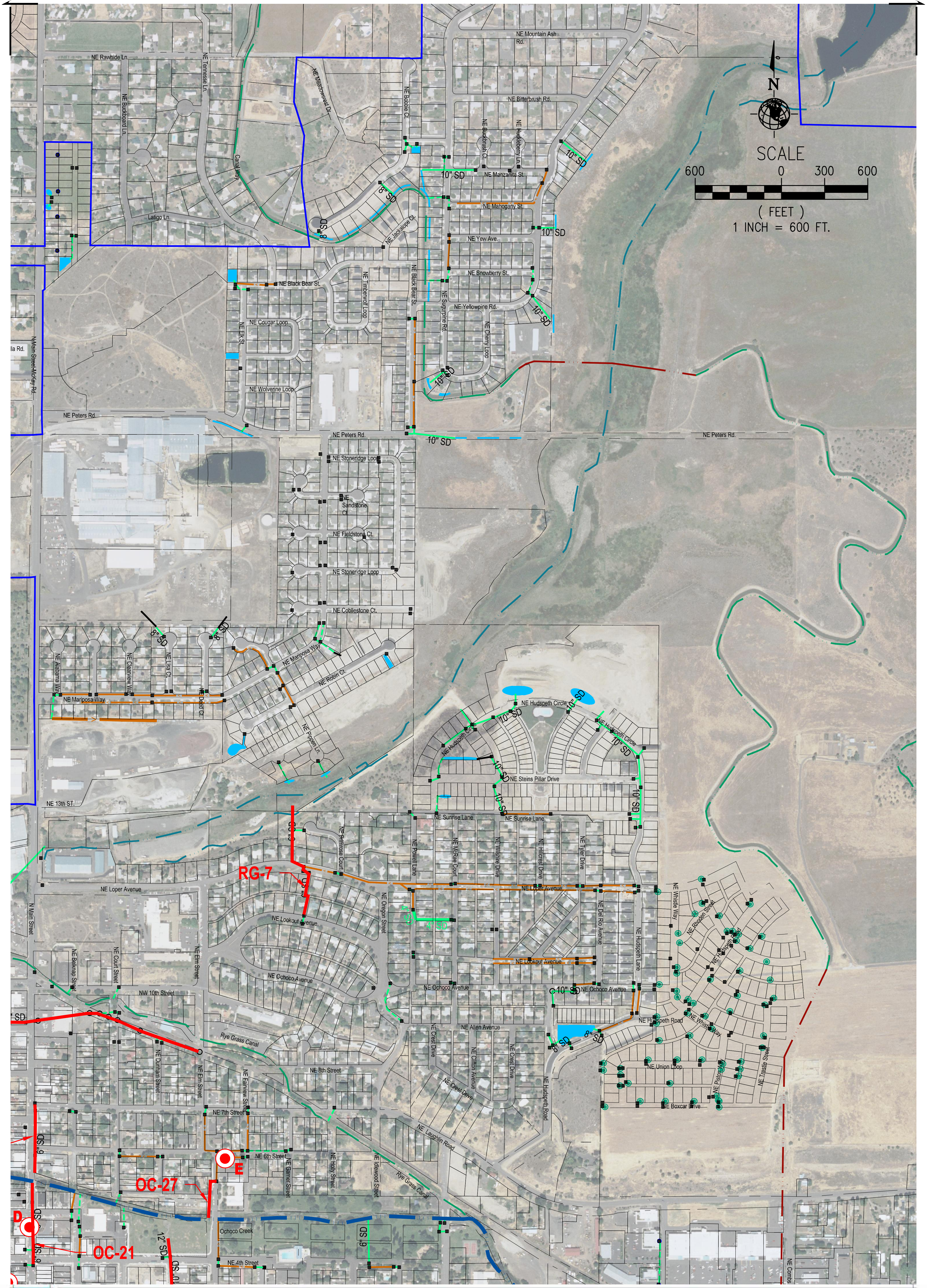


IDENTIFIED DEFICIENCIES
NORTH OF OCHOCO CREEK - EAST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

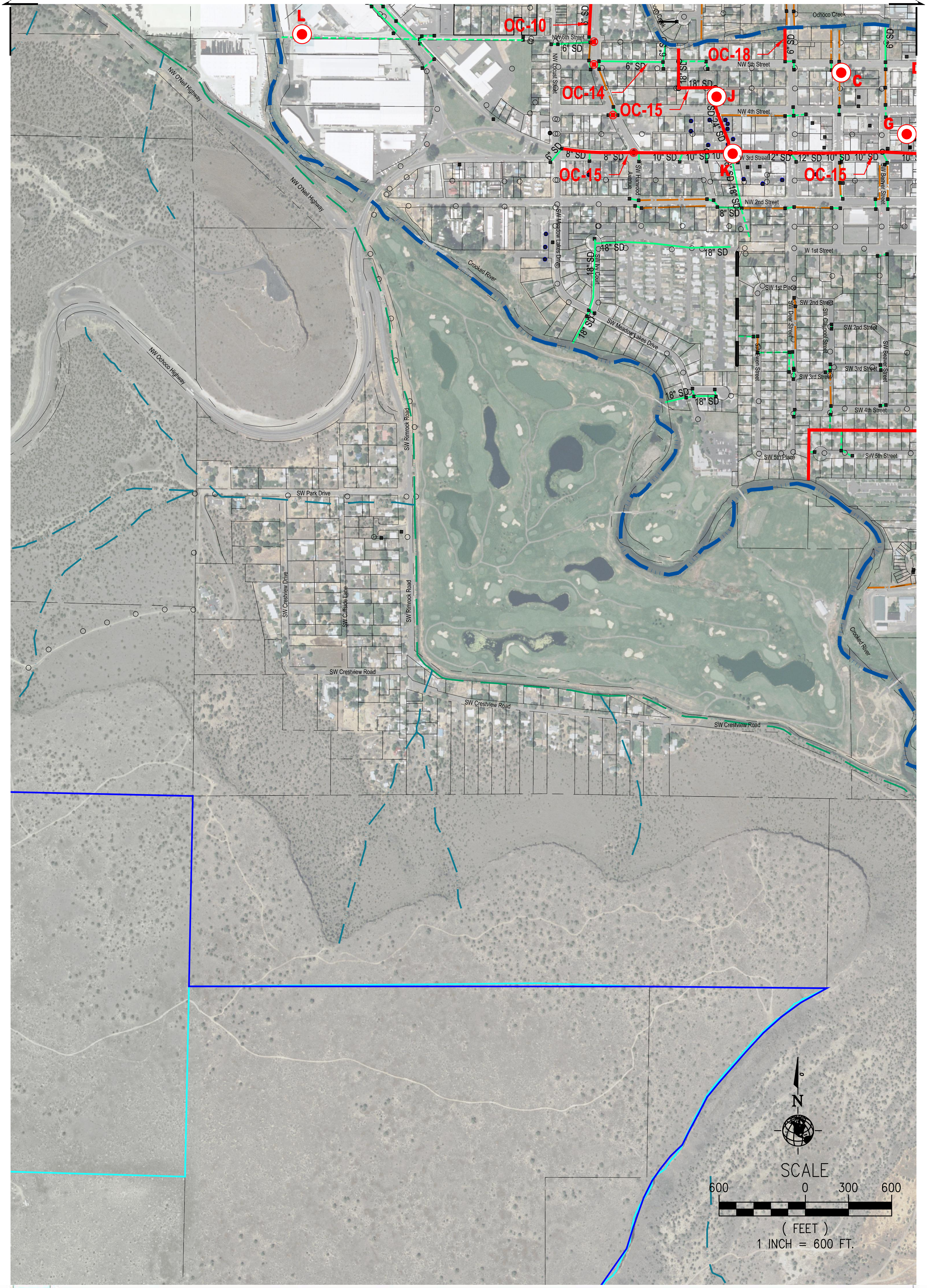
PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-IM-EX3	1" = 600'

EX3.2

LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- 2875 — 50 FT. GIS CONTOUR
- 2860 — 10 FT. GIS CONTOUR
- CITY LIMITS
- UGB
- EXISTING STORM DRAIN, SIZE AS SHOWN
- STORM DRAIN, SIZE UNKNOWN
- SIPHON–CURB FLOW
- FRENCH DRAIN
- PRIVATE DRAINAGE ITEM
- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL
- A — IDENTIFIED DEFICIENCY
- OC-15 — MODELED DEFICIENCY (BASIN IDENTIFIED)

[DATE: 4/22/2011 10:30 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
[PATH: P:\City of Prineville\036612\Design\Drawings\Civil\036612-IM-EX3.dwg] [LAYOUT: EX3.3]



EX3.3

IDENTIFIED DEFICIENCIES
SOUTH OF OCHOCO CREEK - WEST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-IM-EX3	1" = 600'

CITY OF PRINEVILLE

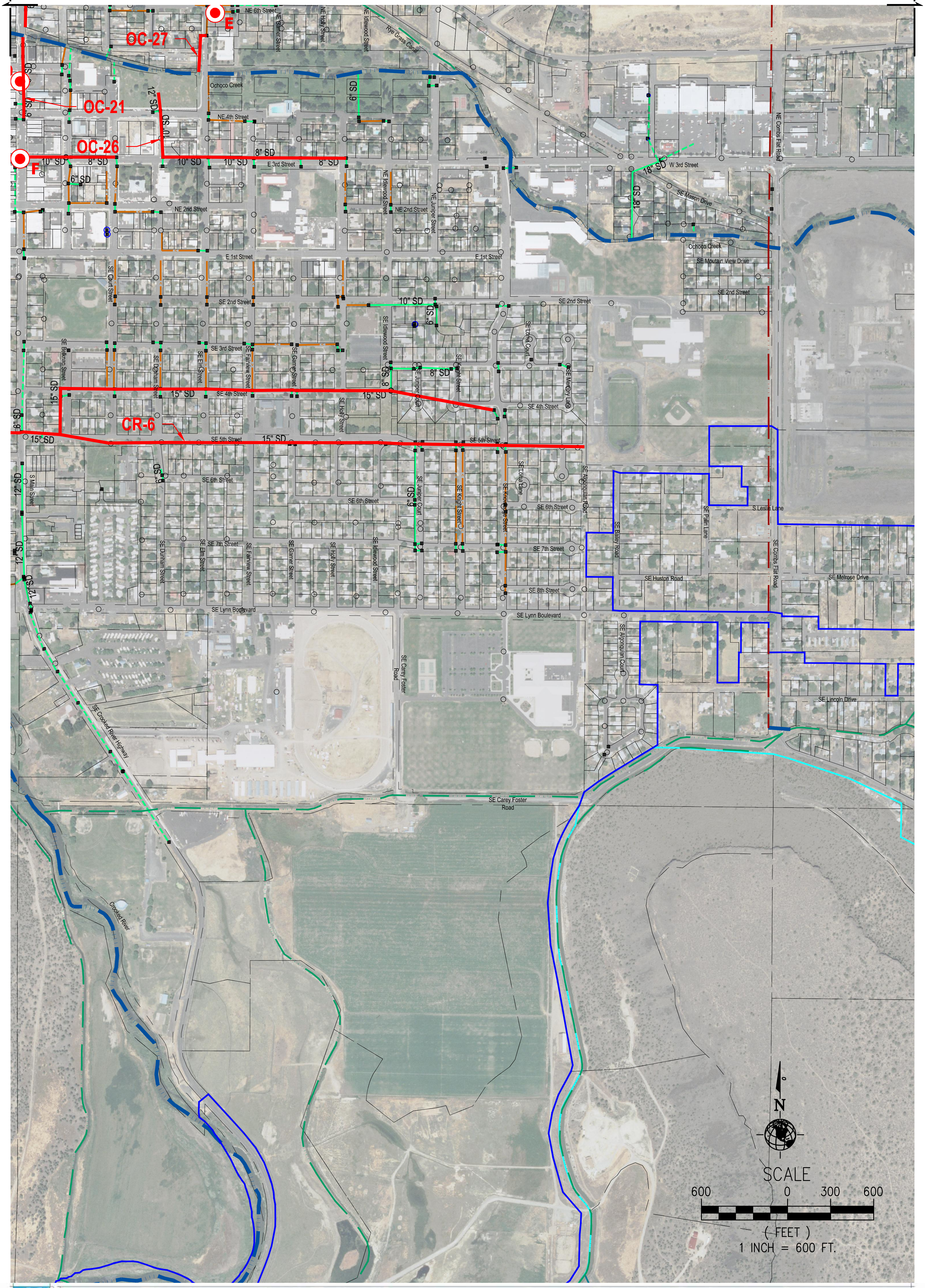
HGE INC

WHPacific

LEGEND

	CROOKED RIVER/OCHOCO CREEK
	NATURAL DRAINAGE WAY
	CANAL
	PIPE IRRIGATION
—2875—	50 FT. GIS CONTOUR
—2860—	10 FT. GIS CONTOUR
	CITY LIMITS
	UGB
	EXISTING STORM DRAIN, SIZE AS SHOWN
	STORM DRAIN, SIZE UNKNOWN
>	SIPHON–CURB FLOW
	FRENCH DRAIN
	PRIVATE DRAINAGE ITEM
	DRAINAGE SWALE, BASIN OR WETLAND
	EXISTING MANHOLE
	EXISTING CATCH BASIN
	EXISTING DRYWELL
A	IDENTIFIED DEFICIENCY
OC-15	MODELED DEFICIENCY (BASIN IDENTIFIED)

[DATE: 4/22/2011 10:30 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
[PATH: P:\City of Prineville\036612\Design\Drawings\Civil\036612-IM-EX3.dwg] [LAYOUT: EX3.4]



IDENTIFIED DEFICIENCIES
SOUTH OF OCHOCO CREEK - EAST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-IM-EX3	1" = 600'

EX3.4

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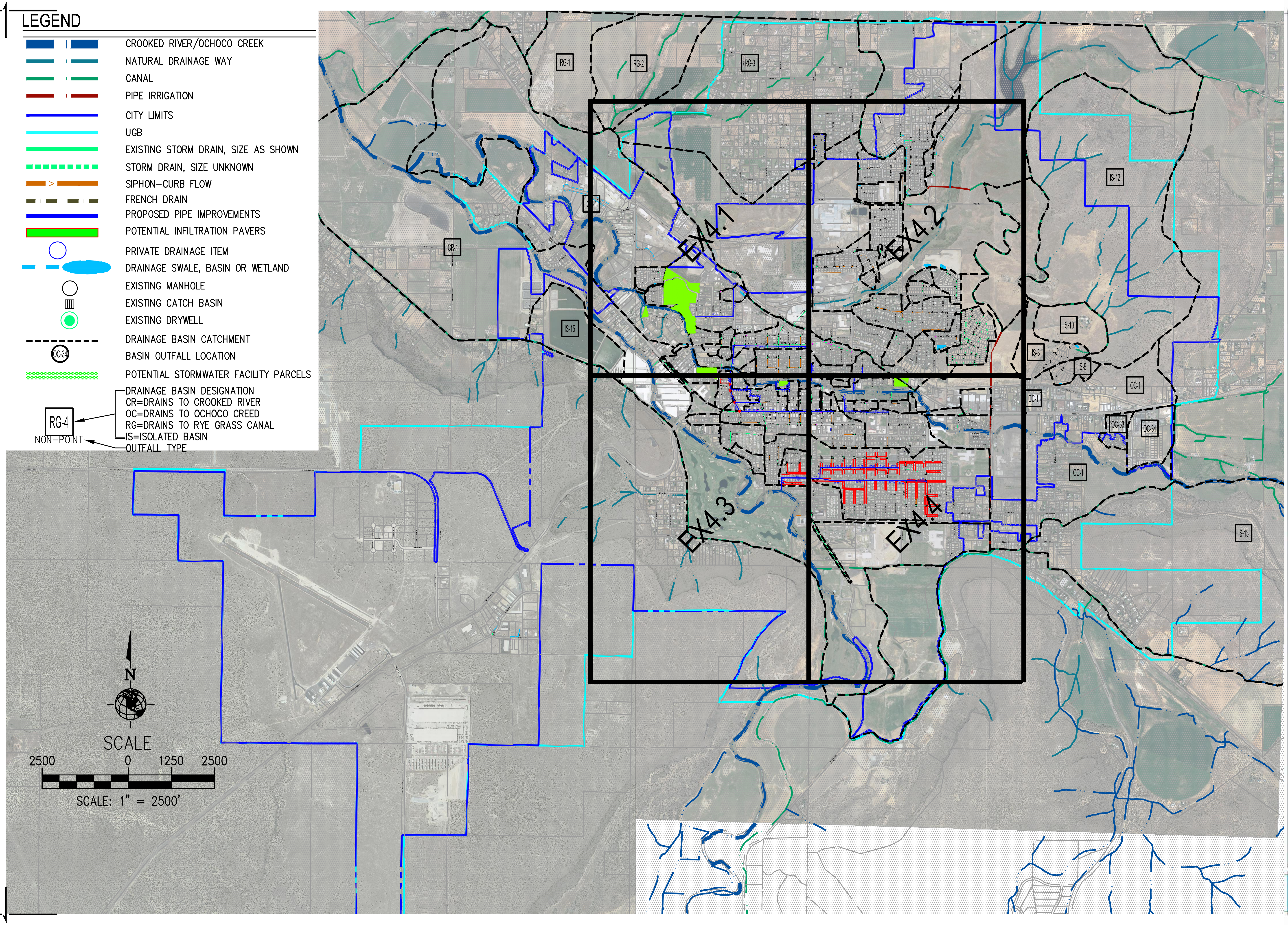
HGE INC

EXHIBIT 4.0 - 4.4

Proposed Improvements



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HGE INC

CITY OF PRINEVILLE

PROPOSED IMPROVEMENTS
OVER ALL

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER 036612

DRAWING FILE NAME 036612-IM-EX4

SCALE 1" = 2500'

EX4.0

[DATE: 4/22/2011 10:55 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
[PATH: P:\City of Prineville\036612\Design\Drawings\Civil\036612-IM-EX4.dwg] [LAYOUT: EX4.0]

LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- CITY LIMITS
- UGB
- EXISTING STORM DRAIN, SIZE AS SHOWN
- STORM DRAIN, SIZE UNKNOWN
- SIPHON–CURB FLOW
- FRENCH DRAIN
- PROPOSED PIPE IMPROVEMENTS
- POTENTIAL INFILTRATION PAVERS
- PRIVATE DRAINAGE ITEM
- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL
- DRAINAGE BASIN CATCHMENT
- OC-34 BASIN OUTFALL LOCATION
- POTENTIAL STORMWATER FACILITY PARCELS

RG-4
NON–POINT

DRAINAGE BASIN DESIGNATION
CR=DRAINS TO CROOKED RIVER
OC=DRAINS TO OCHOCO CREED
RG=DRAINS TO RYE GRASS CANAL
IS=ISOLATED BASIN
OUTFALL TYPE

[DATE: 4/22/2011 10:56 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
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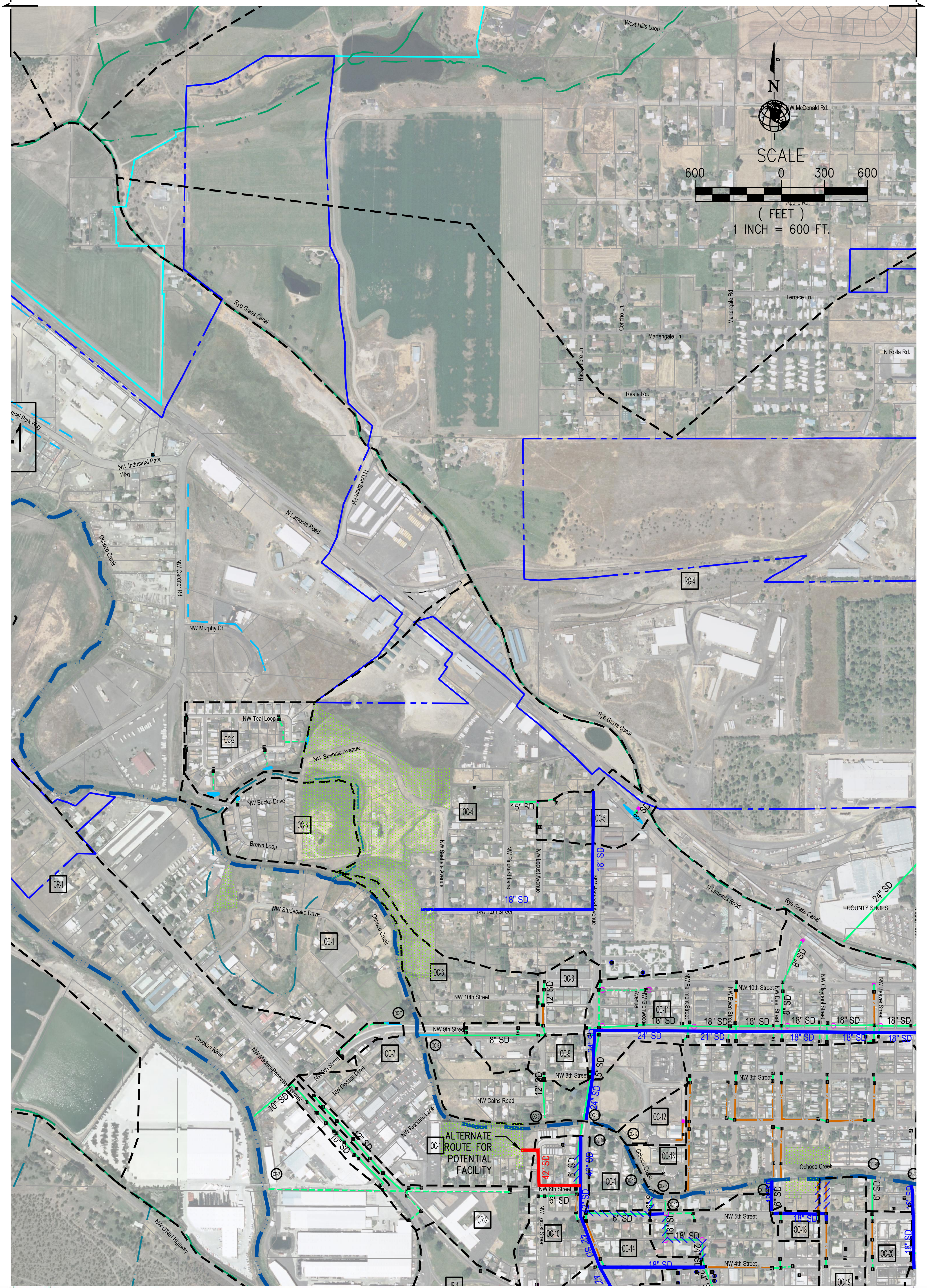

EX4.1

PROPOSED IMPROVEMENTS
NORTH OF OCHOCO CREEK - WEST
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-IM-EX4	1" = 600'

CITY OF PRINEVILLE

HGE INC

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LEGEND

CROOKED RIVER/OCHOCO CREEK
NATURAL DRAINAGE WAY
CANAL
PIPE IRRIGATION
CITY LIMITS
UGB
EXISTING STORM DRAIN, SIZE AS SHOWN
STORM DRAIN, SIZE UNKNOWN
SIPHON–CURB FLOW
FRENCH DRAIN
PROPOSED PIPE IMPROVEMENTS
POTENTIAL INFILTRATION PAVERS
PRIVATE DRAINAGE ITEM
DRAINAGE SWALE, BASIN OR WETLAND
EXISTING MANHOLE
EXISTING CATCH BASIN
EXISTING DRYWELL
DRAINAGE BASIN CATCHMENT
OC-34 BASIN OUTFALL LOCATION
POTENTIAL STORMWATER FACILITY PARCELS

RG-4
NON–POINT

DRAINAGE BASIN DESIGNATION
CR=DRAINS TO CROOKED RIVER
OC=DRAINS TO OCHOCO CREED
RG=DRAINS TO RYE GRASS CANAL
IS=ISOLATED BASIN
OUTFALL TYPE

[DATE: 4/22/2011 10:58 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
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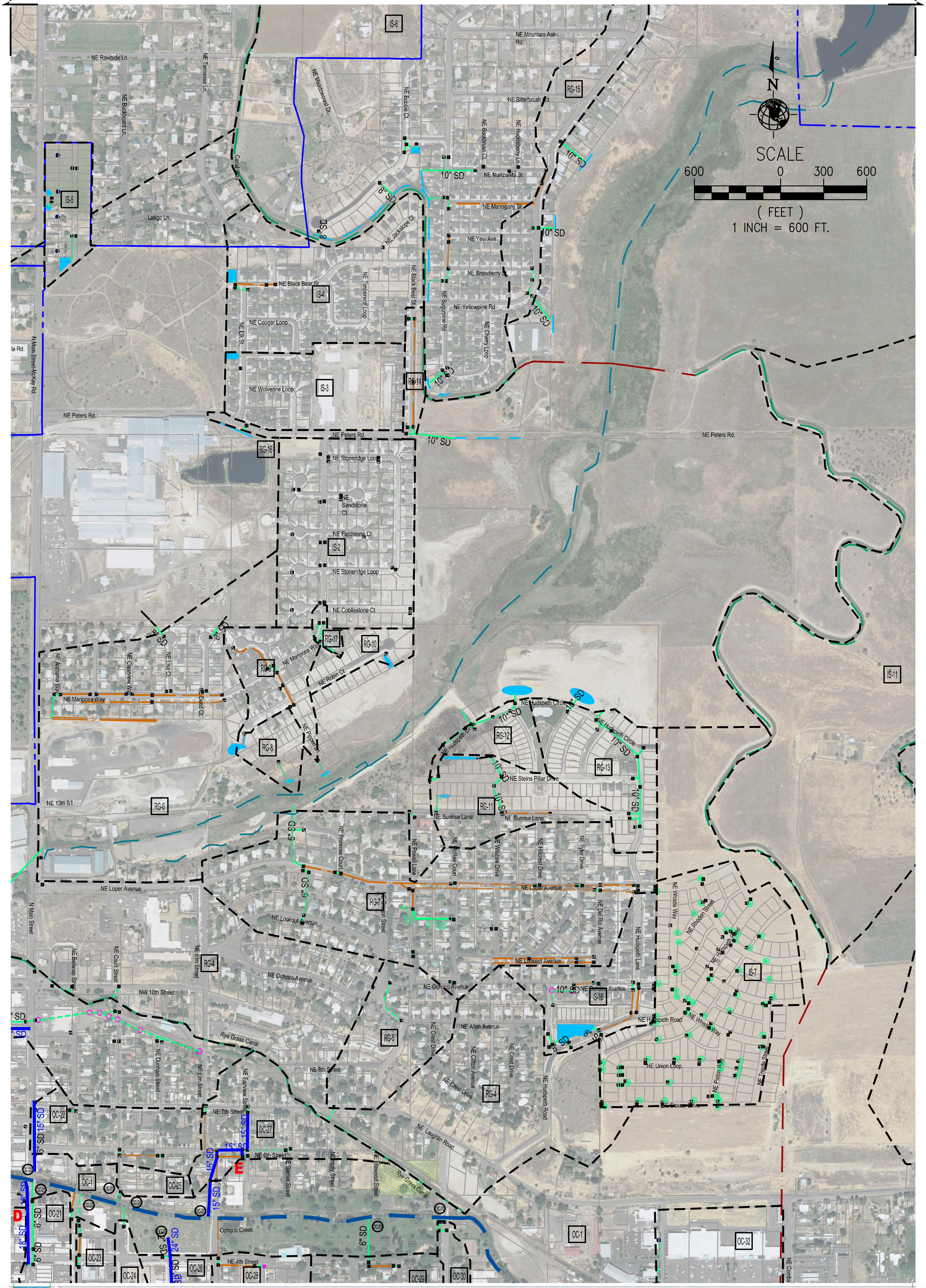

PROPOSED IMPROVEMENTS
NORTH OF OCHOCO CREEK - EAST
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-IM-EX4	1" = 600'

CITY OF PRINEVILLE
HGE INC
WHPacific

EX4.2

LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- CITY LIMITS
- UGB
- EXISTING STORM DRAIN, SIZE AS SHOWN
- STORM DRAIN, SIZE UNKNOWN
- SIPHON–CURB FLOW
- FRENCH DRAIN
- PROPOSED PIPE IMPROVEMENTS
- POTENTIAL INFILTRATION PAVERS
- PRIVATE DRAINAGE ITEM
- DRAINAGE SWALE, BASIN OR WETLAND
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING DRYWELL
- DRAINAGE BASIN CATCHMENT
- OC-34 BASIN OUTFALL LOCATION
- POTENTIAL STORMWATER FACILITY PARCELS

RG-4
NON–POINT

DRAINAGE BASIN DESIGNATION
CR=DRAINS TO CROOKED RIVER
OC=DRAINS TO OCHOCO CREED
RG=DRAINS TO RYE GRASS CANAL
IS=ISOLATED BASIN
OUTFALL TYPE

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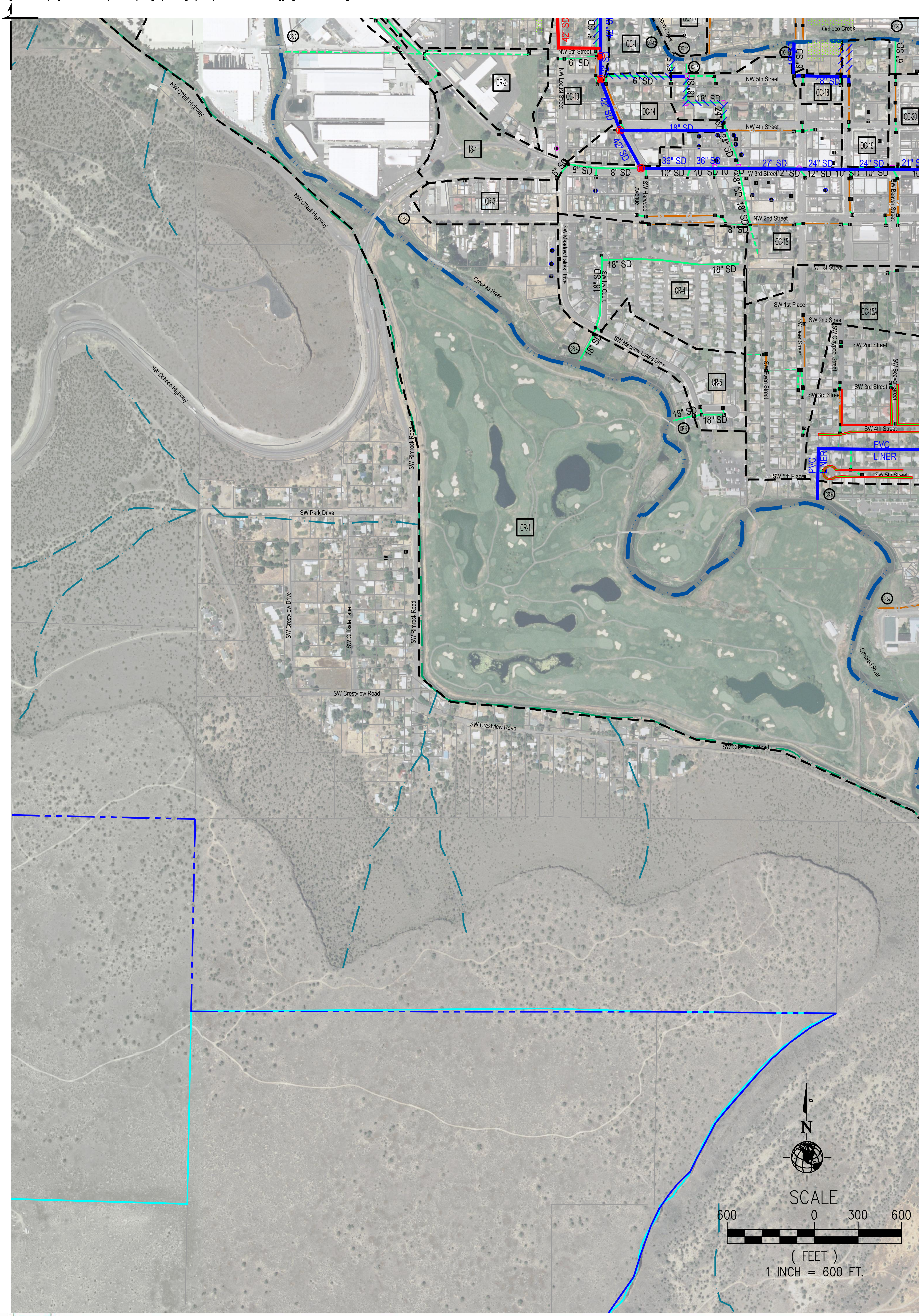

EX4.3

IDENTIFIED DEFICIENCIES - PROPOSED IMPROVEMENTS
SOUTH OF OCHOCO CREEK - WEST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER: 036612
DRAWING FILE NAME: 036612-IM-EX4
SCALE: 1" = 600'

LEGEND

CROOKED RIVER/OCHOCO CREEK
NATURAL DRAINAGE WAY
CANAL
PIPE IRRIGATION
CITY LIMITS
UGB
EXISTING STORM DRAIN, SIZE AS SHOWN
STORM DRAIN, SIZE UNKNOWN
SIPHON-CURB FLOW
FRENCH DRAIN
PROPOSED PIPE IMPROVEMENTS
POTENTIAL INFILTRATION PAVERS
PRIVATE DRAINAGE ITEM
DRAINAGE SWALE, BASIN OR WETLAND
EXISTING MANHOLE
EXISTING CATCH BASIN
EXISTING DRYWELL
DRAINAGE BASIN CATCHMENT
OC-34 BASIN OUTFALL LOCATION
POTENTIAL STORMWATER FACILITY PARCELS

RG-4
NON-POINT

DRAINAGE BASIN DESIGNATION
CR=DRAINS TO CROOKED RIVER
OC=DRAINS TO OCHOCO CREED
RG=DRAINS TO RYE GRASS CANAL
IS=ISOLATED BASIN
OUTFALL TYPE

[DATE: 4/22/2011 11:00 AM] [AUTHOR: jmason] [PLOTTER: DWG To PDF.pc3] [STYLE: WHP-Standard-COPSWMP.ctb]
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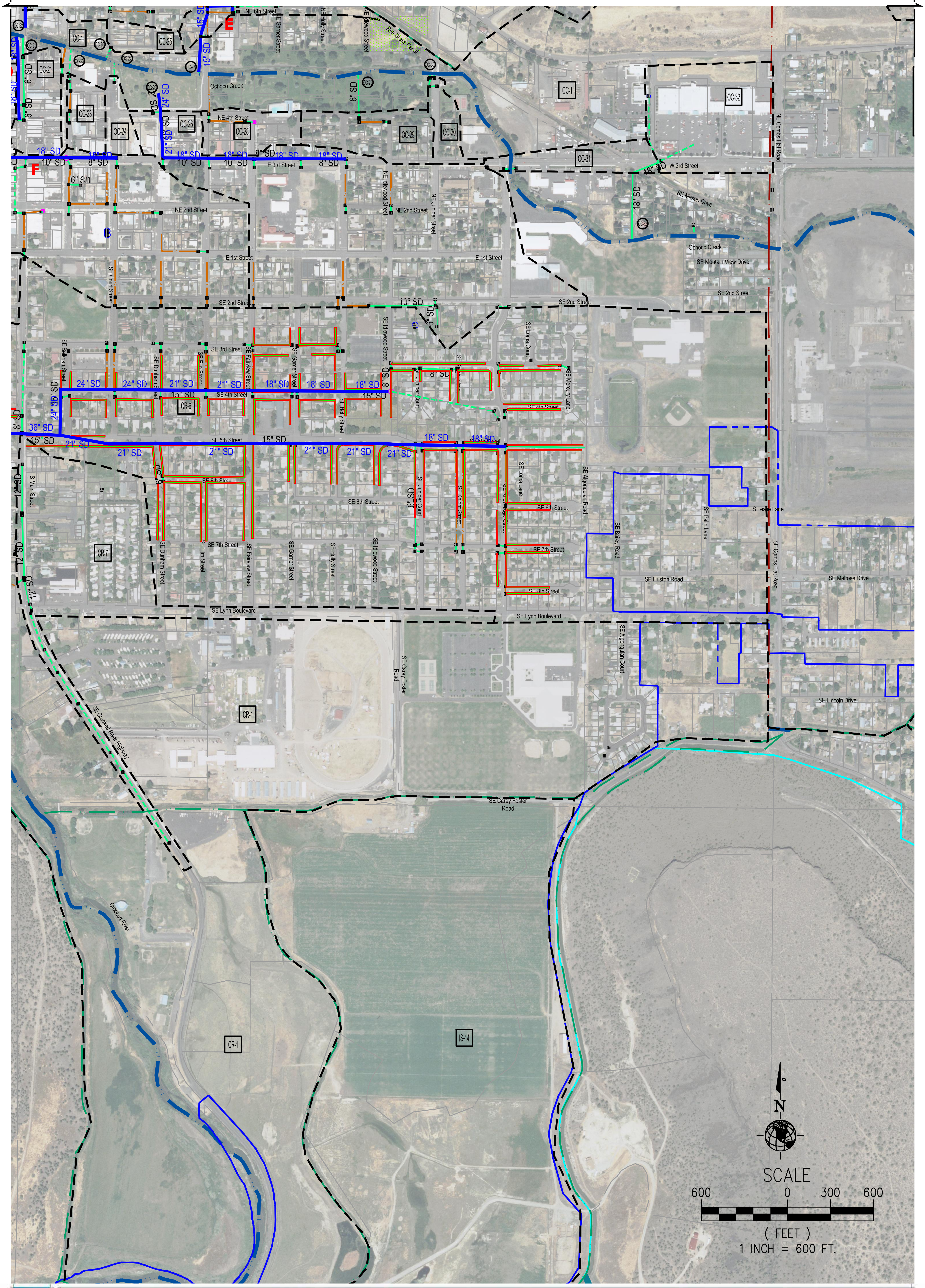


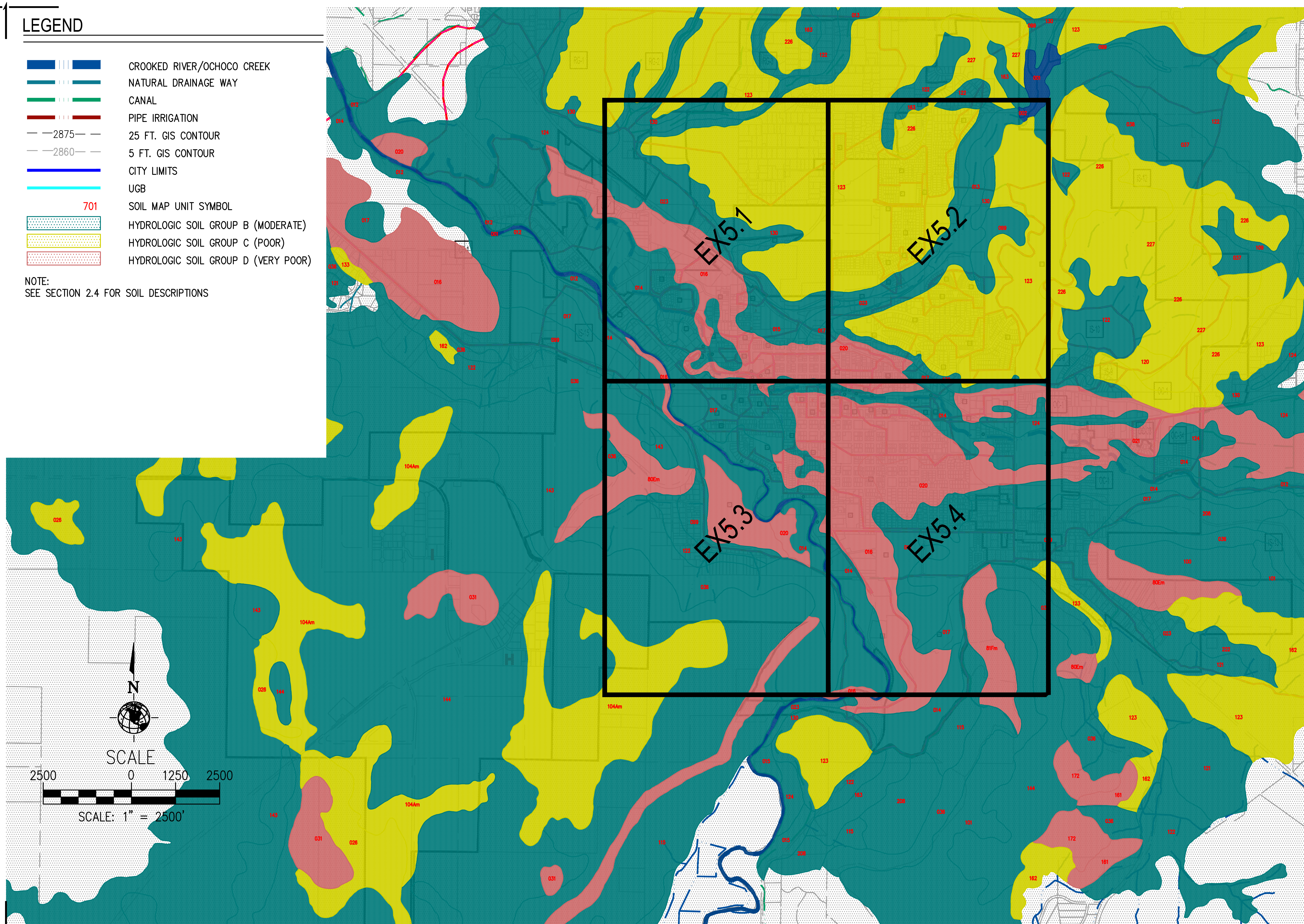
EX4.4

PROPOSED IMPROVEMENTS
SOUTH OF OCHOCO CREEK - EAST
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-IM-EX4	1" = 600'

EXHIBIT 5.0 - 5.1

Soils Maps



[DATE: 4/22/2011 1:18 PM] [AUTHOR: jmoson] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard.ctb]
[PATH: P:\City of Prineville\036612\Design\Drawings\Civil\036612-SLS-EX4.dwg] [LAYOUT: EX4.0]

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EXISTING SOILS - NRCS SOIL SURVEY
OVER ALL
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER 036612
DRAWING FILE NAME 036612-SLS-EX4
SCALE 1" = 2500'

EX5.0

LEGEND

	CROOKED RIVER/OCHOCO CREEK
	NATURAL DRAINAGE WAY
	CANAL
	PIPE IRRIGATION
2875	25 FT. GIS CONTOUR
2860	5 FT. GIS CONTOUR
	CITY LIMITS
	UGB
701	SOIL MAP UNIT SYMBOL
	HYDROLOGIC SOIL GROUP B (MODERATE)
	HYDROLOGIC SOIL GROUP C (POOR)
	HYDROLOGIC SOIL GROUP D (VERY POOR)

NOTE:
SEE SECTION 2.4 FOR SOIL DESCRIPTIONS

[DATE: 1/27/2011 3:15 PM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard.ctb]
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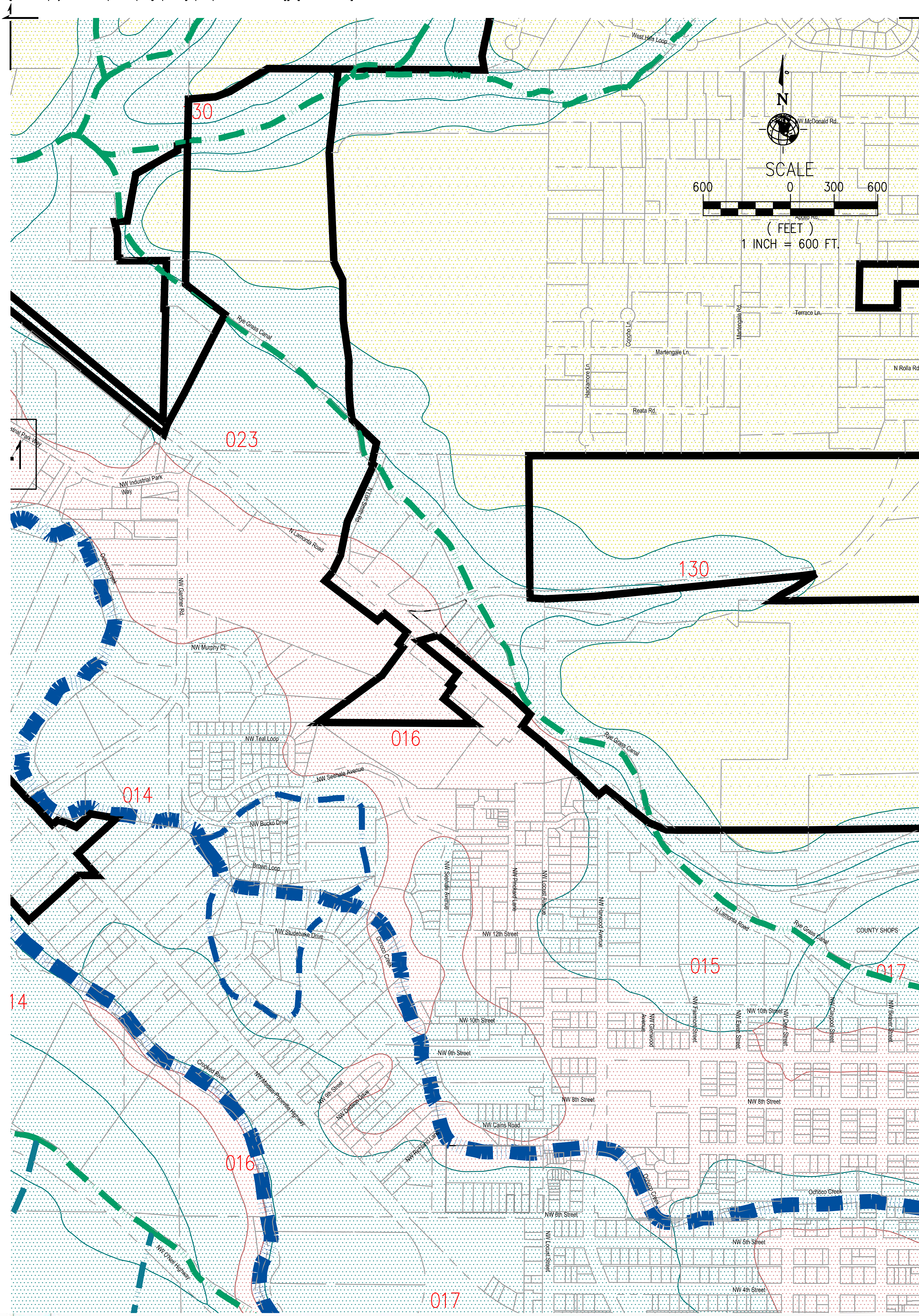

EX5.1

EXISTING SOILS - NRCS SOIL SURVEY
NORTH OF OCHOCO CREEK - WEST
CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-SLS-EX4	1" = 600'

WHPacific

LEGEND

- CROOKED RIVER/OCHOCO CREEK
- NATURAL DRAINAGE WAY
- CANAL
- PIPE IRRIGATION
- 2875 — 25 FT. GIS CONTOUR
- 2860 — 5 FT. GIS CONTOUR
- CITY LIMITS
- UGB
- 701 — SOIL MAP UNIT SYMBOL
- HYDROLOGIC SOIL GROUP B (MODERATE)
- HYDROLOGIC SOIL GROUP C (POOR)
- HYDROLOGIC SOIL GROUP D (VERY POOR)

NOTE:
SEE SECTION 2.4 FOR SOIL DESCRIPTIONS

[DATE: 1/27/2011 3:17 PM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard.ctb]
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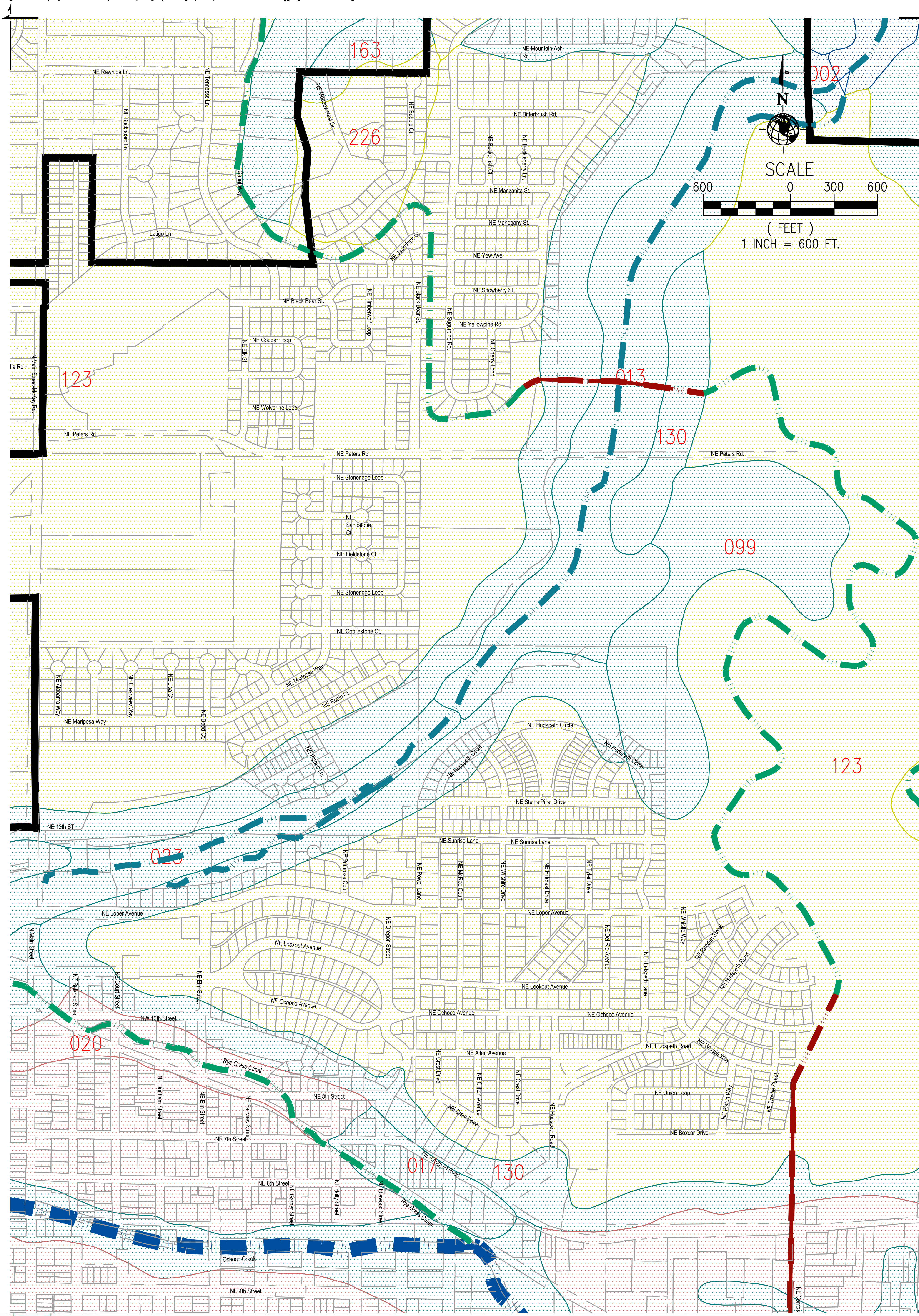

EX5.2

EXISTING SOILS - NRCS SOIL SURVEY
NORTH OF OCHOCO CREEK - EAST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-SLS-EX4	1" = 600'

WHPacific

LEGEND

	CROOKED RIVER/OCHOCO CREEK
	NATURAL DRAINAGE WAY
	CANAL
	PIPE IRRIGATION
2875	25 FT. GIS CONTOUR
2860	5 FT. GIS CONTOUR
	CITY LIMITS
	UGB
701	SOIL MAP UNIT SYMBOL
	HYDROLOGIC SOIL GROUP B (MODERATE)
	HYDROLOGIC SOIL GROUP C (POOR)
	HYDROLOGIC SOIL GROUP D (VERY POOR)

NOTE:
SEE SECTION 2.4 FOR SOIL DESCRIPTIONS

[DATE: 1/27/2011 3:17 PM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard.ctb]
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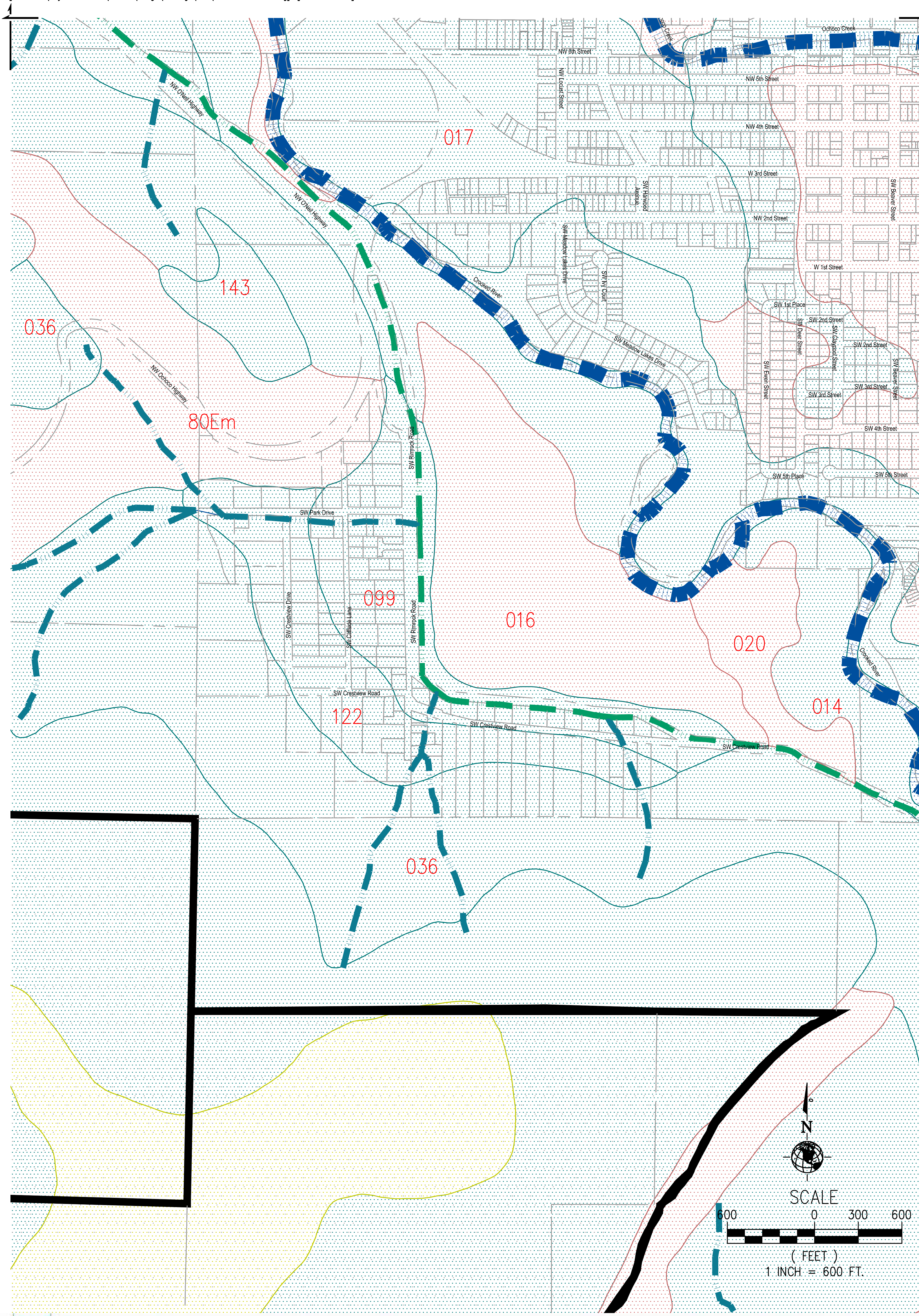


EXISTING SOILS - NRCS SOIL SURVEY
SOUTH OF OCHOCO CREEK - WEST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-SLS-EX4	1" = 600'

WHPacific

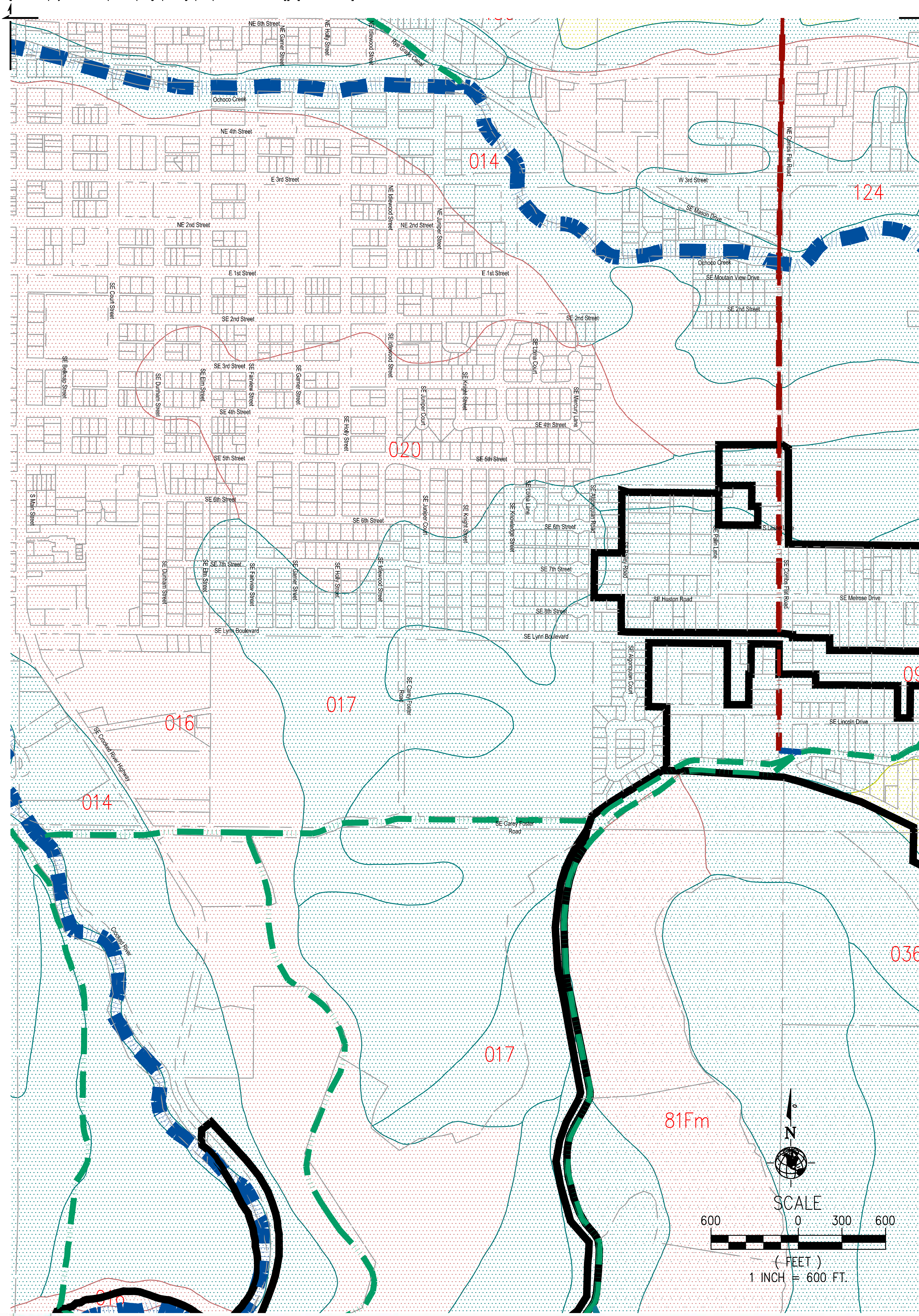
EX5.3

LEGEND

	CROOKED RIVER/OCHOCO CREEK
	NATURAL DRAINAGE WAY
	CANAL
	PIPE IRRIGATION
—2875—	25 FT. GIS CONTOUR
—2860—	5 FT. GIS CONTOUR
	CITY LIMITS
	UGB
701	SOIL MAP UNIT SYMBOL
	HYDROLOGIC SOIL GROUP B (MODERATE)
	HYDROLOGIC SOIL GROUP C (POOR)
	HYDROLOGIC SOIL GROUP D (VERY POOR)

NOTE:
SEE SECTION 2.4 FOR SOIL DESCRIPTIONS

[DATE: 1/27/2011 3:18 PM] [AUTHOR: jmason] [PLOTTER: DWG To PDF Bonus Pack Jm.pc3] [STYLE: WHP-Standard.ctb]
[PATH: P:\City of Prineville\036612\Design\Drawings\Civil\036612-SLS-EX4.dwg] [LAYOUT: EX4.4]



EX5.4

EXISTING SOILS - NRCS SOIL SURVEY
SOUTH OF OCHOCO CREEK - EAST

CITY OF PRINEVILLE
STORMWATER MASTER PLAN

PROJECT NUMBER	DRAWING FILE NAME	SCALE
036612	036612-SLS-EX4	1" = 600'

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APPENDIX 2.1

FEMA Flood Insurance Rate Map
Crook County, Oregon
Selected Panels
Preliminary - April 30, 2010

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

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Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

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NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov/.

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Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

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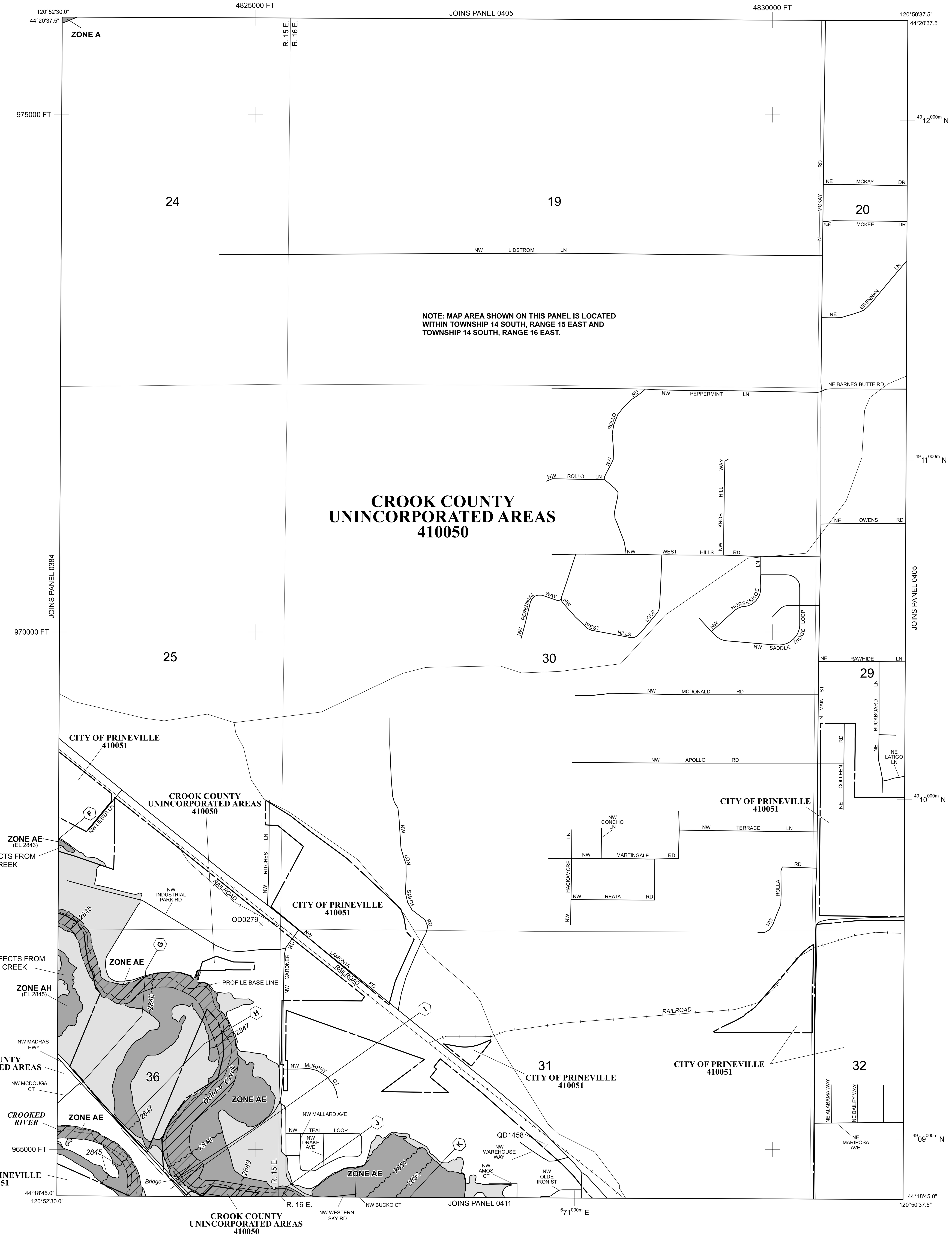
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 Base Flood Elevation line and value; elevation in feet*
(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A—A Cross section line
23- - - -23 Transect line
97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000m N 1000-meter Universal Transverse Mercator grid ticks, zone 10
6000000 FT 5000-foot grid ticks: Oregon State Plane coordinate system, south zone (FIPSZONE 3602), Lambert Conformal Conic
DX5510 Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 17, 1989
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
- to update corporate limits, to change Base Flood Elevations, to change Special Flood Hazard Areas, and to add roads and road names.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0403C

FIRM
FLOOD INSURANCE RATE MAP

CROOK COUNTY, OREGON
AND INCORPORATED AREAS

PANEL 403 OF 1825
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROOK COUNTY	410050	0403	C
PRINEVILLE, CITY OF	410051	0403	C

PRELIMINARY
APRIL 30, 2010

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
41013C0403C

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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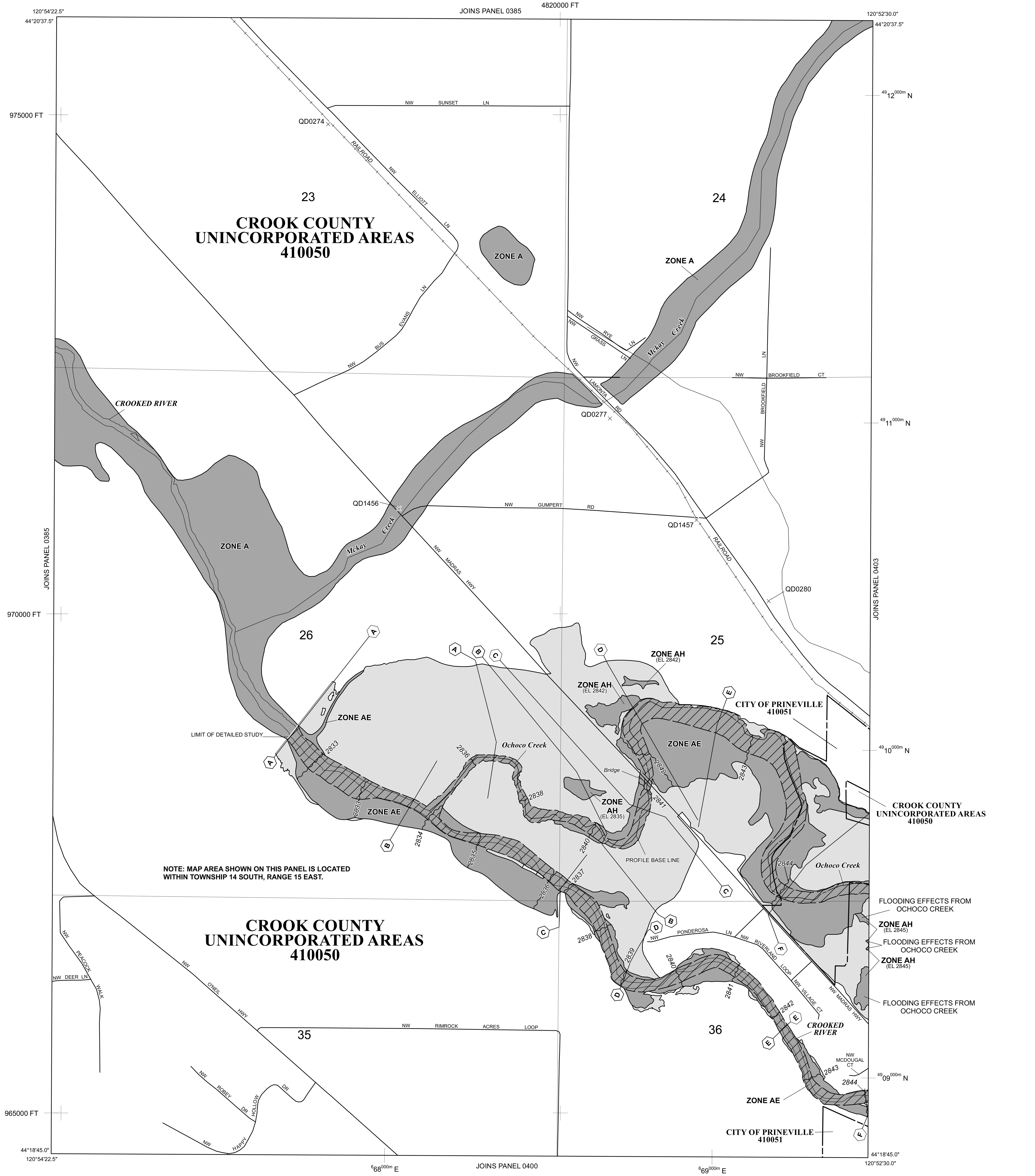

LEGEND

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ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
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ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
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ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
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FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
~~ 513 ~~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)——(A)	Cross section line
(23)- - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000m N	1000-meter Universal Transverse Mercator grid ticks, zone 10
6000000 FT	5000-foot grid ticks: Oregon State Plane coordinate system, south zone (FIPSZONE 3602), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

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EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 17, 1989
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
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MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0384C

FIRM
FLOOD INSURANCE RATE MAP

CROOK COUNTY, OREGON
AND INCORPORATED AREAS

PANEL 384 OF 1825
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROOK COUNTY	410050	0384	C
PRINEVILLE, CITY OF	410051	0384	C

PRELIMINARY
APRIL 30, 2010

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MAP NUMBER
41013C0384C

MAP REVISED

Federal Emergency Management Agency

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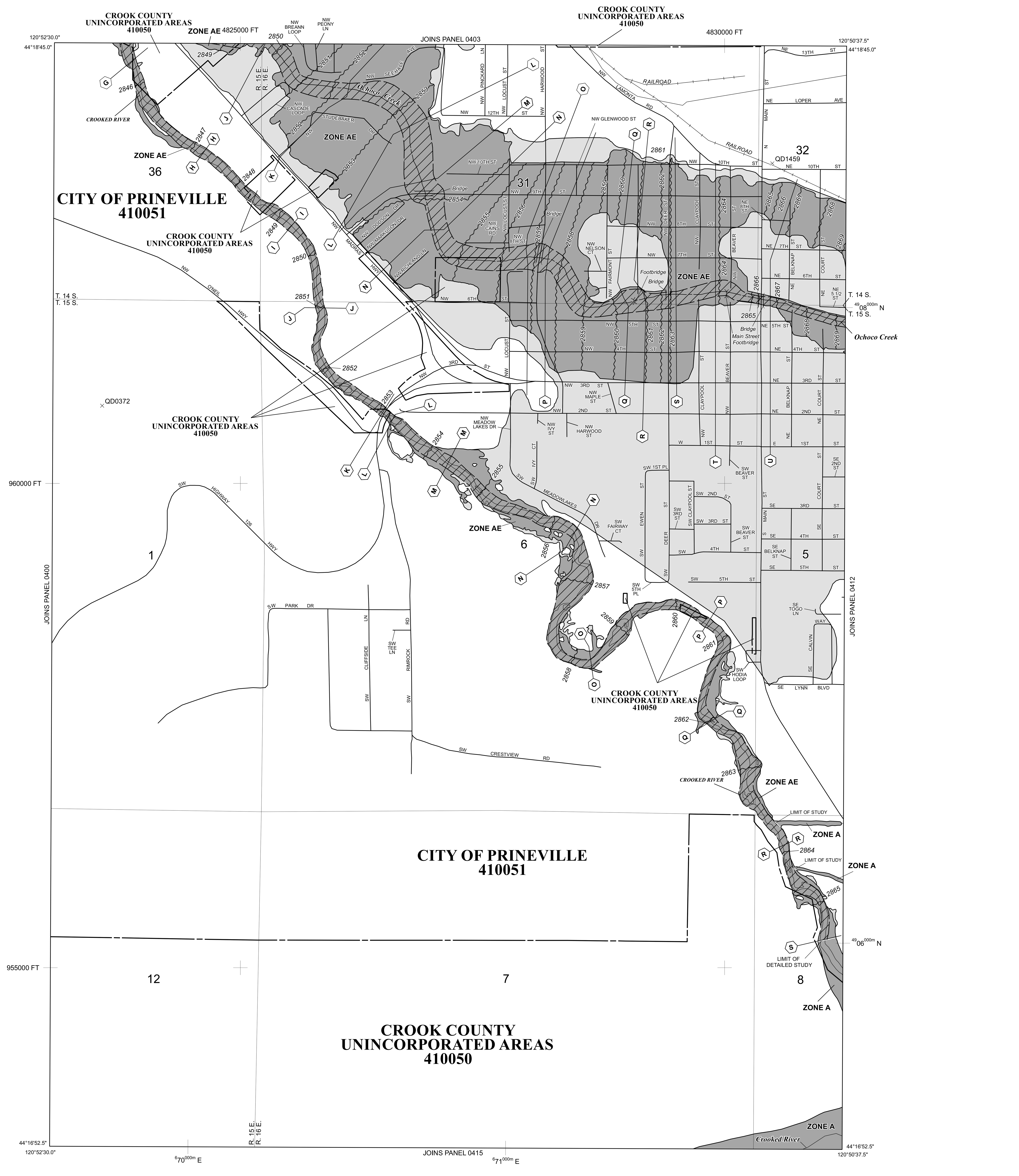

LEGEND

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ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)———(A)	Cross section line
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MAP REPOSITORIES
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FLOOD INSURANCE RATE MAP
July 17, 1989
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
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N

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250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0411C

FIRM
FLOOD INSURANCE RATE MAP

CROOK COUNTY, OREGON
AND INCORPORATED AREAS

PANEL 411 OF 1825
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROOK COUNTY	410050	0411	C
PRINEVILLE, CITY OF	410051	0411	C

PRELIMINARY
APRIL 30, 2010

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MAP NUMBER
41013C0411C

MAP REVISED

Federal Emergency Management Agency

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Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Oregon State Plane south zone (FIPSZONE 3602). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242,** or visit its website at http://www.ngs.noaa.gov/.

Base map information shown on this FIRM was derived from multiple sources. Base map files were provided in digital format by Crook County GIS Department. This information was photogrammetrically compiled at a scale of 1:2000 from aerial photography dated 2003 and 2005.

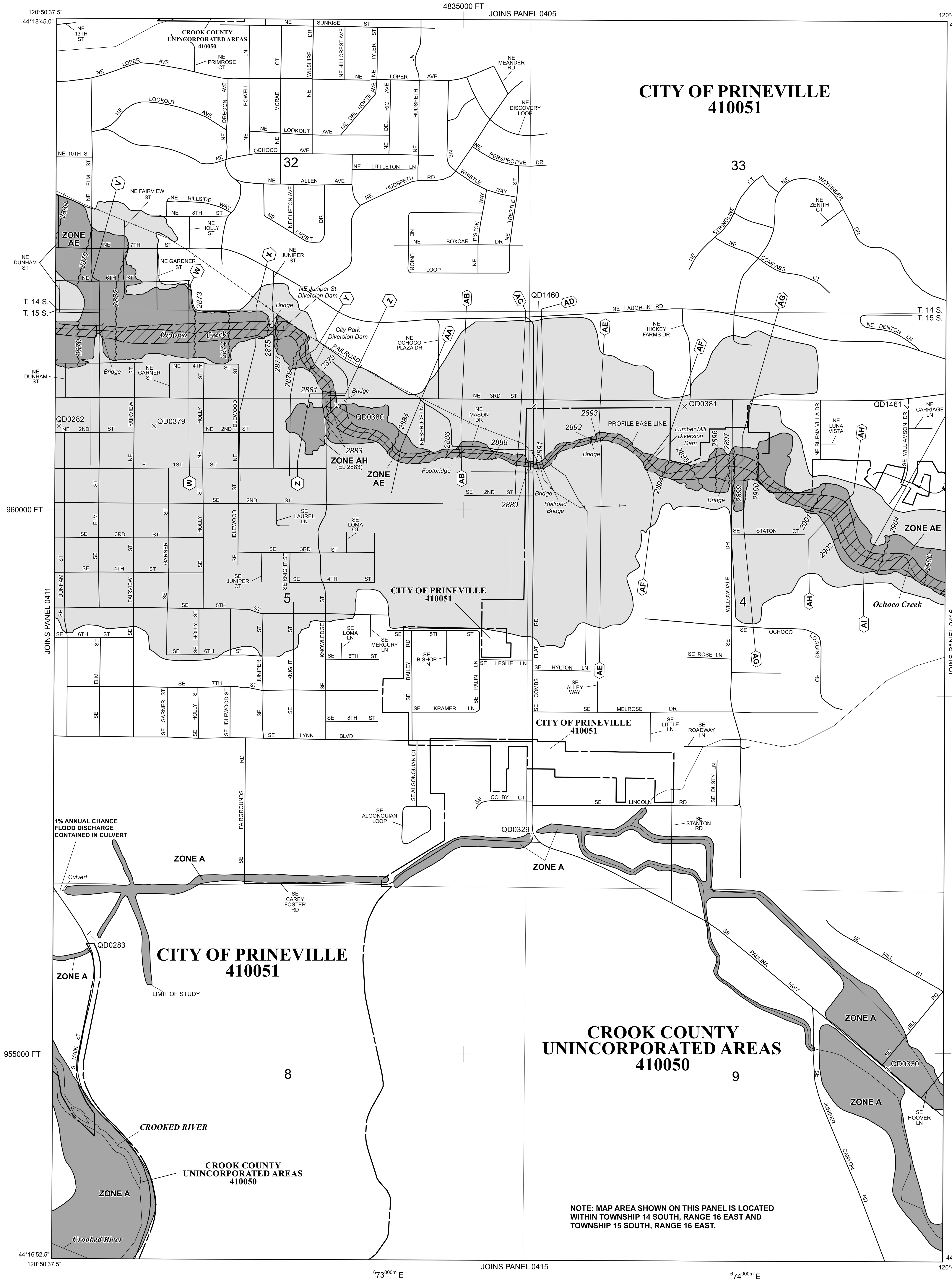
This map reflects more detailed and up- to- date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data*) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de- annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1- 877- FEMA MAP** (1- 877- 336- 2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 10
6000000 FT	5000-foot grid ticks: Oregon State Plane coordinate system, south zone (FIPSZONE 3602), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 17, 1989
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
__________ - to update corporate limits, to change Base Flood Elevations, to change Special Flood Hazard Areas, and to add roads and road names.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1- 800- 638- 6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0412C

FIRM
FLOOD INSURANCE RATE MAP

CROOK COUNTY, OREGON
AND INCORPORATED AREAS

PANEL 412 OF 1825
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROOK COUNTY	410050	0412	C
PRINEVILLE, CITY OF	410051	0412	C

PRELIMINARY
APRIL 30, 2010

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
41013C0412C
MAP REVISED

Federal Emergency Management Agency

APPENDIX 4.1

Table of Contents from
Central Oregon Stormwater Manual
Central Oregon Intergovernmental Council
Updated August 2010

Central Oregon Stormwater Manual

Developed in Conjunction With:

Crook County
Deschutes County
City of Bend
City of Madras
City of Prineville
City of Redmond
City of Sisters
Oregon Association of Clean Water Agencies
Central Oregon Community Investment Board

Updated August 2010

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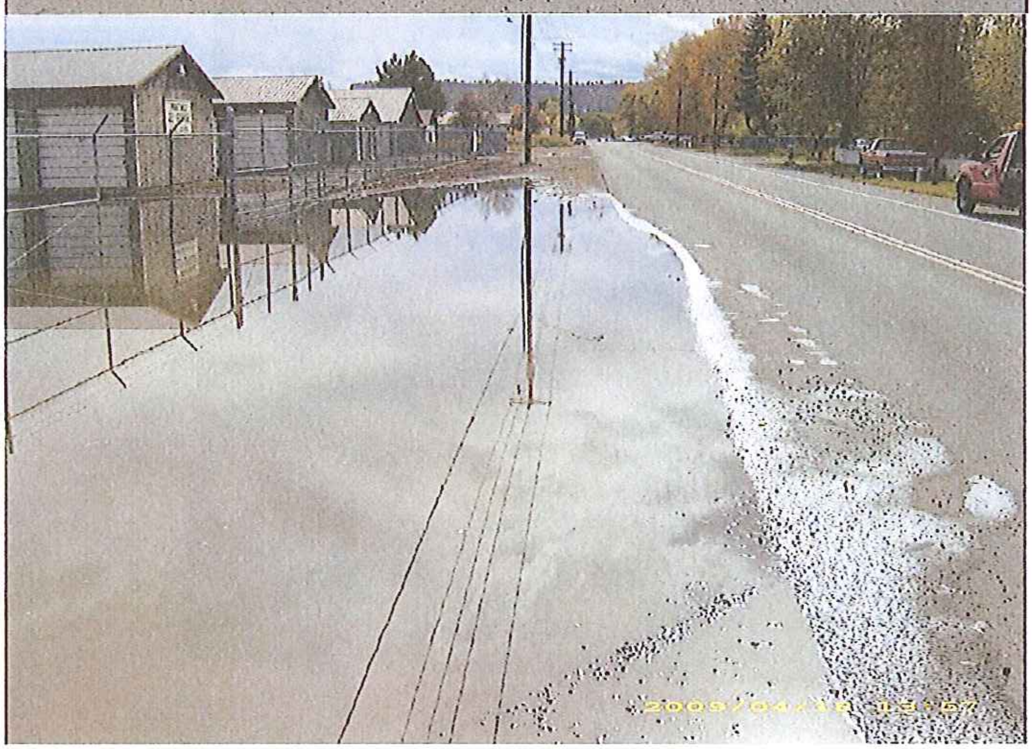
APPENDIX 5.1

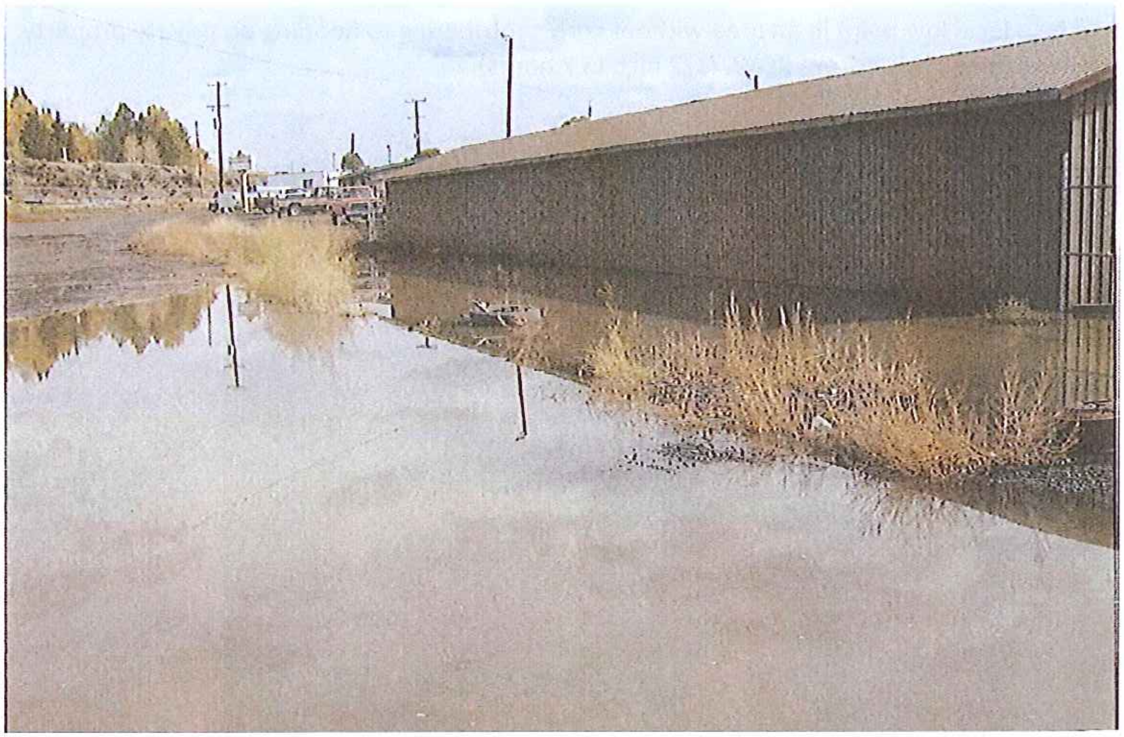
Problem Area Photographs and Supplemental Information

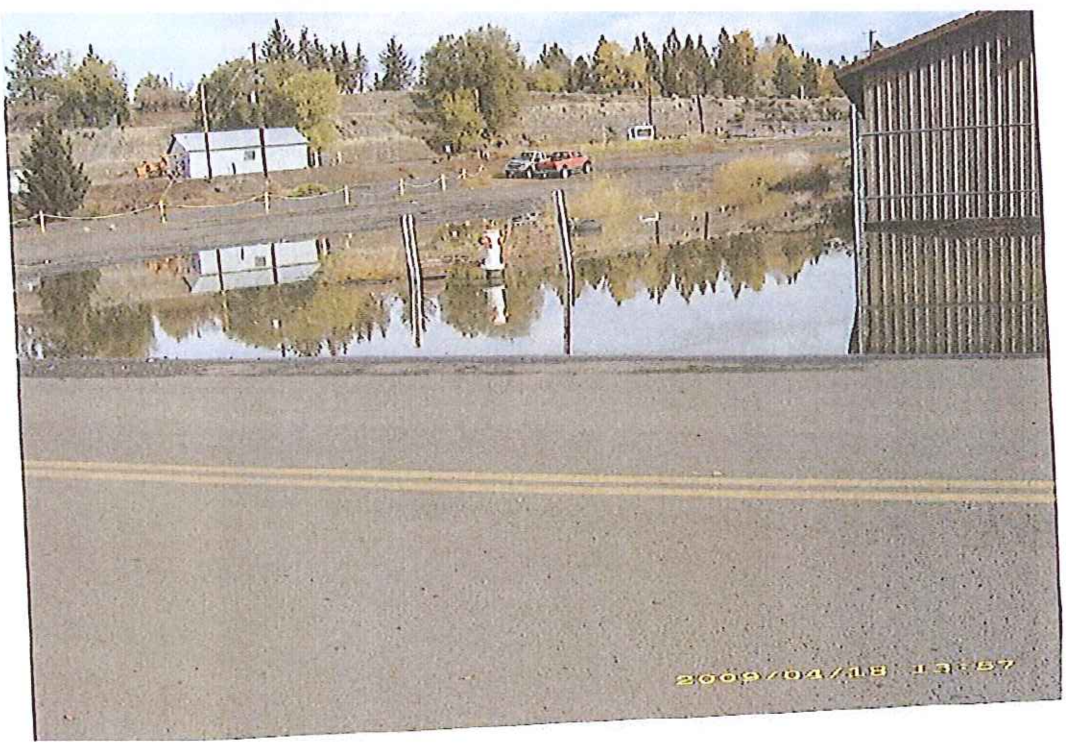
A.

This appears to be a local low point in an area without curb contributing to flooding on private property. It is difficult to determine impact from ROW. (1/2 inch in 7 hours)



A. (cont.)





B.

C.

The inverted siphon across this road is causing the issues. The area around the downstream end of the siphon was raised with road improvements causing the ponding prior to reaching an elevation which it can flow to the creek. (3/4 inch in 9 hours)

C. (cont.)

D.

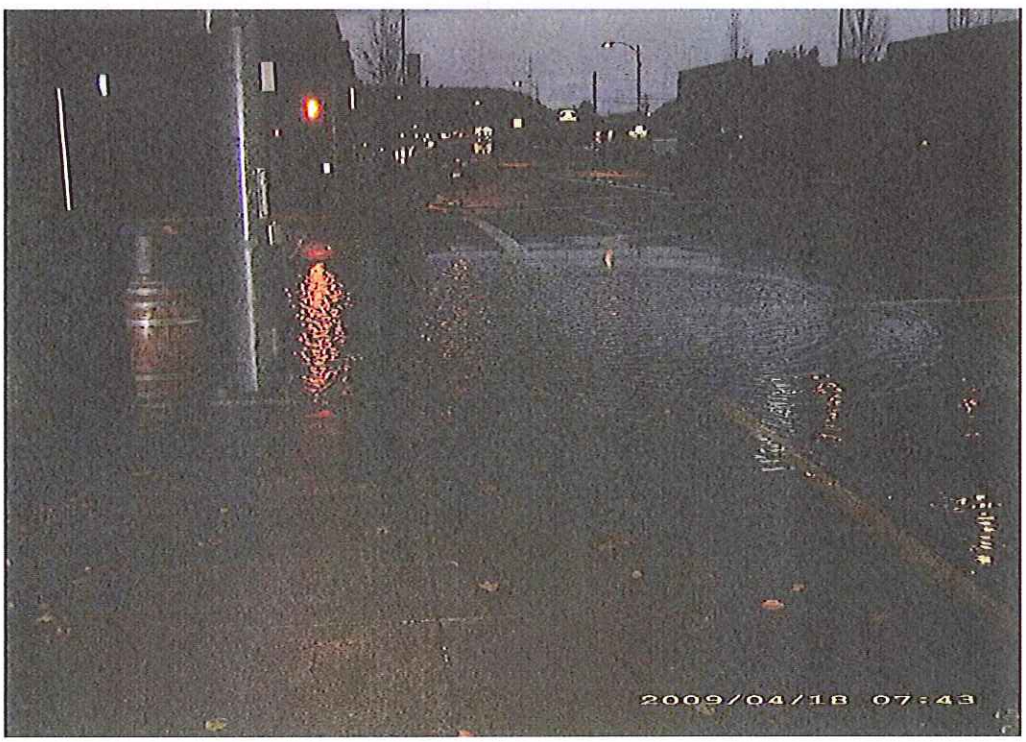
Existing storm drain main line is 6" diameter is located extremely close to the catch basins on the east side of Main Street. This is a maintenance and capacity issue.

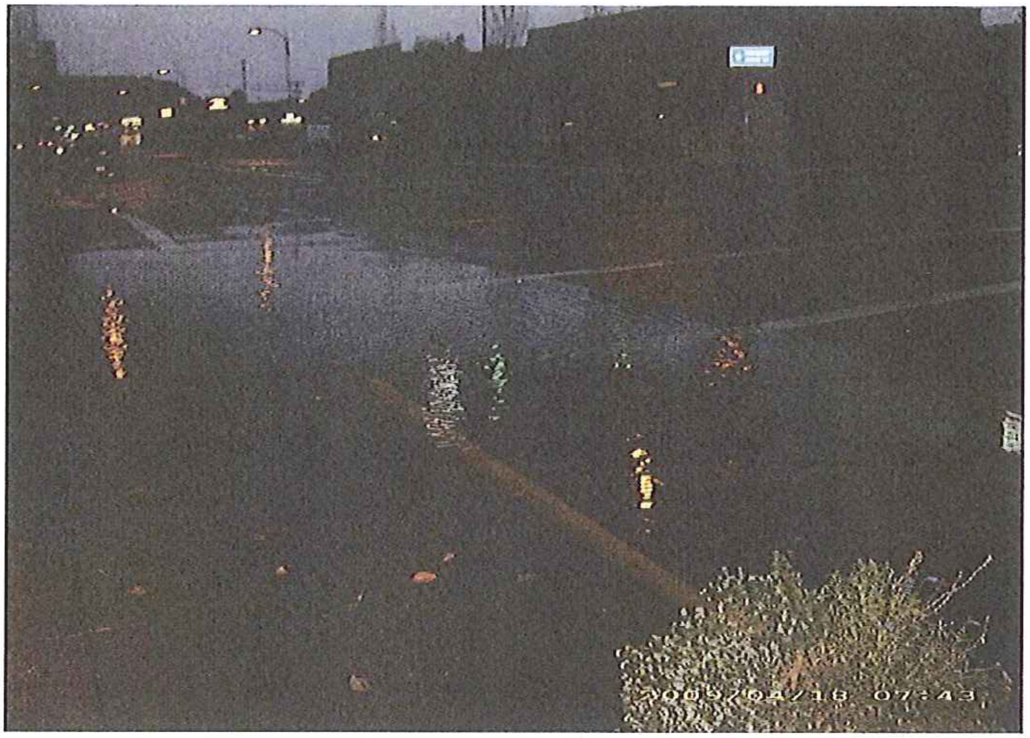
E.

Pipe capacity creates backup flooding issues onto private property. Flooding occurs on the NE corner of 6th Street and Elm Street/Fairview Street.

F.

Flooding during heavy rains is pipe capacity related. Based upon conversations with City staff, the issue comes from a bottle neck reduction in pipe size immediately downstream from the Main St. and 3rd St. intersection. This also impact problem area G. (1/2 inch in 7 hours)





G.

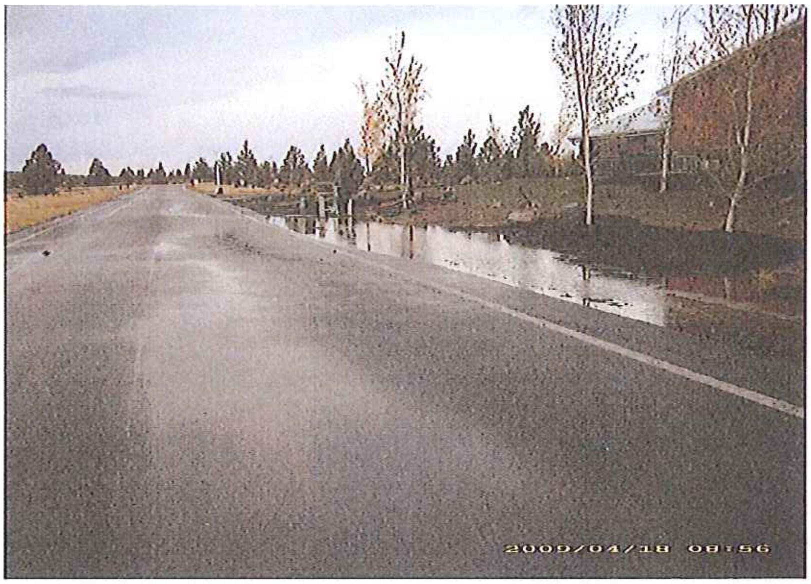
Flooding occurs in the alley and causes damage to adjacent basement areas. Based upon conversations with City staff, it appears the French drain disposal system at the band on the NW corner of Main St. and 3rd St. has been reduced in capacity over years of use. This area now contributes to an existing problem in the alley. Current decision is to grade the alley to drain to Beaver St. If problem area F is resolved, these areas could pipe to the main in 3rd St. to alleviate this problem.

H.

Appears a private pond is overflowing to public right of way without an overflow channel. Sizing of pond is unknown. (1/2 inch in 7 hours)

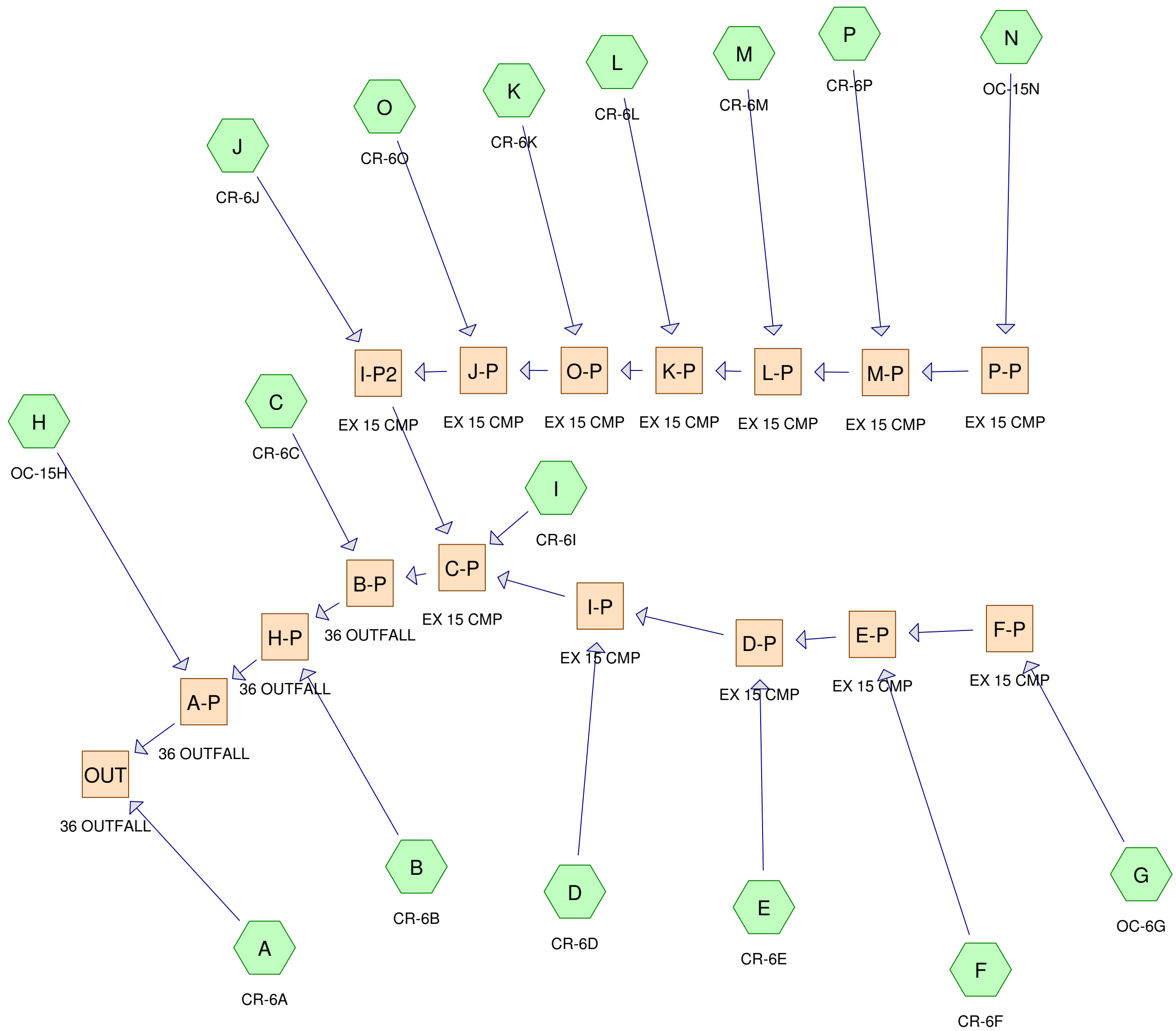
I.

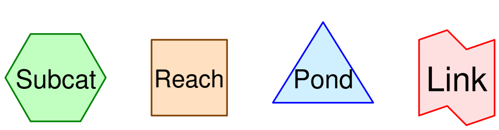
Drainage swale along uncurbed roadway is full after storm. (1/2 inch in 7 hours)



APPENDIX 6.1

Sample HydroCAD Model Output
Basin CR-6, Existing Conditions,
2-year, 24-hour Storm Event





Drainage Diagram for Basin CR6

Prepared by {enter your company name here}, Printed 10/18/2010

HydroCAD® 9.10 s/n 02799 © 2009 HydroCAD Software Solutions LLC

Summary for Subcatchment A: CR-6A

Runoff = 0.25 cfs @ 10.05 hrs, Volume= 0.080 af, Depth= 0.38"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
83,250	75	1/4 acre lots, 38% imp, HSG B
27,850	87	1/4 acre lots, 38% imp, HSG D
111,100	78	Weighted Average
68,882	66	62.00% Pervious Area
42,218	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
50.7	200	0.0050	0.07		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
51.1	300	Total			

Summary for Subcatchment B: CR-6B

Runoff = 0.42 cfs @ 10.06 hrs, Volume= 0.169 af, Depth= 0.43"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
163,100	87	1/4 acre lots, 38% imp, HSG D
43,225	75	1/4 acre lots, 38% imp, HSG B
206,325	84	Weighted Average
127,922	76	62.00% Pervious Area
78,404	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	320	0.0050	1.06		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
50.7	200	0.0050	0.07		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
2.2	150	0.0030	1.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.8	140	0.0050	1.27	0.44	**Pipe Channel,** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.025 Corrugated metal
59.7	810	Total			

Summary for Subcatchment C: CR-6C

Runoff = 3.18 cfs @ 10.07 hrs, Volume= 1.365 af, Depth= 0.41"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
688,700	75	1/4 acre lots, 38% imp, HSG B
1,067,970	87	1/4 acre lots, 38% imp, HSG D
1,756,670	82	Weighted Average
1,089,135	73	62.00% Pervious Area
667,535	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.7	3,675	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
29.1	100	0.0050	0.06		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
71.8	3,775	Total			

Summary for Subcatchment D: CR-6D

Runoff = 1.31 cfs @ 10.07 hrs, Volume= 0.551 af, Depth= 0.45"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
585,900	87	1/4 acre lots, 38% imp, HSG D
58,750	75	1/4 acre lots, 38% imp, HSG B
644,650	86	Weighted Average
399,683	78	62.00% Pervious Area
244,967	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.0	1,120	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
48.0	290	0.0120	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
61.0	1,410	Total			

Summary for Subcatchment E: CR-6E

Runoff = 0.78 cfs @ 10.06 hrs, Volume= 0.272 af, Depth= 0.38"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
232,000	75	1/4 acre lots, 38% imp, HSG B
139,000	87	1/4 acre lots, 38% imp, HSG D
371,000	79	Weighted Average
230,020	68	62.00% Pervious Area
140,980	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.7	217	0.0090	0.08		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
4.3	370	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
9.4	750	0.0080	1.33	0.26	**Pipe Channel,** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.025
56.4	1,337	Total			

Summary for Subcatchment F: CR-6F

Runoff = 0.80 cfs @ 10.06 hrs, Volume= 0.277 af, Depth= 0.38"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
235,000	75	1/4 acre lots, 38% imp, HSG B
143,000	87	1/4 acre lots, 38% imp, HSG D
378,000	80	Weighted Average
234,360	68	62.00% Pervious Area
143,640	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
47.4	260	0.0100	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
8.8	956	0.0080	1.82		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
56.2	1,216	Total			

Summary for Subcatchment G: OC-6G

Runoff = 2.61 cfs @ 10.05 hrs, Volume= 1.091 af, Depth= 0.37"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
1,522,900	75	1/4 acre lots, 38% imp, HSG B
944,198	61	62.00% Pervious Area
578,702	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.7	1,756	0.0050	1.14		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
46.9	230	0.0080	0.08		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
4.9	600	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
77.5	2,586	Total			

Summary for Subcatchment H: OC-15H

Runoff = 1.11 cfs @ 10.06 hrs, Volume= 0.431 af, Depth= 0.39"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
290,000	87	1/4 acre lots, 38% imp, HSG D
280,000	75	1/4 acre lots, 38% imp, HSG B
570,000	81	Weighted Average
353,400	71	62.00% Pervious Area
216,600	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	730	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
55.4	200	0.0040	0.06		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
63.9	930	Total			

Summary for Subcatchment I: CR-6I

Runoff = 1.18 cfs @ 10.04 hrs, Volume= 0.364 af, Depth= 0.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
405,000	87	1/4 acre lots, 38% imp, HSG D
251,100	80	62.00% Pervious Area
153,900	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	455	0.0060	1.57		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
24.3	80	0.0050	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
6.4	490	0.0050	1.27	0.44	**Pipe Channel,** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.025
35.5	1,025	Total			

Summary for Subcatchment J: CR-6J

Runoff = 0.71 cfs @ 10.02 hrs, Volume= 0.192 af, Depth= 0.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
214,280	87	1/4 acre lots, 38% imp, HSG D
132,854	80	62.00% Pervious Area
81,426	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	630	0.0030	1.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
19.3	120	0.0200	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
28.7	750	Total			

Summary for Subcatchment K: CR-6K

Runoff = 0.65 cfs @ 10.07 hrs, Volume= 0.269 af, Depth= 0.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
300,000	87	1/4 acre lots, 38% imp, HSG D
186,000	80	62.00% Pervious Area
114,000	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	460	0.0020	0.91		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
48.6	85	0.0010	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
57.0	545	Total			

Summary for Subcatchment L: CR-6L

Runoff = 0.65 cfs @ 10.06 hrs, Volume= 0.262 af, Depth= 0.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
292,000	87	1/4 acre lots, 38% imp, HSG D
181,040	80	62.00% Pervious Area
110,960	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	545	0.0030	1.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
46.7	140	0.0030	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
54.9	685	Total			

Summary for Subcatchment M: CR-6M

Runoff = 1.04 cfs @ 10.05 hrs, Volume= 0.454 af, Depth= 0.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
505,880	87	1/4 acre lots, 38% imp, HSG D
313,646	80	62.00% Pervious Area
192,234	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6	1,203	0.0040	1.28		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
47.1	200	0.0060	0.07		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
62.7	1,403	Total			

Summary for Subcatchment N: OC-15N

Runoff = 2.74 cfs @ 10.06 hrs, Volume= 1.032 af, Depth= 0.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
1,148,500	87	1/4 acre lots, 38% imp, HSG D
712,070	80	62.00% Pervious Area
436,430	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	960	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
25.5	120	0.0100	0.08		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
8.8	600	0.0040	1.14	0.40	**Pipe Channel,** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.025
4.0	330	0.0025	1.37	1.68	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.025
49.4	2,010	Total			

Summary for Subcatchment O: CR-6O

Runoff = 0.86 cfs @ 10.02 hrs, Volume= 0.233 af, Depth= 0.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
259,770	87	1/4 acre lots, 38% imp, HSG D
161,057	80	62.00% Pervious Area
98,713	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	630	0.0030	1.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
19.3	120	0.0200	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
28.7	750	Total			

Summary for Subcatchment P: CR-6P

Runoff = 0.67 cfs @ 10.06 hrs, Volume= 0.270 af, Depth= 0.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Type I 24-hr 2Yr/24 Hr Rainfall=1.20"

Area (sf)	CN	Description
300,700	87	1/4 acre lots, 38% imp, HSG D
186,434	80	62.00% Pervious Area
114,266	98	38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	545	0.0030	1.11		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
46.7	140	0.0030	0.05		**Sheet Flow,** Grass: Short n= 0.150 P2= 1.10"
54.9	685	Total			

Summary for Reach A-P: 36 OUTFALL

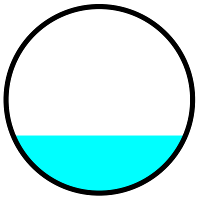
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach H-P OUTLET depth by 0.09' @ 10.20 hrs

Inflow Area = 203.757 ac, 38.00% Impervious, Inflow Depth = 0.43" for 2Yr/24 Hr event
Inflow = 6.51 cfs @ 10.17 hrs, Volume= 7.233 af
Outflow = 6.50 cfs @ 10.22 hrs, Volume= 7.233 af, Atten= 0%, Lag= 3.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.52 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 2.16 fps, Avg. Travel Time= 2.3 min

Peak Storage= 554 cf @ 10.20 hrs
Average Depth at Peak Storage= 0.92'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 31.66 cfs

36.0" Round Pipe
n= 0.015
Length= 300.0' Slope= 0.0030 '/'
Inlet Invert= 57.24', Outlet Invert= 56.34'



Summary for Reach B-P: 36 OUTFALL

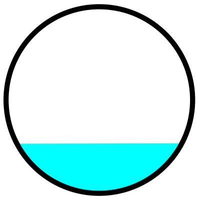
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 185.935 ac, 38.00% Impervious, Inflow Depth = 0.43" for 2Yr/24 Hr event
Inflow = 5.03 cfs @ 10.07 hrs, Volume= 6.633 af
Outflow = 5.01 cfs @ 10.18 hrs, Volume= 6.633 af, Atten= 0%, Lag= 6.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.31 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 2.15 fps, Avg. Travel Time= 4.6 min

Peak Storage= 907 cf @ 10.13 hrs
Average Depth at Peak Storage= 0.80'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 32.18 cfs

36.0" Round Pipe
n= 0.015
Length= 600.0' Slope= 0.0031 '/'
Inlet Invert= 59.36', Outlet Invert= 57.50'



Summary for Reach C-P: EX 15 CMP

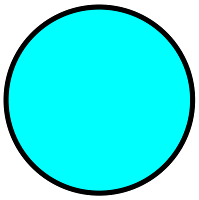
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 273% of Manning's capacity
[76] Warning: Detained 2.464 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach I-P OUTLET depth by 1.24' @ 41.20 hrs
[63] Warning: Exceeded Reach I-P2 INLET depth by 0.05' @ 41.20 hrs

Inflow Area = 145.608 ac, 38.00% Impervious, Inflow Depth = 0.43" for 2Yr/24 Hr event
Inflow = 5.04 cfs @ 10.29 hrs, Volume= 5.268 af
Outflow = 1.98 cfs @ 9.13 hrs, Volume= 5.268 af, Atten= 61%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.71 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 1.16 fps, Avg. Travel Time= 3.8 min

Peak Storage= 325 cf @ 9.15 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 1.85 cfs

15.0" Round Pipe
n= 0.025
Length= 265.0' Slope= 0.0030 '/'
Inlet Invert= 62.23', Outlet Invert= 61.43'



Summary for Reach D-P: EX 15 CMP

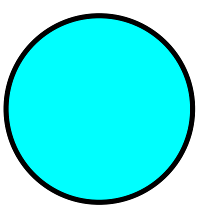
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 143% of Manning's capacity
[76] Warning: Detained 0.138 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach E-P OUTLET depth by 0.74' @ 16.45 hrs

Inflow Area = 52.156 ac, 38.00% Impervious, Inflow Depth = 0.38" for 2Yr/24 Hr event
Inflow = 2.62 cfs @ 10.06 hrs, Volume= 1.640 af
Outflow = 1.95 cfs @ 16.66 hrs, Volume= 1.640 af, Atten= 26%, Lag= 396.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.71 fps, Min. Travel Time= 9.8 min
Avg. Velocity = 0.83 fps, Avg. Travel Time= 20.1 min

Peak Storage= 1,227 cf @ 10.05 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 1.84 cfs

15.0" Round Pipe
n= 0.025
Length= 1,000.0' Slope= 0.0030 '/'
Inlet Invert= 70.45', Outlet Invert= 67.45'



Summary for Reach E-P: EX 15 CMP

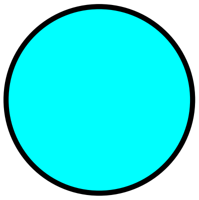
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 144% of Manning's capacity
[76] Warning: Detained 0.116 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach F-P OUTLET depth by 0.72' @ 14.70 hrs

Inflow Area = 43.639 ac, 38.00% Impervious, Inflow Depth = 0.38" for 2Yr/24 Hr event
Inflow = 2.64 cfs @ 10.06 hrs, Volume= 1.368 af
Outflow = 1.84 cfs @ 9.95 hrs, Volume= 1.368 af, Atten= 30%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.71 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.87 fps, Avg. Travel Time= 5.3 min

Peak Storage= 340 cf @ 9.95 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 1.84 cfs

15.0" Round Pipe
n= 0.025
Length= 277.0' Slope= 0.0030 '/'
Inlet Invert= 71.28', Outlet Invert= 70.45'



Summary for Reach F-P: EX 15 CMP

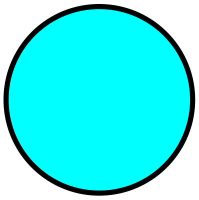
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 142% of Manning's capacity
[76] Warning: Detained 0.052 af (Pond w/culvert advised)

Inflow Area = 34.961 ac, 38.00% Impervious, Inflow Depth = 0.37" for 2Yr/24 Hr event
Inflow = 2.61 cfs @ 10.05 hrs, Volume= 1.091 af
Outflow = 1.84 cfs @ 10.00 hrs, Volume= 1.091 af, Atten= 30%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.71 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 5.9 min

Peak Storage= 368 cf @ 9.95 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 1.84 cfs

15.0" Round Pipe
n= 0.025
Length= 300.0' Slope= 0.0030 '/'
Inlet Invert= 72.18', Outlet Invert= 71.28'



Summary for Reach H-P: 36 OUTFALL

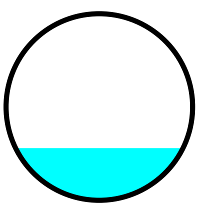
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach B-P OUTLET depth by 0.11' @ 41.40 hrs

Inflow Area = 190.672 ac, 38.00% Impervious, Inflow Depth = 0.43" for 2Yr/24 Hr event
Inflow = 5.42 cfs @ 10.17 hrs, Volume= 6.802 af
Outflow = 5.41 cfs @ 10.20 hrs, Volume= 6.802 af, Atten= 0%, Lag= 1.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.37 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.15 fps, Avg. Travel Time= 0.7 min

Peak Storage= 137 cf @ 10.18 hrs
Average Depth at Peak Storage= 0.84'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 31.97 cfs

36.0" Round Pipe
n= 0.015
Length= 85.0' Slope= 0.0031 '/'
Inlet Invert= 57.50', Outlet Invert= 57.24'



Summary for Reach I-P: EX 15 CMP

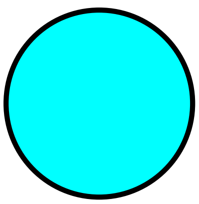
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 175% of Manning's capacity
[76] Warning: Detained 0.316 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach D-P OUTLET depth by 0.78' @ 20.80 hrs

Inflow Area = 66.955 ac, 38.00% Impervious, Inflow Depth = 0.39" for 2Yr/24 Hr event
Inflow = 3.22 cfs @ 10.15 hrs, Volume= 2.191 af
Outflow = 1.97 cfs @ 21.16 hrs, Volume= 2.191 af, Atten= 39%, Lag= 660.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.71 fps, Min. Travel Time= 17.0 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 38.2 min

Peak Storage= 2,135 cf @ 10.05 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 1.84 cfs

15.0" Round Pipe
n= 0.025
Length= 1,740.0' Slope= 0.0030 '/'
Inlet Invert= 67.45', Outlet Invert= 62.23'



Summary for Reach I-P2: EX 15 CMP

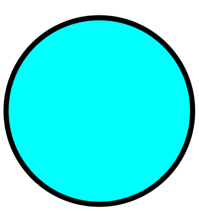
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 138% of Manning's capacity
[76] Warning: Detained 0.144 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach J-P OUTLET depth by 0.70' @ 22.50 hrs

Inflow Area = 69.356 ac, 38.00% Impervious, Inflow Depth = 0.47" for 2Yr/24 Hr event
Inflow = 2.93 cfs @ 9.96 hrs, Volume= 2.713 af
Outflow = 2.16 cfs @ 9.92 hrs, Volume= 2.713 af, Atten= 26%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.97 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 1.10 fps, Avg. Travel Time= 4.6 min

Peak Storage= 368 cf @ 9.90 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 2.12 cfs

15.0" Round Pipe
n= 0.025
Length= 300.0' Slope= 0.0040 '/'
Inlet Invert= 63.43', Outlet Invert= 62.23'



Summary for Reach J-P: EX 15 CMP

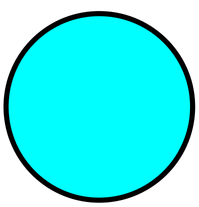
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 140% of Manning's capacity
[76] Warning: Detained 0.156 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach O-P OUTLET depth by 0.68' @ 20.85 hrs

Inflow Area = 64.436 ac, 38.00% Impervious, Inflow Depth = 0.47" for 2Yr/24 Hr event
Inflow = 2.98 cfs @ 10.02 hrs, Volume= 2.521 af
Outflow = 2.27 cfs @ 9.95 hrs, Volume= 2.521 af, Atten= 24%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.97 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 1.10 fps, Avg. Travel Time= 5.5 min

Peak Storage= 442 cf @ 9.95 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 2.12 cfs

15.0" Round Pipe
n= 0.025
Length= 360.0' Slope= 0.0040 '/'
Inlet Invert= 64.87', Outlet Invert= 63.43'



Summary for Reach K-P: EX 15 CMP

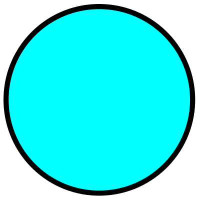
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 137% of Manning's capacity
[76] Warning: Detained 0.138 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach L-P OUTLET depth by 0.68' @ 16.95 hrs

Inflow Area = 51.586 ac, 38.00% Impervious, Inflow Depth = 0.47" for 2Yr/24 Hr event
Inflow = 2.91 cfs @ 10.01 hrs, Volume= 2.018 af
Outflow = 2.27 cfs @ 10.00 hrs, Volume= 2.018 af, Atten= 22%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.97 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 4.7 min

Peak Storage= 387 cf @ 10.00 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 2.12 cfs

15.0" Round Pipe
n= 0.025
Length= 315.0' Slope= 0.0040 '/'
Inlet Invert= 67.39', Outlet Invert= 66.13'



Summary for Reach L-P: EX 15 CMP

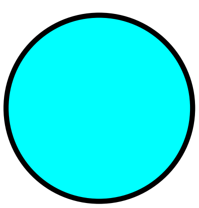
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 149% of Manning's capacity
[76] Warning: Detained 0.171 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach M-P OUTLET depth by 0.54' @ 15.25 hrs

Inflow Area = 44.882 ac, 38.00% Impervious, Inflow Depth = 0.47" for 2Yr/24 Hr event
Inflow = 3.16 cfs @ 10.05 hrs, Volume= 1.756 af
Outflow = 2.27 cfs @ 10.01 hrs, Volume= 1.756 af, Atten= 28%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.97 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 1.10 fps, Avg. Travel Time= 4.8 min

Peak Storage= 387 cf @ 10.00 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 2.12 cfs

15.0" Round Pipe
n= 0.025
Length= 315.0' Slope= 0.0040 '/'
Inlet Invert= 68.65', Outlet Invert= 67.39'



Summary for Reach M-P: EX 15 CMP

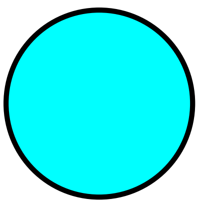
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 132% of Manning's capacity
[76] Warning: Detained 0.068 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach P-P OUTLET depth by 0.66' @ 12.75 hrs

Inflow Area = 33.269 ac, 38.00% Impervious, Inflow Depth = 0.47" for 2Yr/24 Hr event
Inflow = 2.80 cfs @ 10.05 hrs, Volume= 1.302 af
Outflow = 2.16 cfs @ 12.85 hrs, Volume= 1.302 af, Atten= 23%, Lag= 168.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.97 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 5.0 min

Peak Storage= 387 cf @ 10.00 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 2.12 cfs

15.0" Round Pipe
n= 0.025
Length= 315.0' Slope= 0.0040 '/'
Inlet Invert= 70.11', Outlet Invert= 68.85'



Summary for Reach O-P: EX 15 CMP

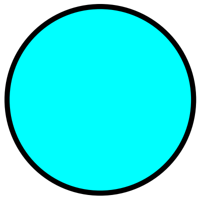
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 137% of Manning's capacity
[76] Warning: Detained 0.164 af (Pond w/culvert advised)
[62] Hint: Exceeded Reach K-P OUTLET depth by 0.68' @ 19.00 hrs

Inflow Area = 58.473 ac, 38.00% Impervious, Inflow Depth = 0.47" for 2Yr/24 Hr event
Inflow = 2.91 cfs @ 10.01 hrs, Volume= 2.288 af
Outflow = 2.12 cfs @ 10.00 hrs, Volume= 2.288 af, Atten= 27%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.97 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 4.7 min

Peak Storage= 387 cf @ 9.95 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 2.12 cfs

15.0" Round Pipe
n= 0.025
Length= 315.0' Slope= 0.0040 '/'
Inlet Invert= 66.13', Outlet Invert= 64.87'



Summary for Reach OUT: 36 OUTFALL

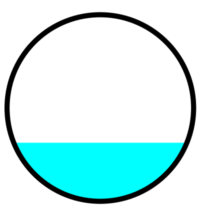
[52] Hint: Inlet/Outlet conditions not evaluated
[62] Hint: Exceeded Reach A-P OUTLET depth by 0.07' @ 41.50 hrs

Inflow Area = 206.308 ac, 38.00% Impervious, Inflow Depth = 0.43" for 2Yr/24 Hr event
Inflow = 6.74 cfs @ 10.22 hrs, Volume= 7.313 af
Outflow = 6.73 cfs @ 10.26 hrs, Volume= 7.313 af, Atten= 0%, Lag= 2.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.56 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 2.16 fps, Avg. Travel Time= 1.5 min

Peak Storage= 378 cf @ 10.24 hrs
Average Depth at Peak Storage= 0.94'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 31.66 cfs

36.0" Round Pipe
n= 0.015
Length= 200.0' Slope= 0.0030 '/'
Inlet Invert= 56.34', Outlet Invert= 55.74'



Summary for Reach P-P: EX 15 CMP

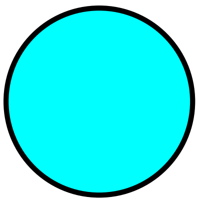
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 129% of Manning's capacity
[76] Warning: Detained 0.022 af (Pond w/culvert advised)

Inflow Area = 26.366 ac, 38.00% Impervious, Inflow Depth = 0.47" for 2Yr/24 Hr event
Inflow = 2.74 cfs @ 10.06 hrs, Volume= 1.032 af
Outflow = 2.27 cfs @ 11.44 hrs, Volume= 1.032 af, Atten= 17%, Lag= 83.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-240.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.97 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 1.03 fps, Avg. Travel Time= 5.8 min

Peak Storage= 442 cf @ 10.00 hrs
Average Depth at Peak Storage= 1.25'
Bank-Full Depth= 1.25', Capacity at Bank-Full= 2.12 cfs

15.0" Round Pipe
n= 0.025
Length= 360.0' Slope= 0.0040 '/'
Inlet Invert= 71.55', Outlet Invert= 70.11'



WHPacific

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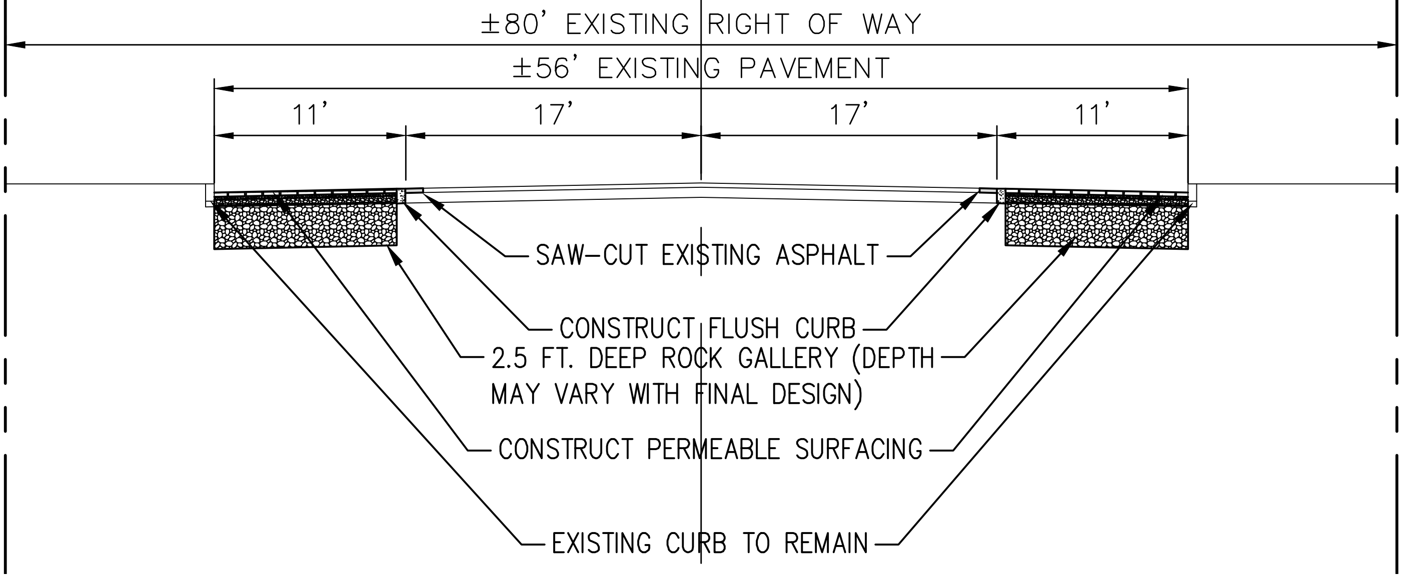
APPENDIX 7.1

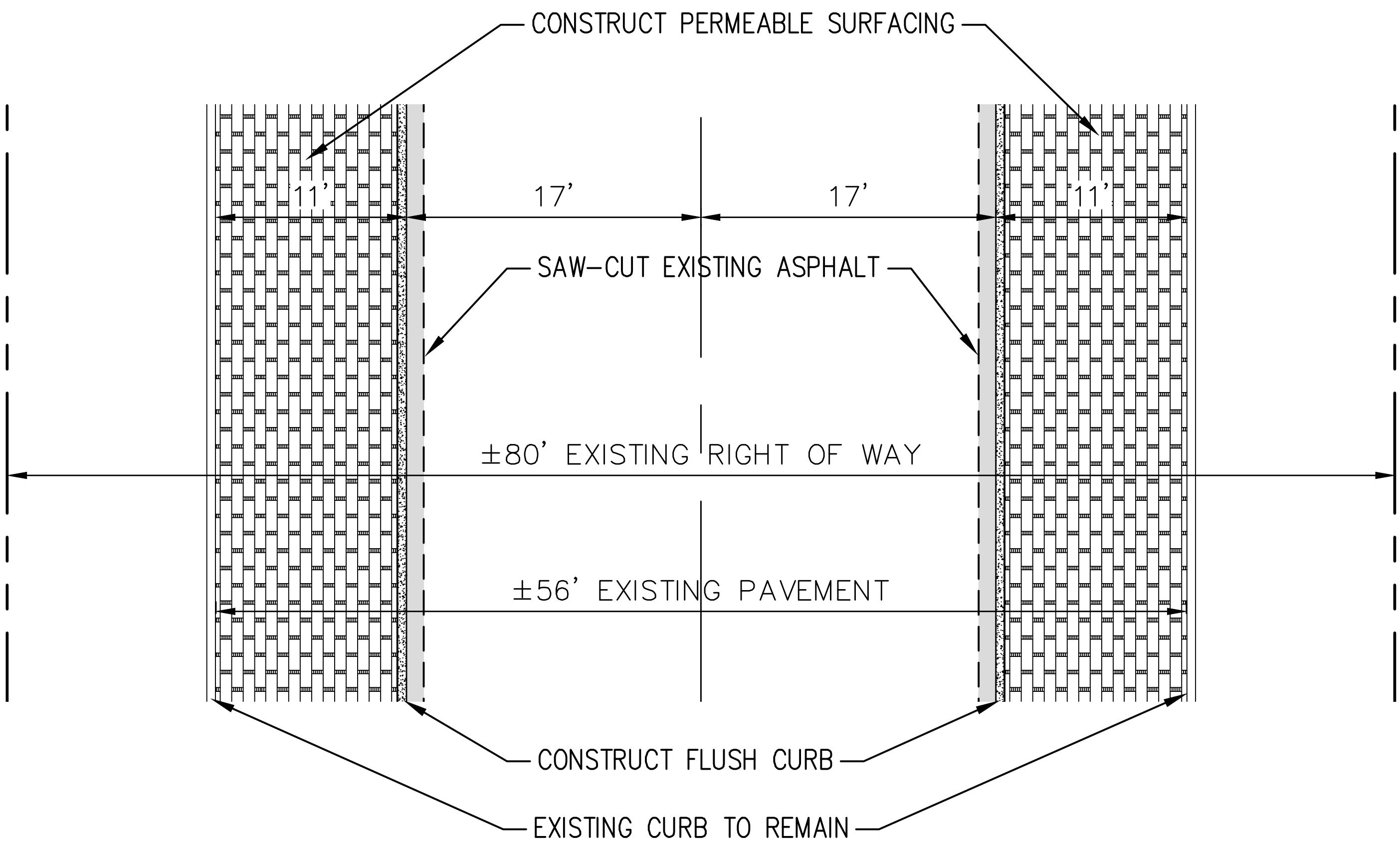
Permeable Surfacing Detail



TYPICAL PERMEABLE SECTION

1
1 OF 1

SCALE: N.T.S.



TYPICAL PERMEABLE PLAN

2
1 OF 1

SCALE: N.T.S.

DRAFT

SHEET NUMBER		DRAWING INFO	SHEET INFO		
1 of 1	BASIN CR-6 PERMEABLE SURFACING OPTIONS CITY OF PRINEVILLE STORMWATER MASTER PLAN	036612	DRAWN	JAM	WHPacific
		DRAWING1	CHECKED		
			LAST EDIT	9/23/2009	
		NTS	PLOT DATE	12/28/2010	

APPENDIX 7.2

Simple Site Methodology

1) Design Storms for simple site projects utilizing the Modified Rational Method per the COSM. **Only to be used at the discretion of the City Engineer.**
   a) Utilize the modified rational method for the detention and overflow volumes. For more complex designs, or to reduce facility size, see design parameters in #2.
   b) Complete calculations for the Water Quality Storm, Detention Storm, and Overflow Storm
      i) The Water Quality Storm shall be the 2 year 24 hour storm. Verify the facilities can hold the water quality storm without considering infiltration. The 2 year 24 hour storm event for Prineville is approximately 1.2".
      ii) The Detention Storm shall be the 50 year storm. Verify the facilities can hold the detention storm with infiltration factored in. The storm depth for the modified rational method varies based upon the following spreadsheet.
      iii) The Overflow Storm shall be the 100 year storm. Verify the facilities can hold the overflow storm with infiltration factored in. If the facilities overflow, verify the excess water is maintained onsite without causing any damage to the site. If the site overflows to the public right of way, verify the overflow does not impact existing facilities. If the overflow impacts the existing facilities, determine required upgrades to the existing public system. The storm depth for the modified rational method varies based upon the following spreadsheet.
   c) Utilize the Oregon Department of Transportation Zone 10 Rainfall Intensity – Duration-Recurrence Interval Curves (see column (3) of the worksheets).
   d) Determine the runoff area(A) for the proposed site in acres (43,560 sf/acre) and enter into column (4)
   e) Assume runoff coefficient (C) of 0.85 for developed lot (column (5)).
   f) Determine effective site runoff area (A_e) by multiplying the runoff area by the runoff coefficient (09.0*A) and insert into column (6) of the worksheets.
   g) Multiply the effective site area from column (6) and the storm intensity in column (3) and place product in column (7).
   h) Multiply the storm duration in column (2) by the inflow in column (7) by 1.34 (coefficient from the Modified Rational Method for $t_c \leq$ storm duration) to determine the runoff volume in column (8).
   i) Determine infiltration of the existing soil per testing procedures (in./hr) and place in column (9).
   j) Determine approximate area (square feet) of the proposed detention/infiltration facilities and place in column (10).
   k) Multiply column (9) and column (10) and divide by 720 (conversion from in/hr to ft/min)to determine infiltration flow rate during each storm event.
   l) Multiply column (11) and column (1) to determine infiltration volume and place in column (11).
   m) Compare the larger of the water quality design storm and the largest detention volume required as shown in column (12) for the 50 year storm to determine minimum detention facility size.
   n) Review the volumes of the 100 year storm to determine this runoff does not impact the site, neighboring properties, or downstream facilities.
2) Standard Stormwater Detention Design Criteria to Follow the Central Oregon Stormwater Manual and as follows;

a) Determine the calculation method. This can be the Santa Barbara Urban Hydrograph method, the SCS TR-20 method, or the rational method.
b) Design Storms for the SCS TR-20 and Santa Barbara Urban Hydrograph per the Oregon Isopluvial Maps.
   i) Water Quality Storm shall be the 2 year, 24 hour storm (1.2")
   ii) Detention Storm shall be the 50 year, 24 hour storm (2.2")
   iii) Overflow Storm shall be the 100 year, 24 hour storm (2.4")
c) Complete calculations for the Water Quality Storm, Detention Storm, and Overflow Storm
   i) The Water Quality Storm shall be the 2 year 24 hour storm. Verify the facilities can hold the water quality storm without considering infiltration.
   ii) The Detention Storm shall be the 50 year 24 hour storm. Verify the facilities can hold the detention storm with infiltration factored in.
   iii) The Overflow Storm shall be the 100 year 24 hour storm. Verify the facilities can hold the overflow storm with infiltration factored in. If the facilities overflow, verify the excess water is maintained onsite without causing any damage to the site. If the site overflows to the public right of way, verify the overflow does not impact existing facilities. If the overflow impacts the existing facilities, determine required upgrades to the existing public system.

An understanding of the groundwater elevation will also be important in sizing an infiltration pond in Prineville. Oregon DEQ requires a minimum of 18" of sandy soil in the bottom of a pond to get adequate treatment. The potential groundwater elevations should also be considered when sizing a detention pond for capacity. If the pond bottom is below a high water elevation, special consideration may be needed to make sure adequate storage is available above that high water elevation.

City of Prineville

In-Situ Infiltration Rate Field Test Procedure

1. Excavate an approximate 2 foot wide by 4 foot long rectangular test pit at the location of the proposed storm water facility. Extend the bottom of the pit to the approximate depth of the bottom of the proposed facility.
2. Measure and record the dimensions (length, width, depth) of the test pit. Include photographs of the test pit both before and after the test.
3. Insert an 18 inch long (min.) rebar, PVC pipe, or stake into the approximate center of the test pit. Make sure the rebar is firm in the soil. Leave approximately 16 to 18 inches of the rebar exposed above the bottom of the pit.
4. Introduce clean water into the test pit. An in-flow meter may be used for the test procedure. Fill water to a depth of approximately 12 inches in the pit. Measure the depth of water against the rebar. Record this measurement in field notes and note the time. Begin field test.
5. Adjust the flow rate into the pit to maintain the constant head level in the pit, 12 inches. Monitor the flow rate required to maintain the constant head level at appropriate intervals. In no case shall the interval exceed 15 minutes. (Alternatively, measure the volume of water dispensed into the pit every 15 minutes to maintain the 12 inch depth. Use this data to calculate flow rate).
6. Continue to maintain the constant head until a stabilized flow rate has been achieved. Consider the flow rate stable when the incremental flow rate required to maintain the head does not vary by more than 5 percent between increments. The maximum time for this portion of the test is 2 ½ hours. The intent of this section is to achieve a relatively steady-state flow condition between test durations, and to saturate soils located in the immediate vicinity of the test pit.
7. Upon completion of the constant head portion of the test, discontinue flow, note the time in field notes, and measure and record the depth of the water against the rebar every 30 minutes for a maximum time period of 4 hours. Note the time in field notes at the conclusion of the 4 hour time period.
8. Calculate the average infiltration rate based on measurements collected in the 30 minute time intervals.

   Infiltration rate = (Depth 1 (in.) – Depth 2 (in.))/0.5 hr.) for a 30 minute time period

9. Calculate the design infiltration rate using the average infiltration rate and the appropriate safety factor value given in Table 4C-1, page 4C-3, Appendix 4C of the Central Oregon Stormwater Manual. This safety factor is based on the native soil type at the site.

Table 4C-1 (from COSM) - Required Safety Factors

General Soil Type	Safety Factor
Clean Medium to Coarse Gravel or Equivalent Such as Large Granular Volcanic Pumice	2.5 (with woven geotextiles) 5.0 (with no-woven geotextiles
Sandy Gravels or Mixed Granular Pumice and Coarse Degrade Pumice	3.3
Medium to Coarse Sands or Coarse Loose Sandy Pumice	3.3
Fine Sands and Finely Degraded Pumice	1.7
Silts, Glacial Till, Volcanic Ash, Consolidated Fine Pumice	1.25

Stormwater Calculations - Modified Rational Method

Site Area		Acres
Infiltration Rate		In/Hr
Drainage Facility Area		SF

2 Year Water Quality Design Storm

2 Yr./24 Hr. Storm Depth (in.)	Site Runoff Area (Acres)	Effective site runoff area (Ae) (3)x(4)	Detention Volume Required
1.2			

Stormwater Calculations - Modified Rational Method

Site Area		Acres
Infiltration Rate		In/Hr
Drainage Facility Area		SF

50 Year Detention Storm Worksheet for Simple Sites

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Storm Duration (min.)	Storm Duration (sec.)	50 year Storm (in/hr)	Site Runoff Area (Acres)	Assumed runoff coefficient (C)	Effective site runoff area (Ae) (4)x(5)	Inflow (cfs) (3)x(6)	Runoff Volume (2)x(7)x1.34	Infiltration Rate with Safety Factor (in/hr)	Facility Area (sf)	Infiltration Flow Rate (cf/min) (9)x(10)/720	Infiltration Volume (11)x(1)	Detention Volume Required (8)-(12)
5	300	3.22		0.85								
10	600	2.45		0.85								
20	1200	1.87		0.85								
30	1800	1.48		0.85								
40	2400	1.22		0.85								
50	3000	1.05		0.85								
60	3600	0.92		0.85								
100	6000	0.61		0.85								
200	12000	0.38		0.85								
300	18000	0.28		0.85								
400	24000	0.25		0.85								

Stormwater Calculations - Modified Rational Method

Site Area		Acres
Infiltration Rate		In/Hr
Drainage Facility Area		SF

100 Year Detention Storm Worksheet for Simple Sites

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Storm Duration (min.)	Storm Duration (sec.)	100 year Storm (in/hr)	Site Runoff Area (Acres)	Assumed runoff coefficient (C)	Effective site runoff area (Ae) (4)x(5)	Inflow (cfs) (4)x(6)	Runoff Volume (2)x(7)x1.34	Infiltration Rate with Safety Factor (in/hr)	Facility Area (sf)	Infiltration Flow Rate (cf/min) (9)x(10)/720	Infiltration Volume (11)x(1)	Detention Volume Required (8)-(12)
5	300	3.70		0.85								
10	600	2.89		0.85								
20	1200	2.15		0.85								
30	1800	1.68		0.85								
40	2400	1.41		0.85								
50	3000	1.21		0.85								
60	3600	1.08		0.85								
100	6000	0.70		0.85								
200	12000	0.42		0.85								
300	18000	0.32		0.85								
400	24000	0.27		0.85								

APPENDIX 7.3

WHPacific August 13, 2010 Letter re:
Water Quality Sampling

WHPacific

August 13, 2010

Mr. Eric Klann
City of Prineville
387 NE Third Street
Prineville, Oregon 97754

Re: Prineville Stormwater Master Plan
Water Quality Sampling
WHPacific File No.: 36612.1004

Dear Eric:

As part of the overall analysis of water quality data for the Crooked River Watershed, pertaining particularly to the quality of the City of Prineville's stormwater, WHPacific has reviewed available water quality data collected from numerous sources. The data was reviewed primarily for timeframe, location and analysis performed. The multi source data was reviewed to potentially supplement the City of Prineville's non-point source stormwater sampling as part of the preparation of a Stormwater Master Plan.

WHPacific has evaluated the locations and potential analytes of concern for the water quality testing performed by various entities over the last 20 years within the Crooked River Watershed on The Crooked River and Ochoco Creek near Prineville. As a result of this evaluation, we have concluded that the locations are useful for the intended watershed reviews, but are not directly useful for the specific urban stormwater testing requirements of this project.

To be used in urban stormwater evaluations, representative samples would need to be collected during heavy storm events, both upstream and downstream from existing outfalls and further, analyses conducted, would need to include parameters typically found in urban stormwater, including Total Petroleum Hydrocarbons (TPH), total metals, and poly aromatic hydrocarbons (PAH) and volatile organic compounds (VOC). In addition, careful quality assurance/quality control (QA/QC) measures would need to be followed for the testing to be considered valid. The existing data falls short of these expectations, however portions of common data may be used as antidotal background information relevant to this project.

To better meet the goals of stormwater testing, we propose new sampling locations for the collection of future water quality data for the City of Prineville. The new locations should be at or near the Urban Growth Boundary both upstream and downstream of Prineville on the Crooked River and Ochoco Creek. Each sample location should be documented and marked by the placement of a steel fence post or other semi-permanent method. This will allow for water quality sampling locations to be established for all future sampling and will add a constant parameter to the data. The City of Prineville will need to secure access to the sampling locations for city staff and the Crook County High School (CCHS) students working on this project. WHPacific can identify the preferred sampling locations and the landowners associated with each location for the purpose of securing access. WHPacific can further assist with the facilitation of this process.

WHPacific proposes to have the CCHS students prepare a budget and work plan for one sampling event consisting of collecting water quality data at each of four sample locations (TBD). This budget will be used to evaluate the number of students involved and the student-hours each sampling event will require. The number of sampling events in which data will be attained will depend on the CCHS student budget, work plan and accessibility to the sites.

We propose the CCHS students acquire the following information by using a multi-parameter, portable water quality meter (TBD) during a sampling event. The following water quality data will be collected for each of four sample locations:

Classroom Collection

Precipitation data including dates (30 day) and amount of rainfall on those dates
River/creek flow rates at the time of sampling

Field Collection

Ambient conditions
Water temperature
Field pH
Conductivity
Dissolved oxygen
Turbidity
Etc.

The field meters must be calibrated prior to usage. The water quality data acquired will receive a QA/QC review. WHPacific is available to coordinate assistance in preparation of a data sheet for the collection of field data. WHPacific understands that field water meters are available for the CCHS students to use. The data will be used as the beginning step in acquiring baseline water quality data preceding the City of Prineville's collection of stormwater quality data.

This sampling will not only give the CCHS students an opportunity to learn about their environment but will also be a pivotal piece of acquiring reliable, water quality data for use in the evaluation of the effects of urban activities on the water quality as the water bodies flow through town. This data will help in later evaluations of the yet to be acquired stormwater data and establishing baseline water quality parameter data for later comparison.

Sincerely,

WHPacific, Inc.

Amber Hudspeth
Project Manager

WHPacific, Inc.

James Frost, P.E.
Senior Project Manager

CC: Jerry Brummer